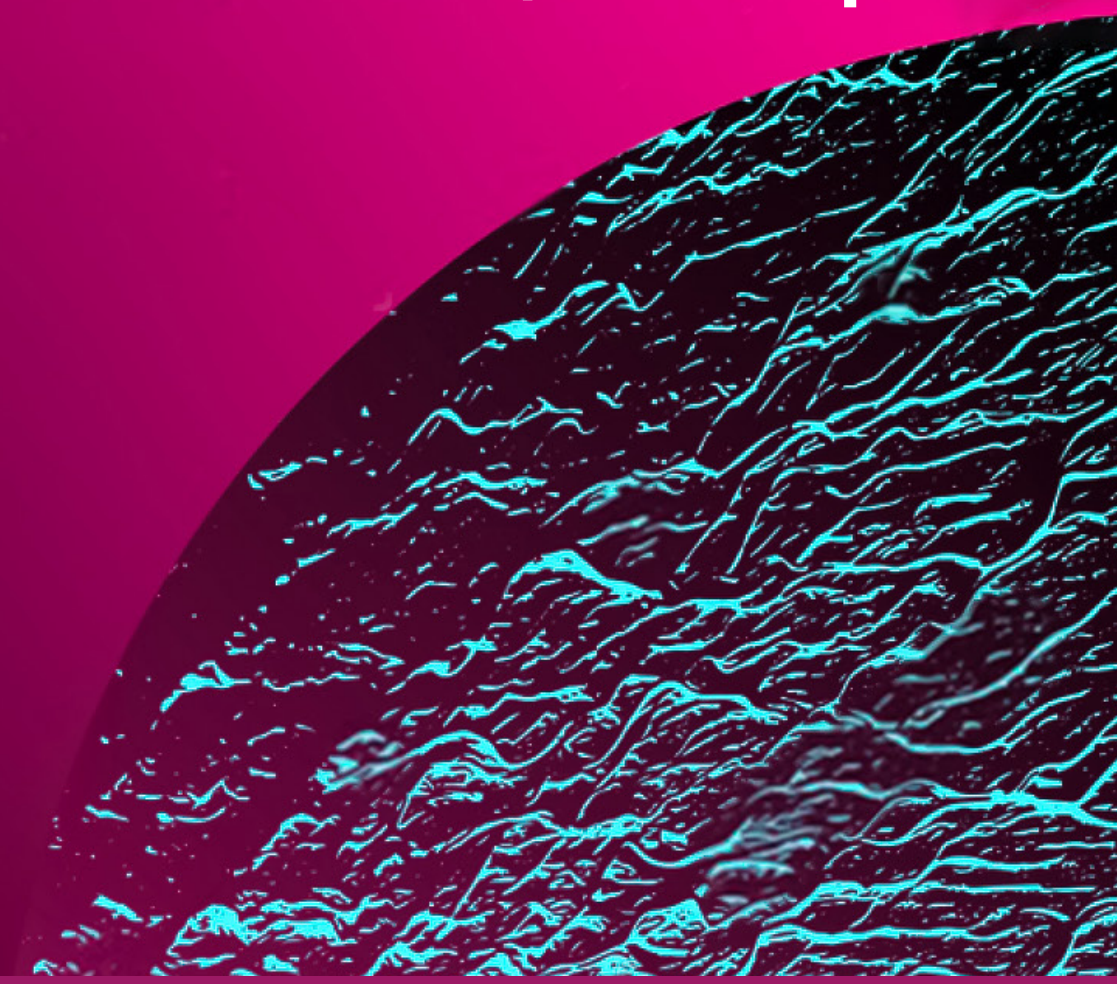
DEPARTMENT OF
SCIENCE & TECHNOLOGY
GOVERNMENT OF JAMMU AND KASHMIR

G20
भारत 2023 INDIA

DOCUMENTATION OF JKST&IC

Sponsored Research and Development Projects at IUST, Awantipora



JK SCIENCE, TECHNOLOGY & INNOVATION COUNCIL
DEPARTMENT OF SCIENCE & TECHNOLOGY, GOVERNMENT OF JAMMU & KASHMIR
www.jkstic.jk.gov.in

SPONSORED REASERCH AND EXTENSION PROGRAM

OF

Jammu and Kashmir Science Technology and Innovation Council (JKST&IC)

Department of Science & Technology
Government of Jammu & Kashmir

सत्यमेव जयते

Dr. Arun Kumar Mehta, IAS

Chief Secretary
Jammu & Kashmir

Message

I am pleased to know that the JK Science Technology & Innovation Council, under the aegis of Department of Science and Technology is bringing out a publication highlighting the findings of first year of 20 research and development projects allotted to the Islamic University of Science & Technology, Awantipora.

We are aware that a better understanding of the principles of science and advancement in technology has helped solve various problems. Researchers have made a significant contribution in understanding the causes of these problems and in developing efficient diagnostic and prognostic strategies to overcome them. This has led JK Science Technology & Innovation Council to provide an opportunity to the students, scientists, researchers, investigators and other stakeholders to be a part of an initiative to share knowledge, research, ideas, opinions, experiences and to come up with recommendations and strategies to help address various issues faced by the people of Jammu & Kashmir.

I wish JKST&IC technical committee members, scientists, delegates and participants all the best, for making this initiative intellectually productive.

Dr. Arun Kumar Mehta, IAS

Chief Secretary
Jammu & Kashmir

सत्यमेव जयते

Saurabh Bhagat, IAS
Commissioner Secretary to
Govt. Science & Technology
Department

Message

It is really a matter of pride to know that JK Science, Technology & Innovation Council is bringing out a Report on the findings of Research & Development projects being carried out by various R&D Institutions, Universities and Colleges. It gives me immense pleasure that during the year 2020-21 & 2021-22 JK Science, Technology and Innovation Council, Department of Science & Technology, J&K Government has sponsored 123 Research & Development Projects in various R&D Institutions/Universities/Colleges etc under the mentorship of Commissioner/Secretary to Government, Science & Technology Departments programme under the programme "Sponsored Research & Extension". The scheme is aimed at promotion of scientific research, studies and surveys based on the local problems of UT of J&K for arriving at a scientific solution. The programme also envisages providing of employment to good number of research scholars and students.

It is pleasant to know that during the implementation programme in various R&D Institutions, a good number of scientific infrastructures required during the research work of the project is also being created for the benefit of future scientific community of the UT.

I am glad to know that JKST&IC has sponsored 123 R&D projects during the year 2021-22 and 2022-23, out of which 20 projects have been allotted to Islamic University of Science & Technology, Awantipora, Kashmir involving an amount of Rs. 134.21 lacs.

I firmly believe that this Report will certainly provide useful scientific solutions to address problems of local importance.

I congratulate tern of officers of JK Science, Technology & Innovation Council for their sincere efforts in releasing this important Report and wish them a grant success in future endeavours.

Saurabh Bhagat, IAS

Prof. Shakil Ahmad Romshoo
Vice Chancellor

Message

I am pleased to learn that Jammu and Kashmir Science and Technology Innovation Council (JKSTIC) under the auspices of the Department of Science and Technology, Government of Jammu and Kashmir is publishing a compendium that highlights the salient outcomes from the twenty-one sponsored research projects that the Council has sanctioned for IUST.

The JKSTIC has supported extramural research projects at IUST worth Rs. 1.35 crores during 2021-22, on themes of tremendous societal, economic and scientific importance. The knowledge and outcomes from these projects have helped IUST address some of the important societal issues inter alia, nurturing an ecosystem of research, innovation and entrepreneurship within the university. Five patents, one copyright and over a score of research publications in peer reviewed national and international journals are the outcomes of these sponsored research projects. In particular, the research projects have helped us in inventing a technique for identification of hand-woven and machine-woven fabrics, detection and classification of Pashmina shawls, designing an air pump, air filter and handling unit for purifying respirator, and development of an artificial intelligence based system for pashmina artwork identification and classification.

Researchers and faculty at IUST are encouraged by the support extended by the Council to undertake high impact research in diverse areas that are crucial to science, society and economy. We look forward to working closely with JKSTIC and other government agencies to find creative and innovative solutions to some of the most pressing problems confronting the society, businesses and industry.

I therefore, take this occasion to thank the Council for their continued support and I hope that this publication will serve as a ready reference for researchers, government functionaries, businesses and industries and serve as an inspiration for them.

Prof. Shakil Ahmad Romshoo

सत्यमेव जयते

Dr NASIR SHAH
Additional Director,JKST&IC
DST J & K goverment

Introduction

I am pleased to share with you the outcomes of the research projects sponsored by JK Science Technology and Innovation Council to Islamic University of Science Technology Kashmir. The purpose of these projects was to promote research and development in various fields and to come up with recommendations that can be implemented on the ground.

The projects undertaken by the researchers at the Islamic University of Science Technology Kashmir have produced some promising results that can be utilized to address various issues faced by our society. These research projects have contributed significantly to the advancement of knowledge in different areas, including science, technology, and innovation.

The recommendations from the outcome of these scientific projects shall be presented to the government for implementation wherever required. We hope that these findings will help in shaping policies and strategies to improve the overall socio-economic conditions of our region.

We appreciate the efforts of the researchers at the Islamic University of Science Technology Kashmir and look forward to seeing more innovative projects in the future.

NASIR SHAH
Additional Director, JKST&IC
DST J & K goverment

NOTES

Sunita Razdan
Joint Director

"About the Research, Development and Extension Programme of JKST&IC Science Technology and Innovation Council under the Scheme "Sponsored Research and Extension Programme" is aimed at promoting and sponsoring small, medium and short term Scientific Research Project upto 2 years of duration and scientific surveys/studies relevant to the UT of J&K, the basis objective of the scheme is to promote quality Research among the student/ scholars to disseminate the scientific knowledge and to strive for the resolution of the various problems. The outcome/recommendation obtained from research projects are submitted to various line departments for implementation on ground. The implementation of these projects also provides employment opportunities to students/ scientific and researchers for a period of two years besides infusing interest in scientific research among them."

Sunita Razdan
Joint Director (Scheme Incharge)

NOTES

Bilal Ahmad
Joint Director

JKST&IC, Department of Science and Technology is going to publish a book on Research and Development Projects in which JKDST is going to make people aware about the modern methods to deal with basic Scientific issues and carry out research in diverse fields of Science and Technology. As the world is running so fast, it becomes a basic need to accept the challenges of it with dynamic warrants and scientific solutions.

JKST&IC created an opportunity for the students, scientists, researchers, investigators and many other stake holders to share their findings, ideas, deliberations, researches and progresses in R&D Projects/ Innovations. I am sure that this initiative will prove fruitful to all and inspire many other young scientists and scholars to collaborate with us in scientific research and studies.

I am confident that such Projects/ programmes will open a vide vista platform in promoting scientific researches and innovations and further inculcating scientific temper among the academician and masses.

I firmly believe that this Report will certainly provide useful information about the scientific solutions to the problems of local importance.

I congratulate all the officers of JK Science, Technology & Innovation Council for their sincere efforts in releasing this important Report and wish them a grand success in future endeavours.

Bilal Ahmad
Joint Director

TITLE OF THE PROJECT

A Study of basic hyper-geometric functions and their applications with special reference to Integral Transforms

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Name of the Institution:
Islamic University of Science and Technology Awantipora J&K

Brief Synopsis of the Project:

The basic hypergeometric series was defined in 1946 by Heine. Subsequently many mathematicians including Adams, Baily Sears, Slater, Exton, Andrews and others enrich the field by their significant contributions. The study received impetus when Jackson embarked on a lifelong program of developing the theory of basic hypergeometric series in a systematic manner. Still the subject did not earn a widespread interest of mathematicians apparently due to lack of applications. Later, several applications were explored and a great resurgence of interest in the theory of basic hypergeometric functions has been witnessed.

Fitouhi, A. et. al. introduced q-analogue of Mellin transform by using a standard method of q-calculus involving the q-Jackson integral. Some of its properties coincided with the corresponding classical ones when q tends to 1 are studied. Khalaf, R.F et. al. have studied the connections of the Sumudu transform to other well-known transforms, such as the Fourier, Laplace, and Mellin transforms. Due to its properties, the Sumudu transform is found to be the source of the other transforms. Andrews, G. E. made a survey of recent applications of basic hypergeometric functions to partitions, number theory, finite vector spaces, combinatorial identities and physics. Rakha, M. A. et. al. used some concepts of basic hypergeometric series to give an extremely simple derivation of the exact formula for the expected number of nodes on level l in a random digital search tree, built from and random data. Fitouhi, A. et. al. studied the correspondence between poles of the q-Mellin transform in quantum calculus [5]. They also gave a new technique (in q-analysis) to derive the asymptotic expansion of some functions defined by q-integrals or by q-harmonic sums. Subsequently, a q-analogue of the Mellin–Perron's formula was given. Katatbeh, Q. D. extended the applications of Sumudu transform to fractional integrals and derivatives. Some Sumudu properties were also generalized. The Sumudu operator was used to solve wide classes of fractional differential equations. Blaschke, P. et. al. generalized hypergeometric function that satisfied many identities or "transforms" which were used to establish their asymptotic behaviour for large argument and even, in some cases, for large parameters. They also used a similar "calculus" to compute asymptotic expansions in higher dimensions.Kim, Y.S. et. al. obtained unknown Laplace transforms of three general cases of Kummer's confluent hypergeometric function 1F1(a; b; x) by employing generalizations of Gauss's second summation theorem. Karp, D. et. al. have applied generalized Stieltje's transform representation to study the generalized hypergeometric function and from those results they have obtained new integral representations, inequalities, properties of the Padé table and the properties of the generalized hypergeometric function. Butler, R.W. et. al. designed the general form of the approximation to exploit the Laplace approximations to hypergeometric functions of a single matrix argument. Karp, D.B. et. al. studied integral representations of hypergeometric functions and their properties and extended the known representations to arbitrary values of the parameters. They showed that the extended representations could be interpreted as examples of regularizations of integrals containing Meijer's G function. They also gave some new applications of both, known and extended representations.

Srivastava, H.M. et. al. derived a number of transformations

involving certain families of basic (or q-) hypergeometric functions of two variables. These results provided basic (or q-) extension of numerous transformations associated with the ordinary Kampe' de Ferriet function with different sets of arguments. Layman, J.W. defined Hankel transform of an integer sequence and some of its properties. It was shown that the Hankel transform of a sequence S was the same as the Hankel transform of the Binomial or Invert transform of S. Dernek, A. et. al. have shown that iterations of the Hankel transform with Kν-transform is a constant multiple of the Widder transform. They have used iteration identities, several Parseval–Goldstein type theorems for these transforms and the Laplace transform. Saxena, R.K. et. al. have defined new basic hypergeometric function, which is an extension of the basic H-Function defined by Saxena. Three basic integral representations for this function have been investigated, which can provide elegant generalizations of the results given earlier by Saxena. Vidunas, R. obtained explicit algebraic transformations of some Gauss hypergeometric functions and applied the results to hypergeometric solutions of hypergeometric differential equations with the local exponent differences. Belgacem, et. al. have shown it to be the theoretical dual to the Laplace transform, and hence ought to rival it in problem solving. Using the Laplace-Sumudu duality (LSD), the authors avail with a complex formulation for the inverse Sumudu transform. Also, they generalize all existing Sumudu differentiation, integration, and convolution theorems in the existing literature. Vidunas, R. studied the contiguous relations for Gauss hypergeometric series and observed that any three 2F1 series whose corresponding parameters differ by integers are linearly related over the field of rational functions in the parameters. Also, they discuss contiguous relations of generalized and basic hypergeometric functions, and their several applications

Work Done Report:

The project has been started from 30th Nov. 2021 with amount / grant received so far of Rs. 7.50 Lakhs and expenditure so for of Rs. 3.90 Lakhs. As per the requirements of this project we have purchased and installed one Mathematical software (Mathematica) for analysis purpose. Literature review of the project has been completed and three papers have been submitted to the reputed Journals (SCI/ ESCI/ UGC care listed). One papers has been published, one accepted and one communicated till date which are as under:

Two research papers have been accepted / published namely:

i. Scaled Wigner distribution in the offset linear canonical domain, *Optik,* 262 (2022) 169286
ii. Generating functions of (p,q) analogue of Aleph function satisfying Truesdell's ascending and descending Fp,q equation, Journal of Applied Mathematics and Informatics, Accepted in *Applied Mathematics and Informatics*.
iii. Generating operators of I-transform of the Mellin convolution type, Communicated.

Likely Outcome of the Research Project:

The theory of basic hypergeometric functions and Integral transforms have a wide range of applications in various fields of Mathematics, Physics and Engineering Sciences, namely Number theory, Partition theory, Lie-theory, Fractional calculus, Integral transformation, Quantum theory etc.
The outcome of the study will help in understanding the basic hypergeometric functions and Integral transforms. It will also facilitate to develop the new procedures for finding the solution of complicated problems in the field of basic hypergeometric functions. The study will aid and enhance the application of Integral transforms and quantum calculus operators to the difference, differential and integral equations arising in real world problems. The study will facilitate to investigate different dimensions of q-Integral transforms and basic analogue of hypergeometric functions which in turn will increase their accessibility to the real-world problems of engineering sciences. The study will inculcate among the learners the principles and the mechanism to be adhered to in applications of hypergeometric functions and their basic analogues, in the light of different mathematical disciplines of calculus, like Integral transforms and q-Integral transforms.

Recommendations: N/A

Colored Photographs with Captions indicating progress of work/activities:

Mathematica Software

Tab for Computation

TITLE OF THE PROJECT

An Approach to model Covid-19 Outbreak

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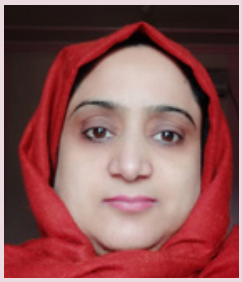

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Abstract

The pandemics are believed to change the human perception and significantly effect the socio- economical, environmental and psychological outlook of affected people. The recent Covid-19 pandemic has challenged the state of art healthcare systems and has put modern day technology driven healthcare system to a task. While the doctors, biotechnologist, epidemiologist and technologist put their heart in, to model and study the impact of Covid-19; the researchers were tirelessly working on identifying a vaccine that can efficiently put an end to the pandemic. The mass vaccination has always seemed a solution to communicable diseases, pandemics and endemics. The authors believe an efficient vaccination strategy / model is needed to reach the major population in least possible time. It will facilitate to reach the goal of mass vaccination and decrease the spread of virus. We propose a PageRank based vaccination model that utilizes the depth first search to traverse a social graph that proves to converge faster than most widely used Random Walk. The idea is to prioritize the vaccination of the most connected individual who is more likely to be a victim or be a super-spreader. Further we will be studying the hesitation and acceptance of vaccination among various communities.

Introduction

COVID-19 vaccines are being developed by several research and development teams across the world. As vaccines are created and manufactured, pandemic preparedness and planning for mass vaccination and immunization have become increasingly critical. Public health organizations have deployed mass vaccination drives throughout the world and are now being proposed as a potential alternative for COVID-19 immunization. Different mass vaccination solutions exist to quickly and safely immunize a large number of people against SARS-CoV-2. In order to combat communicable diseases, mass vaccination has been a popular method. In the instance of COVID-19, the desire for mass immunization became necessary once the vaccine was made available to the entire public. To enable wider access to all elements of society, several mass vaccination approaches have been adopted. But there is a need to identify an effective vaccination strategy that could effectively be used against Covid-19. Thus mass vaccination for COVID-19 requires the need of construction of new and creative vaccination strategies. Our project aims to provide a new vaccination strategy that could be effectively used to vaccinate the mass population for Covid-19

Work Done

A comparative analysis was conducted on various sets of datasets obtained from the internet. The PageRank and Random Walk algorithms were used to determine the rank or relevance of the entries in these datasets. Initially, these two techniques were tested on a set of 500, 1000, and 10000 nodes in a Python-generated network. Following that, two publicly available datasets were employed for performance analysis. The first dataset was a network of 257397 nodes, of which

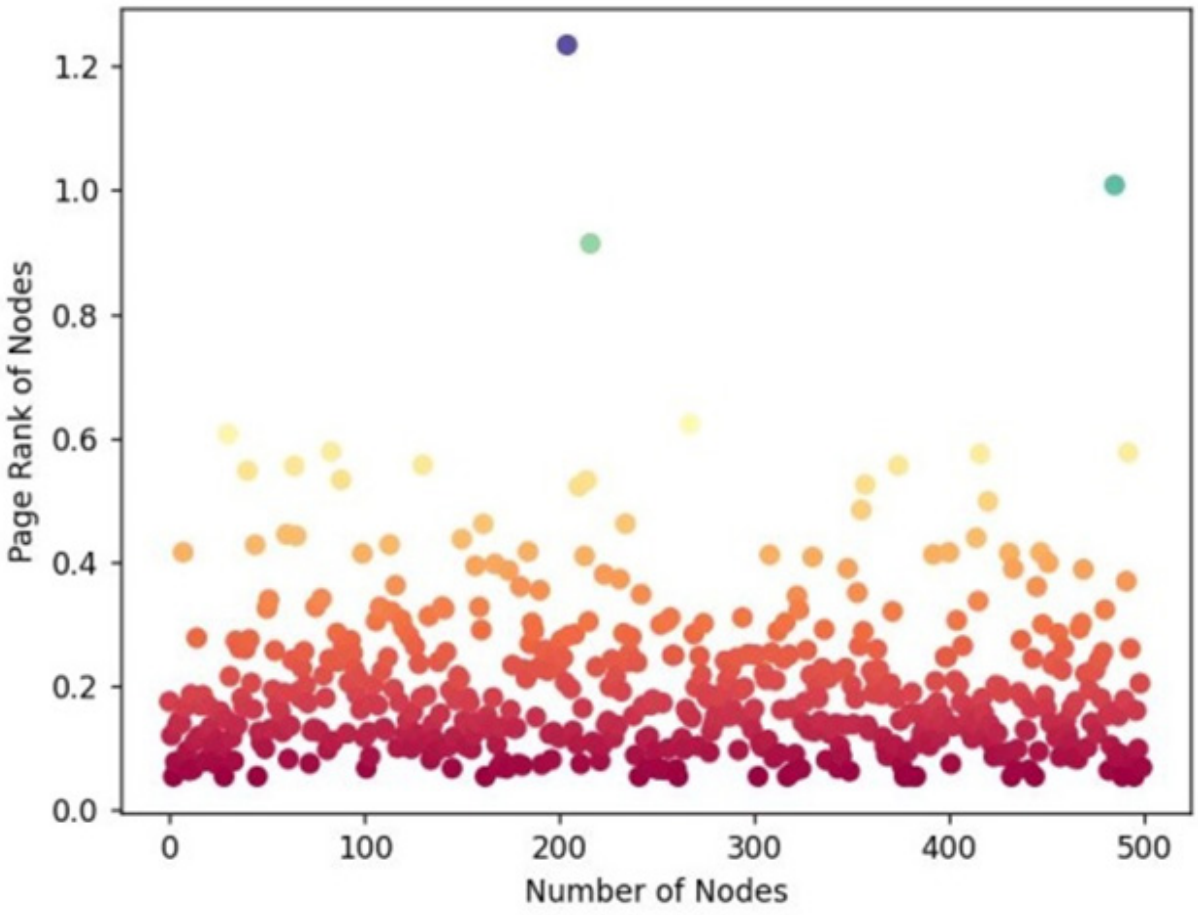
the first 5000 were used. The second dataset contains information about an airline's flight schedules from several airport terminals in the United Kingdom. Each row in the dataset contains details about a scheduled flight from one airport terminal to another. It contains around 65499 entries, 3356 of which were chosen for study. Finally, we applied the models to a social network dataset developed by John Templon, Anthony Cormier, Alex Campbell, and Jeremy Singer-Vine as part of a larger project for BuzzFeed News to map "Trump World". It is made up of network data from approximately 179 nodes that show links between President Donald Trump and others in his administration. The number of nodes used in each dataset is represented in Table 1.

Table 1: Number of nodes used within each dataset

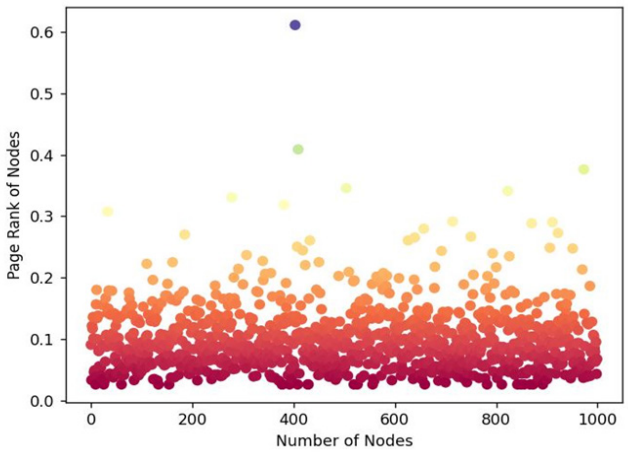
Dataset	Number of Nodes Used
Dummy dataset A	500
Dummy Dataset B	1000
Dummy Dataset C	10000
Real Network Dataset	5000
Airline Dataset	3356
Social Network Dataset(Trump Dataset)	179

Results and Analysis

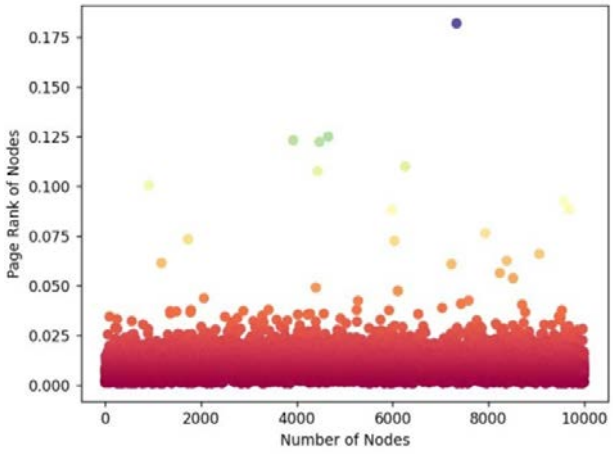
Initially the performance analysis of PageRank and Random Walk algorithm was carried out on a network of size 500, 1000 and 10,000 nodes generated randomly using python. Their results are shown in figure 1.



a: PageRank of 500 dummy nodes

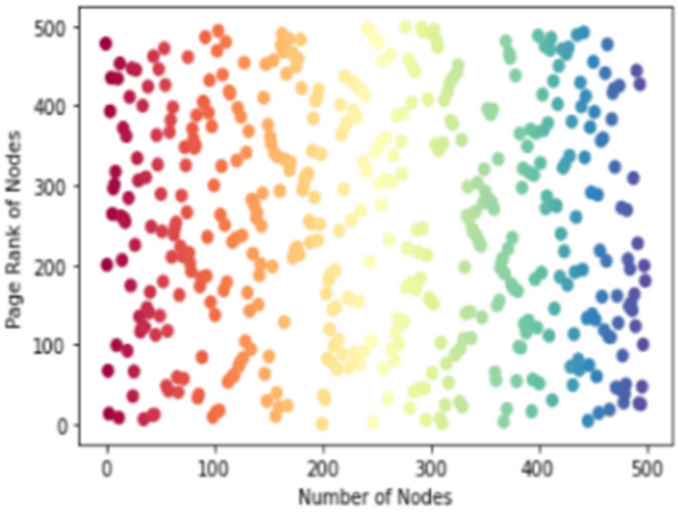


b: PageRank of 1000 dummy nodes

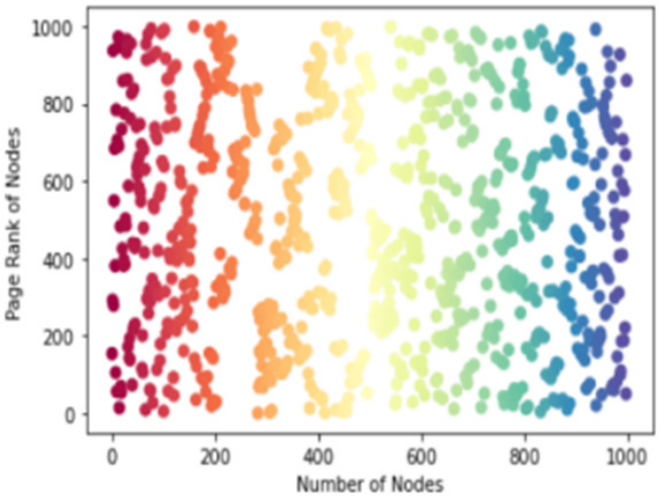


c: PageRank of 10000 dummy nodes

Fig. 1. Graphical representation of rank of nodes using PageRank algorithm



a: PageRank of 500 dummy nodes



b: PageRank of 1000 dummy node

Further the performance comparison of these algorithms was carried out on three publicly available datasets mentioned above. Figure 3 and 4 shows the performance of PageRank and Random Walk algorithm on a social network dataset representing the connection between Donald Trump and other persons in his office. The dataset comprises of network data of about 179 nodes.

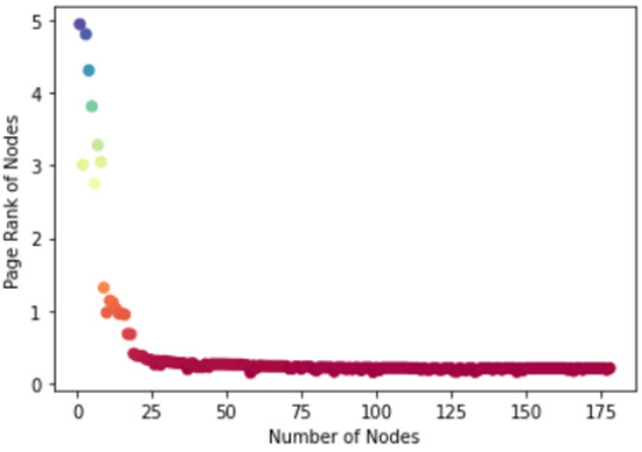


Fig. 3. Graphical representation of Rank of nodes using PageRank algorithm on Trump Dataset

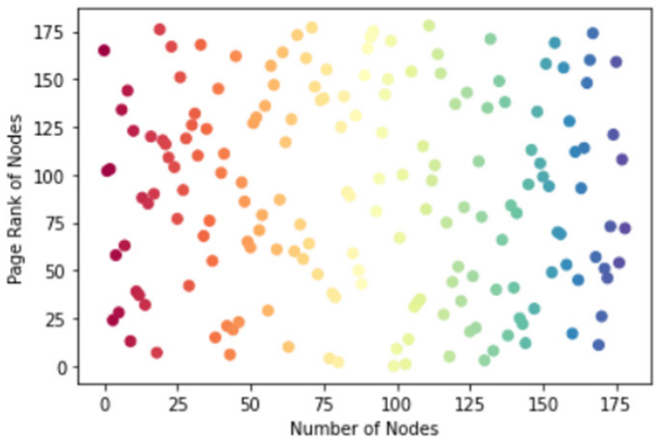


Fig. 4. Graphical representation of Rank of nodes using Random Walk algorithm using Trump Dataset

Since Page Rank algorithm has correctly depicted the rank or importance of nodes present in the above datasets. Preliminary analysis of the results shown in figure 3 and 4 reveals that the nodes with highest connections have high PageRank value. Thus, if same procedure is used to vaccinate people i.e. calculating PageRank of nodes in a social network and then vaccinating according to their PageRank value, i.e. from highest to lowest at each level of the graph, the spread of virus can be minimized.

Moreover analysing convergence matrix it was concluded that PageRank algorithm has high convergence matrices than random walk algorithm i.e. PageRank algorithm converges in less time as compared to random walk algorithm and can perform better if it's used as a vaccination strategy on a large social network.

Achievements/Outcome

1. The above mentioned work was compiled in the form of a research paper titled "Using Social Interactions to Redefine Vaccination Strategy". The paper was accepted at 9th International Conference on Behavioral and Social Computing (BESC 2022) to be held in a hybrid mode and hosted by Matsuyama University, Japan, 29-31 October 2022.

2. Another paper titled "A Covid story: Corresponding Vibe Dissection for Covid-19 Pandemic" has been accepted at ACM Journal on Computing and Sustainable Societies.

Recommendations

We would like you to release the budget for the upcoming year.

TITLE OF THE PROJECT

Authenticating Pashmina using Deep Learning (artificial intelligence)

Project Investigator

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Brief synopsis of the project

Pashmina is one of the most luxurious and finest fibers in the world. It is a special kind of wool which is obtained from cashmere goats. Since Counterfeit shawls pose a major threat to the authenticity of the product and credibility of the Pashmina trade. Given the tediousness of traditional testing methods, and based on ease of using Artificial Intelligence based methods, we propose to develop a deep learning technique based on imagery data to identify the purity of Pashmina fiber. Technique developed will be translated into an android application for its wide availability and instant use.

Objectives:

i. To collect a high-quality imagery dataset of Kashmir Pashmina fiber

ii. To identify the best approach for designing an optimal Convolutional Neural Network best suit for our dataset(s)

iii. Evaluate the results of our model with human expert-based results

iv. Develop an android application based on the generated artificial intelligence model accessible to end user for identification of the purity of Pashmina

Work Done Report

i. Dataset

Dataset collected containing 4297 images of both Pashmina and Non-Pashmina

ii. Experiments

Two major experiments done

a. Pashmina Embroidery Classification

Pashmina embroidery classification using Deep Convolutional Neural Networks splendidly with an accuracy of 93%.

b. Pashmina Authentication

Artificial Intelligence (Deep Learning) based Pashmina authentication with test accuracy of 97.4%

iii. Publications

a. Patent number: 202211045949 , Title of invention: SYSTEM AND METHOD FOR IDENTIFICATION AND CLASSIFICATION OF HAND WOVEN AND MACHINE WOVEN FABRICS

b. Patent number: 202211018901, Title of invention: SYSTEM AND METHOD FOR DETECTING AND CLASSIFYING PASHMINA SHAWL

c. One research paper communicated

Title: Pashmina Authentication on Imagery Data using Deep Learning

Communicated to: AI & SOCIETY

Likely outcome of the project

i. Standard dataset containing images of both Pashmina and Non-Pashmina fabrics for future researches

ii. Deep learning model for Pashmina fabric authentication and Embroidery classification

iii. API of the deep learning model

iv. Web/Mobile User Interface (UI) to access API of Deep Learning Model for end users

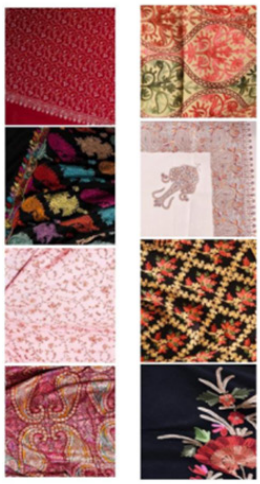
Recommendations

i. The project has a good scope to be converted into an entrepreneurial opportunity. In order to do that, a bigger and standardized data set involves a more diverse and rich collection of quality data with a possibility of taking the experiment to microscopic or spectropic level. Data collected on this scale demands extra logistic expenses. Additional budgetary allocations are recommended.

ii. Two patents have been published on this project. Further funds are required as legal and professional fees to approve the grants of these patents.

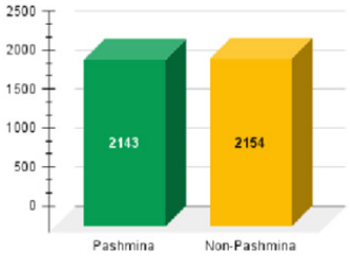
Photographs showing progress of work/activities

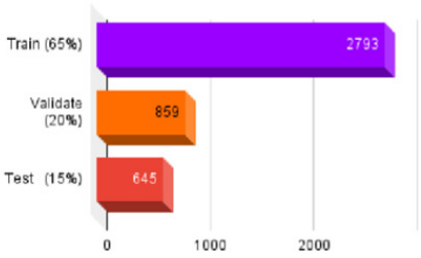
Dataset



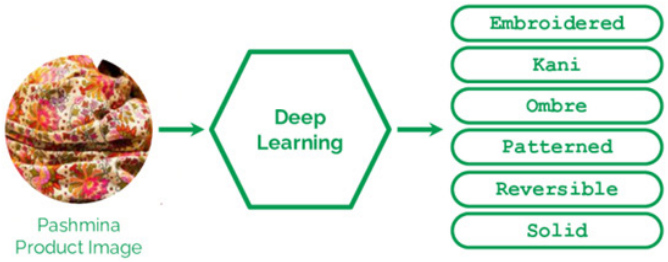
4297

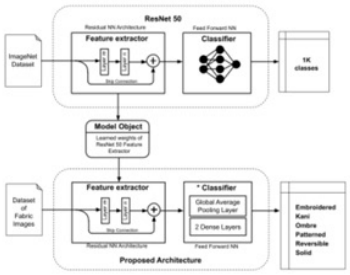
Dataset containing 4297 images of both Pashmina and Non-Pashmina
Image Dimensions: 224x224

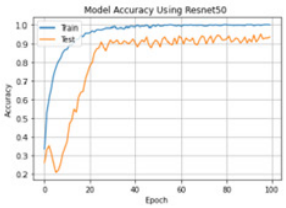


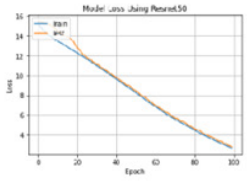


Experiment 1: Pashmina Embroidery Classification





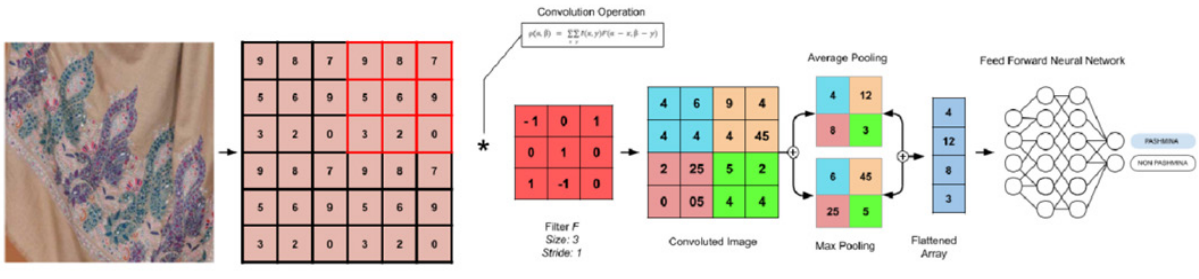


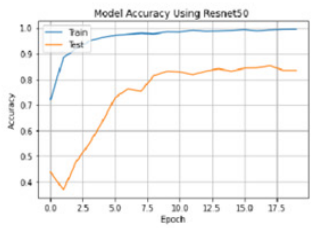


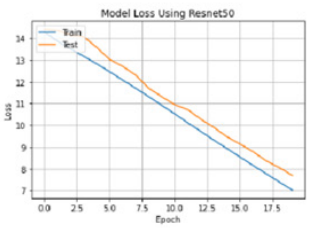
Test Results

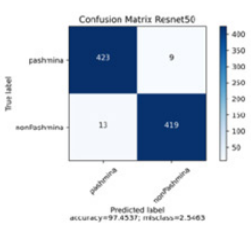
Test accuracy 93.24%

Experiment 2: Pashmina Authentication









Test Results

Test accuracy 97%

TITLE OF THE PROJECT

Blockchain University: An immutable e-learning assessment platform using blockchain.

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Brief Synopsis of the project

Blockchain is an open distributed ledger that keeps a record of all transactions taking place in a peer-to-peer network. The properties of blockchain such as immutability, provenance and peer executed smart contracts brings a new level of security, trust and transparency to e-learning. We introduce our proof of concept blockchain based e-learning curriculum personalisation in higher education context. Most notably, our platform automates assessments and issues credentials. The design is pedagogically neutral and content-neutral, in order to showcase the benefits of a blockchain back-end to end users such as students and teaching staff. The project describes an application of blockchain and smart contracts in e- learning to tackle various issues in higher education.

Work done report

Submitted a review paper, "Blockchain as an indispensable asset for educational institutions: A systematic review".

Likely outcome of the project

The end product will be a Blockchain based technology meant to be implemented in various Universities and Colleges of the Union Territory of Jammu and Kashmir that will provide important features which include:

1. Increased trustworthiness of educational achievements: Blockchain-based university certificates are a great leap forward- a verifiable lifetime transcript would reduce CV fraud, streamline student transfers between universities, reduce the overhead related to credential verification, and make moving between states and countries less complex.

2. Seamless payments Since processing student payments is labor-intensive and may involve the students, parents, scholarship-granting agencies, financial institutions, governments, and educational institutions, blockchain makes the process a whole lot easier, by allowing students to store their very own cryptocurrency funds – which should be usable over time to pay for their higher education fees.

3. Improve record keeping: The most promising use case for blockchain in education is to transform the "record-keeping" of degrees, certificates, - making credentials digital and placing them under the learner's control, without the need for an intermediary to verify their authenticity.

4. Teaching and storage space: Lessons, courses, tests, and quizzes can be coded into the technology and executed on their own when all of the qualifying conditions are verified by incorporating the smart contract feature of a blockchain which can easily verify when the task has been completed, making it an ideal tool for evaluating students.

Since not all institutions can afford to purchase terabytes of cloud storage for all of their files, blockchain can provide an affordable and seamless file storage solution.

Recommendations

Due to the late recruitment of the Research Assistant, the work on the project technically started in late February, 2022.

In addition, we are targeting good and well-established research journals for publishing our work which usually takes more than three months for the acceptance. Therefore, an extension of six months may be granted for the completion of the project.

Coloured photographs with captions indicating progress of work

Figure 1: Journal submission proof

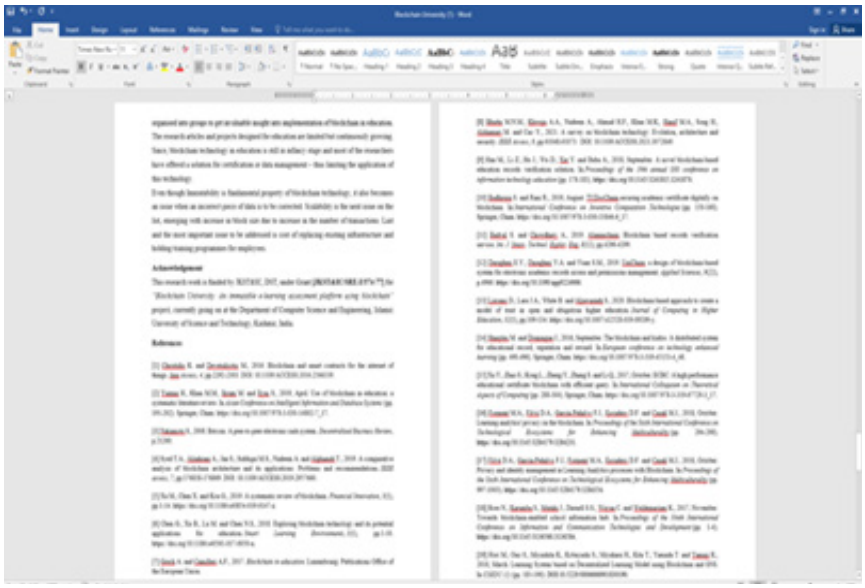

Figure 2: Acknowledgement proof

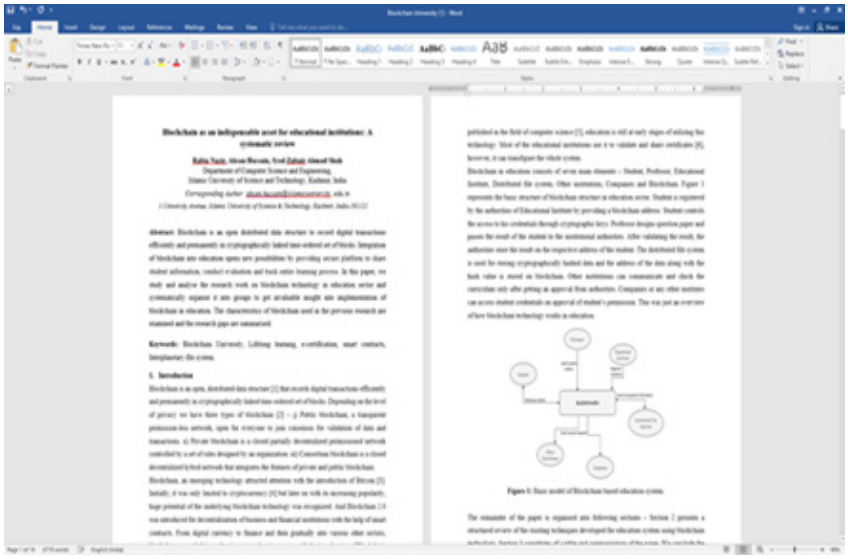

Figure 3: Paper title

TITLE OF THE PROJECT

Data Gathering, Analysis and Protection of Privacy through Randomized Response Algorithm

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Brief Synopsis of the Project:

Survey techniques are now being used in almost every field of scientific and social studies ranging from physical sciences to economics, from business studies to bioinformatics, from educational behaviors to reliability engineering etc. Obtaining reliable data has emerged challenging issue especially in socio-economic and behavioral studies since making reliable and valid inferences mainly depends upon the reliability of the data. One of the leading paraphernalia for obtaining data pertaining to human populations is the social survey. To measure opinions, attitudes, and behaviors that cover a wide band of interests, the social survey has been established as being tremendously practical. The surveys are conducted due to many reasons, non-availability of certain facts/information in the archives being the most understandable and apparent. For instance, if one is interested in knowing crime rates, information about unseen crimes or unreported victimization experience is not available in formal records on crime. Sometimes the facts about the individuals (in a population) are inaccessible to the investigators for legal reasons. For example, in many countries, certain information about criminals is kept confidential, due to security and privacy concerns. In most studies, the study population may be so geographically dispersed that studying a whole population is simply infeasible. Questionnaires, in particular social surveys, generally consist of many items. Some of the items may be about sensitive/high risk behavior, due to the social stigma carried by them. One problem with research on high-risk behavior is that respondents may consciously or unconsciously provide incorrect information. In psychological surveys, a social desirability bias has been observed as a major cause of distortion in standardized personality measures. Survey researchers have similar concerns about the truth of survey results/findings about such topics as drunk driving, use of marijuana, tax evasion, illicit drug use, induced abortion, shop lifting, cheating in exams, and sexual behavior.

Direct queries often fail to give reliable data on such confidential aspects of human life. Non-response or false or evasive responses to attempt direct quires about such private matters are so settled in practice that it is difficult to measure and control their effective use of the acquired data from samples to reach a correct and satisfactory inference about the populations. Thus to obtain trustworthy data on such confidential matters, especially the sensitive ones, instead of open surveys alternative procedures are required. Such an alternative procedure known as "randomized response technique" (RRT) was first introduced by Warner (1965). It provides the opportunity of reducing response biases due to dishonest answers to sensitive questions. This technique creates a stochastic relationship between the questions and individual's response and thus provides protection to confidentiality of the respondent.

The technique of randomized response (RR) is one of the available devices aimed at cutting down the level of non-responsive, willful misstatements and lies and thus trying to improve the efficacy of inferences and to eliminate bias in estimation. Of course, once devised, an RRT needs to be applied in an effective and convincing manner so that not only is it desirable that one trust that prima facie a specific RRT should appear to protect a respondent's privacy, but more important, that the latter will believe it to be so, and on his or her own volition, answer the query honestly. Given a proposed RRT, it is most difficult to make an appraisal about its efficacy, and once applied, it is quite hazardous to guess and measures its fruitfulness. Of course, theoretical exercise is not difficult to implement in measuring an RRT's potentiality, but it is not easy to gauge how well it may fare in practice.

Work Done Report:

The project has been started from 30th Nov. 2021 with amount / grant received so far of Rs. 4.30 Lakhs and expenditure so for of Rs. 3.10 Lakhs. As per the requirements of this project we have purchased and installed two Mathematical / Statistical software's for analysis purpose. Literature review of the project has been completed and three papers have been submitted to the reputed Journals (SCI/ ESCI/ UGC care listed). Two papers have been published till date which are as under:

Two research papers have been accepted / published namely:

i. Decipher Multi-Objectives gathering with liberating Dates Problem,Journal of scientific research of the Banaras Hindu University. Volume 66 (4) – 2022.

ii. A New Data Gathering Exponential Type Ratio Estimator for the Population Mean, Journal of Scientific Research & Reports. Volume 28 (10) – 2022.

Likely Outcome of the Research Project:

Our aim is to identify the best fit randomized response model based on the experimental data by applying mathematical algorithms. One of the important things is to measure opinions, attitudes, and behaviors that cover a wide band of interests, and a social survey will be established. The surveys will be conducted due to many reasons, the non-availability of certain facts/information in the archives being the most understandable and apparent. Further, Finding the primary data regarding tax evasion using a randomized response algorithm with a weighted variant of the randomized response algorithm. Also, finding some modified randomized response techniques to develop an efficient randomized response model with optimal values based on the experimental data by applying mathematical Algorithms. Our results will mostly be used by that part of the Mathematical /Statistical society who works in randomized response techniques and their applications. . Few research papers will be published under this research project in reputed Journals / International conferences.

Recommendations: N/A

Colored Photographs with Captions indicating progress of work/activities:Since our research project is simulation/software based therefore the hardware prototype is not applicable to our project. The color photograph of the STATISTICA software and MATHEMATICA software purchased for completing this project are attached.

TITLE OF THE PROJECT

Design and Analysis of a Bag Valve Mask based Frugal Ventilator

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Details of the staff engaged, if any:

Name	Ph. No	Email ID	Designation	Qualification
Sobia Shafi	9682525438	sobia.shafi@iust.ac.in	Research Assistant	B-Tech, ECE

Brief synopsis of the project: Attached as Annexure-I

Work done report: Attached as Annexure-II

Likely outcome of the project: Attached as Annexure-III

Recommendations: The grants allowed for travel during the first year could not be utilized due to Covid-19 restrictions. Hence it is requested to carryover the grants to next year. Also, the project should have the flexibility to hire project staff at higher salaries, preferably 20,000 per month for project assistant. This would encourage good students to join these projects and stay till their completion.

Colored photographs with captions indicating progress of work/activities: Attached as Annexure-IV

Annexure-I: Brief Synopsis of the Project

This project will focus on design, development and analysis of a frugal mechanical ventilator based on a Bag Value Mask (BVM). Mechanical ventilation is used when there is a respiratory failure and a person is unable to take sufficient oxygen on his own. This situation may arise because of an accident or a particular disease affecting lungs of a person. In recent times, we have seen the scarcity of high-end ventilators across the world due to ongoing pandemic COVID-19. A need was felt for the design of a low-cost mechanical ventilator. Apart from the emergency situations like the ongoing pandemic COVID-19, not every medical facility in developing nations can afford a high-end ventilator. Therefore, a low-cost ventilator is a viable solution for hospitals located in rural areas and can also be equipped in an ambulance to cater to the needs of a patient during transportation. The easiest way to develop a low-cost mechanical ventilator is to automate the compression of a BVM. A BVM is a hand-held manual resuscitator. It has a silicon rubber membrane that is elastic and is used to provide oxygen to a patient in case of an emergency by pressing it repeatedly by hands. Since the device is manually operated, often by a care-taker of the patient, it is impossible to have a proper control on amount of air pushed in the lungs and respiration rate. These are essential parameters and vary from patient to patient. Forcibly pushing improper amounts of oxygen into the lungs may lead to various types of lung injuries. Therefore, if manual compression is replaced by an automated piston, it will lead to a better control on these parameters. At the same time, many sensors can be incorporated in the setup which will also monitor various other parameters like proper pressure is maintained in the airways of the patient. Thus, the basic objective here is to replace the human effort in compression of BVM and achieve controlled cyclic compression of the BVM.

Annexure-II: Work Done Report

Literature Review: A thorough literature survey was carried to study the mechanical ventilators currently in the market. Mechanical ventilators currently in the market vary from a low-cost hand operated Bag Valve Mask (BVM) to high end sophisticated machines which employs different mechanisms for delivering the oxygen as per the required breath cycle for such patients. Bag valve mask (also called an ambulatory bag or AMBU bag) is a hand-held manual resuscitator that incorporates a silicon rubber membrane and is a standard makeshift arrangement used to provide oxygen to a patient in case of an emergency. The mask that contains air is pressed repeatedly by hands so that air is forced in the lungs of the patient. The device is manually operated usually by a hospital attendant or a care-taker and there is no control on essential parameters of human breath cycle like the amount of air inhaled and the respiration rate. This may lead to various types of lung injuries [1], [2]. On the other hand, high-end ventilators have sophisticated sensing and control features, which help them to mimic the patient breath cycle, but their price runs in millions. The idea here is to fill the gap between a low cost BVM and a high-end ventilator. The need for such type of ventilators was highlighted by the COVID-19 pandemic. The replacement of manual compression by one based on automatic control was first demonstrated in [3] which bears similarity to the work being done by a team at MIT [4]. Similar kind of work has also been reported in [5] and [6].

Mechanical Design and Assembly of the Prototype: Mechanical design of the prototype includes selection of compression and release mechanism, materials used and the manufacturing processes required. Since our objective was to replace the human effort and achieve controlled cyclic compression of the BVM, a mechanical arrangement for the same was conceived. With a heuristic comparison of the advantages of one over the other, in terms of simplicity in manufacturing, required number of standard components, and overall cost, a rack and pinion arrangement was chosen as the compression and release mechanism for the BVM. The above mechanism was housed on a flat wooden plate of appropriate dimensions with a flat vertical plate to compress the BVM with an appropriate force. The arrangement was further allowed to move back and forth on two off the shelf linear bearings. A 'bag and plate interface' part of suitable dimension and shape fixed to the 'lower moving plate' part was used to provide effective force distribution on the BVM. Most of the structural parts, namely the base of the ventilator, front support, and the slider, etc. were built out of high grade 19 mm plywood. Parts like rack and pinion and motor brackets were readily manufactured of PLA material using 3D printers available at the university. The development of the prototype involved several manufacturing processes which include Laser cutting, 3D printing, power tool operations (grinder, circular saw) etc.

Electric and Electronic Design: In this section the electrical aspects of the designed prototype are discussed. Since our objective was to implement volume controlled continuous mode ventilation, the values of TV, respiratory rate and IE ratio need to be set by an operator. The values of these three parameters determine the rate and amount of compression of the BVM and hence the specifications of the actuator. After proper calculations a DC motor of 250 watts and 210 RPM was selected as the actuator. A microcontroller needs to be used to read the inputs pertaining to TV, respiratory rate and IE ratio from the user and determine the desired motion of the piston compressing the BVM. We used an Arduino Uno as our controller. It is cheap, easily available in the market, has ex tensive documentation and online support available and has got sufficient pins for the interfacing of all the input and out- put devices. Apart from this, a differential pressure sensor with two inlets will be used to constantly monitor the pressure in the airway of the patient. The system was also equipped a flow sensor to measure the flow rate in real time. A DC power supply of 300 watts was selected to power up the whole system.

Identification of DC Motor Transfer Function: Transfer function of DC motor (without load) was identified using two different approaches. The rack-pinion arrangement, the BVM load and flow sensor were not used in this experiment. In the first approach, Speed-Step response of the motor was used to identify the transfer function. In the second approach, MATLAB System Identification toolbox was used. Hence a suitable model representing the DC motor was identified.

System Identification with BVM: The next step was to identify the overall system model which is quite complex and nonlinear. It consists of motor coupled with rack-pinion arrangement pushing a BVM load. We tried to establish a relationship between the input (Applied Voltage) and the output (flow measured from the installed flow sensor). Again, two approaches were used. In first approach, MATLAB System Identification toolbox was utilized to obtain an appropriate system model. In the second approach, Sparse Identification for Non-linear Dynamics (SINDy) algorithm was used. Results obtained in both the cases were not satisfactory as the model identified failed the validation data tests.

Model Independent Control: We also explored ways of controlling the system that do not need exact models. This was the result of our observation that system identification methods did not yield encouraging results. Three different strategies were explored. In the first approach PID controller was implemented to control the position of piston. Incorporation of BVM in the system with flow sensor as output variable made PID control less effective. This forced us to explore Data Driven PID Controller where gain values are updated in real time a s model changes. However, we concluded that it has limited utility in application like ours because of the fast nature of control action required with limited computational resources. We also explored Model Predictive Control which we found computationally very expensive and system knowledge dependent. We are currently exploring Active Disturbance Rejection Control.

Publications: A manuscript titled "Design and Development of a Bag valve Mask based frugal ventilator" has been communicated to journal "Sadhana – Academy proceedings in engineering Sciences" in the month of September, 2022. In addition, two conference level papers are also in preparation.

References

1. Tobin Martin. Principles and Practice of Mechanical Ventilation. McGraw Hill, 2007.
2. Gattinoni, Luciano and Protti, Alessandro and Caironi, Pietro and Carlesso, Eleonora. Ventilator-induced lung injury: The anatomical and physiological framework. Critical Care Medicine, 2010.
3. Husseini, Abdul and Lee, Heon Ju and Negrete, Justin and Powelson, Stephen and Servi, Amelia and Slocum, Alexander and Saukkonen, Jussi. Design and Prototyping of a Low-Cost Portable Mechanical Ventilator. Journal of Medical Devices- transactions of The Asme, 2010.
4. Alexander Slocum and Daniela Rus and et al. MIT Emergency Ventilator Design Toolbox. https://emergency-vent.mit.edu, 2020.
5. H. Hirani. Mechanical Ventilator Using Motorized Bellow. Transactions of the Indian National Academy of Engineering, 2020.
6. Danny Blacker and et al. ApolloBVM - Emergency Use Ventilator. http://oedk.rice.edu/apollobvm, 2020.

Annexure-III: Likely Outcome of the Project

The research project will be able to deliver following outcomes/serve the following purposes:

1. Medical facilities, most notably ventilators in the UT of JK are in scarcity. Less than a hundred ventilators are available to cater to the needs of population of over 7 million in the valley. Further, most of these ventilators are present in tertiary care hospitals located in the capital cities of Srinagar and Jammu. Given the frugal nature of our proposed ventilator it has the potential to serve as a life saving equipment in the resource constrained hospital and health centers located in rural areas of the UT.

2. Given the portable nature of our proposed ventilator, it has the potential to serve as a valuable asset during emergency transportation of critical patients from sub-district hospitals and rural health centres to super specialty hospitals.

3. The proposed ventilator has useful pedagogical potential, it can prove beneficial in education and training of doctors, nurses and other emergency medical staff.

Annexure-IV: Colored photographs indicating the progress of the work

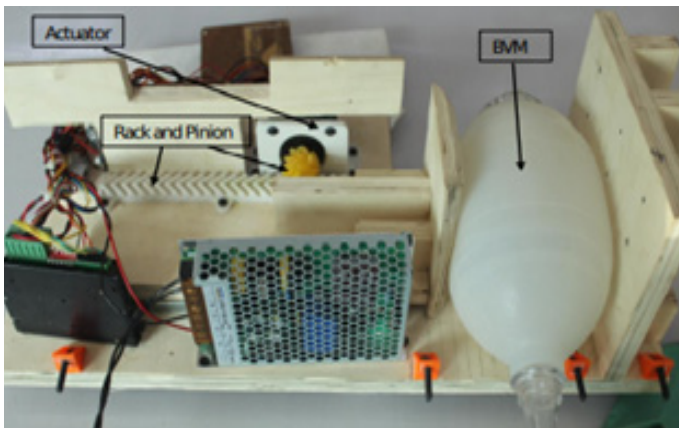


Figure 1: The compression and mechanism with bearings and actuator in action.

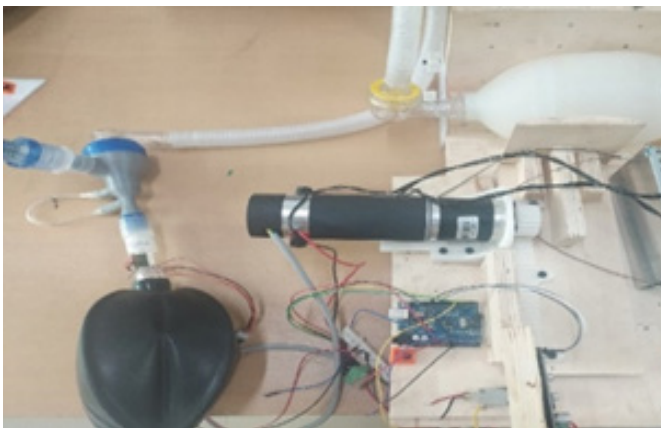


Figure 2: Setup showing compression of a bag valve mask using DC servo motor with an encoder.

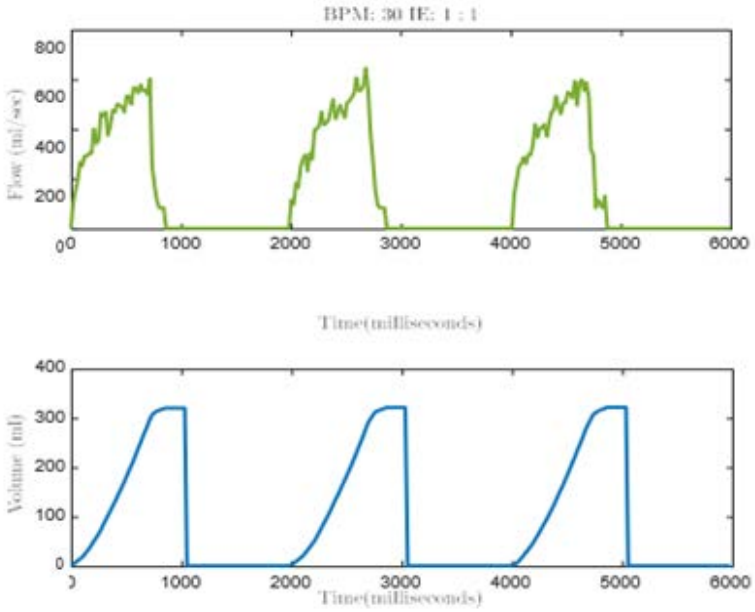


Figure 3: Preliminary results examining the Flow and Tidal Volume Profiles at BPM:30 and IE ratio: 1 : 1.

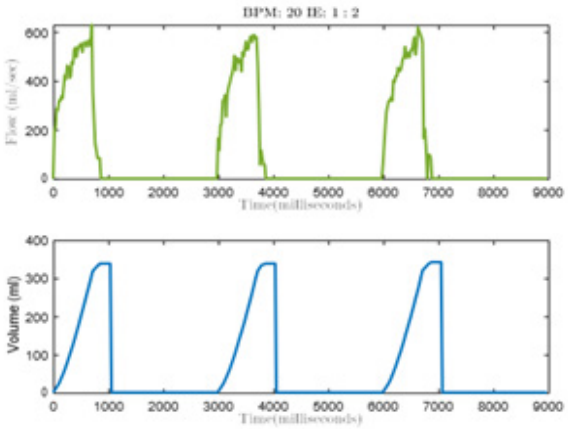
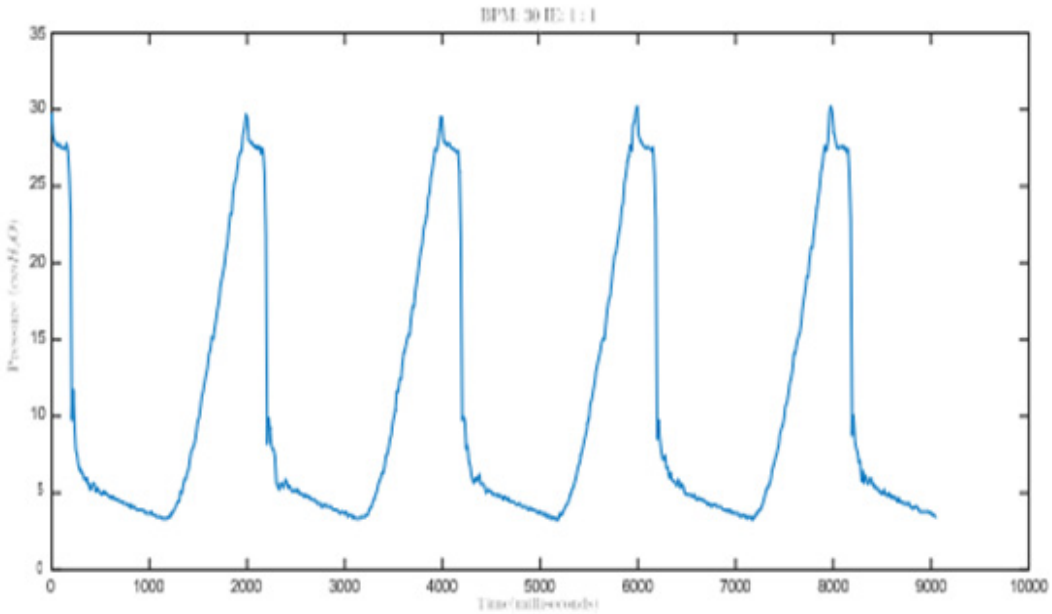


Figure 4: Preliminary results examining the Flow and Tidal Volume Profiles at BPM:20 and IE ratio: 1 : 2.



liminary results examining the Pressure Profile at BPM:30 and IE ratio: 1 : 1.

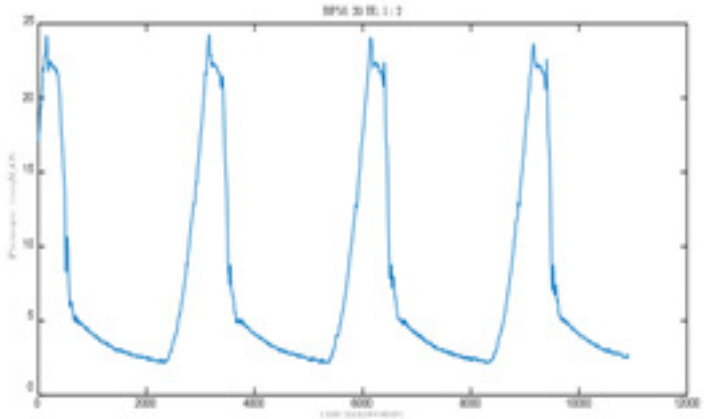


Figure 6: Preliminary results examining the Pressure Profile at BPM:20 and IE ratio: 1 : 2.

TITLE OF THE PROJECT

Design and Development of Domain Specific Machine Translation System for Kashmiri Language

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Brief Synopsis of the Project:

Machine Translation being an emerging area of research has currently gained significant attention of researchers across the globe. Number of automatic machine translation tools accordingly have been designed for most of the languages. There has been very less or negligible research work related to the Kashmiri language in Natural Language Processing field. Only four research reports have been reported with respect to Kashmiri language till date. Among them two are with reference to machine translation from English to Kashmiri, two are related to creation of Morph Analyser, one related to Transliteration from English to Kashmiri. It is therefore imperative to come up with automatic machine translation tools for Kashmiri language so as to widen its horizon like that of other languages.

The project therefore aims at creation of Natural Language Processing resources necessary for Kashmiri to English Translation. Kashmiri belongs to a class of scheduled language of the Republic of India. Unlike other Indian languages, very less research work is reported in literature with regard to Kashmiri language machine translation especially in the digital domain. Various Natural Language investigations are available which vary from simple word count to Machine translation. But with respect to Kashmiri there is no mention of any substantial work related to such investigation.

Kashmiri or Koshur is a language which belongs to Dardic sub-group of the Indo-Aryan family of languages. There are about 7 million speakers as per census 2011, primarily belonging to Kashmir Valley, Chenab valley, Neelam valley, Leepa valley & district of Haveli in divided territory of Jammu & Kashmir. It is one among the 22 scheduled languages of the republic of India. Kashmiri is mainly written in modified Perso-Arabic and Devanagari scripts. Perso-Arabic however is more commonly used at present.

Kashmiri language besides being among the 22 scheduled Indian languages was also a part of the Eight Schedule in the constitution of Jammu & Kashmir. For the development of Kashmiri language, Government of Jammu and Kashmir made Kashmiri language as a compulsory subject in school education up to secondary level since November 2008. It is one of the fifteen languages printed on the paper notes of Indian currency.

A plethora of automatic machine translation systems are currently available for a wide range of languages across the globe. However there is no mention of any such system related to translation of Kashmiri language till date. The project therefore aims at design and development of machine translation system capable of translating from Kashmiri to English which is a universally spoken language. Moreover there is no prominent dataset available in Kashmiri language, limiting its access to research profile in digital domain. Therefore to begin with, the project will encompass the creation of an optimal dataset in a specific domain such as tourism, healthcare, education etc.

Work Done Report:

In line with the objectives envisaged for the project, the following activities have been completed till date:

1. The work on creation of maiden dataset related to Kashmiri language necessary for translation work is in progress, a bilingual dataset of around 4000 sentences has been created so far.

2. One research paper related to machine translation status of Indian Scheduled languages, highlighting least researched languages including Kashmiri language has been communicated to an SCI journal.

3. The basic prototype of translation model has been designed.

Likely Outcome of the Research Project:

The project being a maiden project pertaining to machine translation of Kashmiri language envisages following output/ outcomes at its completion:

a. A detailed report on current scenario of machine translation work pertaining to Kashmiri language with the aim to highlight its scope and associated challenges.

b. A domain specific dataset related either to Education, Healthcare or Tourism for machine translation of Kashmiri language which can be published for further research endeavours by prospective researchers in order to boost the overall research work vis-a-vis Kashmiri language

c. A machine translation model for translation of Kashmiri to English language, which will be highly useful for those people who are not the native speakers. It will further take Kashmiri language at par with other national as well as international languages in terms of natural language processing.

d. Publication of dataset as well as working model in journals of international repute.

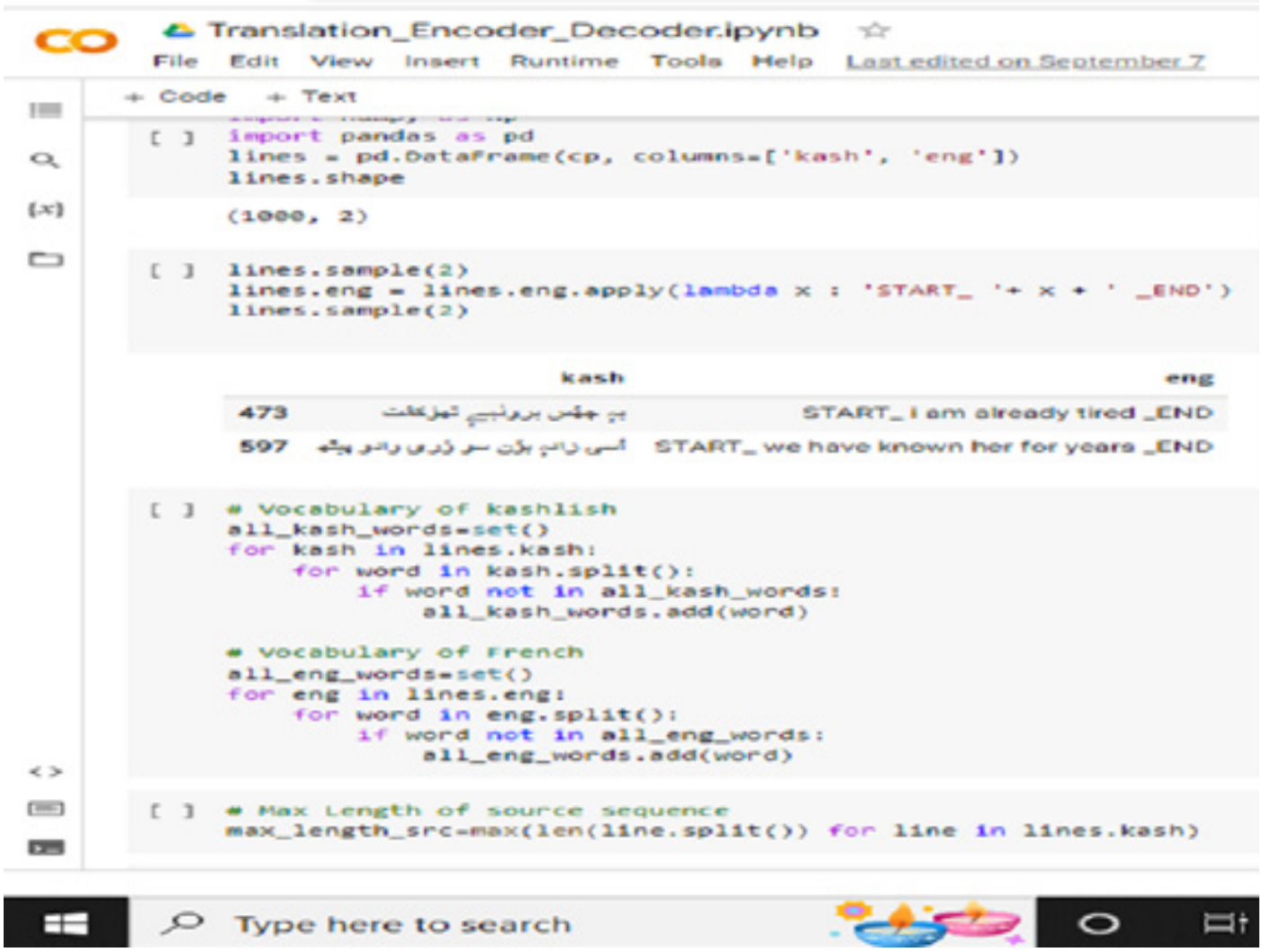
Colored Photographs with Captions indicating progress of work/activities:

Snapshot of Bilingual Dataset

2131	Call me at nine tomorrow morning.	پگاہ نیہِ بجہِ صبحآے کُرِ زِ وفون۔
2132	Can she come in time?	سو ییا وقتس پٹھ۔
2133	I am not sleeping.	بہٕ چھُس نہٕ شوٚنگتھ۔
2134	is not that where we first met?	تتی سمکھیے نا أسِ گوڈنکہِ پھرِ۔
2135	I am not nervous.	بہٕ چھُس نہٕ گھبراوُن۔
2136	That does not change anything.	سُہ بدلایہِ نہٕ کینٛہ۔
2137	Please Do not call me anymore.	مہربآنی کرِتھ کُرِ زِ نہٕ دُبارِ کال۔
2138	It is getting worse.	بہٕ چھُس بدتر گژھان۔
2139	Do not wait for me for dinner.	میٚہ پرارِ زِ نہٕ شامکِس بتس۔
2140	Do we know each other?	أسِ زانو اکھ أکِس ؟
2141	Just start talking.	بس کر کتھ شروع۔

Sheet1 Sheet2 Sheet3

2. A Snapshot of Machine Learning Model



TITLE OF THE PROJECT

Design and Fabrication of Low Cost PAPR (Powered Air-Purifying Respirator) for Medical Practitioners.

Mr. Jawaaz Ahmad
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Brief synopsis of the project:

A powered air-purifying respirator (PAPR) is a type of respirator used to safeguard workers against contaminated air. PAPRs consist of a headgear-and-fan assembly that takes ambient air contaminated with one or more type of pollutant or pathogen, actively removes (filters) a sufficient proportion of these hazards, and then delivers the clean air to the user's face or mouth and nose. They have a higher assigned protection factor than filtering face piece respirators such as N95 masks. PAPRs are sometimes called positive-pressure masks, blower units, or just blowers.

A PAPR is a battery-powered blower that provides positive airflow through a filter, cartridge, or canister to a hood or face piece. The type and amount of airborne contaminant will dictate the type of filter, cartridge or canister required for the PAPR. A PAPR maintains a positive air pressure inside the hood or helmet and is used mainly by Doctors and Medical Workers working in hospital ICUs related to airborne diseases.

A PAPR is very useful during air borne virus based pandemic situations like that going on right now and if implemented correctly, reduces the risks of doctors and medical workers from falling ill themselves.

Using the proprietarily developed tested technology of Negative Pressure Chamber System, with some modifications, I designed and developed a highly efficient prototype model of a PAPR at DIC using funds from JKSTIC and facilitation from DIC, IUST, Awantipora.

Work done report:

Project Objectives :

- To successfully design, prototype and deploy a PAPR device in local market.
- To save lives of medical workers and doctors working in Hospital ICU's.
- To save additional costs required to build isolation chambers.
- To increase productivity of doctors working in contaminated environments.

Methodology

The following methodology was deployed for carrying out the project work:

1. Design the project in Autodesk inventor.
2. Estimate the costs of implementing the prototype.
3. Purchase the necessary equipment/parts for implementing the prototype.
4. Write the software code.
5. Test the software code.
6. Assembly the prototype.
7. Test the prototype with the software.
8. Check for any errors.

9. Correct the errors if any in the software.

10. Test the prototype again for final checks

11. Apply for patent of the design.

12. Apply for design registration of the design.

13. Sent the product to market for mass production.

Timeline of Project

Period of Study	Achievable Targets
1st Month	1. Procurement of Equipment Literature 2. Discussions with the medical community. 3. Incorporation of any changes suggested by the medical community.
2nd Month	1. Mechanical Design. 2. Electric and Electronic Design. 3. Incorporation of various sensors.
3rd Month	1. Mechanical Assembly of the prototype.
4th Month	1. Programming the prototype 2. Tests, Validation and Analysis 3. Study of the behaviour of PAPR.
5th and 6th Month	1.Apply for patent of the design. 2.Apply for design registration of the design 3.Sent the product to market for mass production.

Utilization of Research Outcomes:

It is intended to use the research outcomes in the following ways:

a. Deploy a locally designed and manufactured low cost PAPR device for medical Practitioners.

b. Patent its design in India.

Details of Project Work Carried Out

First of all, I had to know the required airflow which is a standard defined by OSHA and NIOSH certification. So, after some literature review, I found the following requirements set by the National Library of Medicine, National Center for Biotechnology Information, Government of USA

Defining PAPRs and Current Standards

As per the Assigned Protection Factors for the Revised Respiratory Protection Standard by Occupational Safety and Health Administration (OSHA), a functional definition of a PAPR is provided as "an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering" (29 CFR 1910.134(b)). The National Institute for Occupational Safety and Health (NIOSH) definition of PAPRs describes the components in a PAPR—a facepiece, hood, or helmet; a breathing tube; a canister or cartridge with filter; and a blower (42 CFR 84.2(z)).

NIOSH CERTIFICATION STANDARDS

OSHA regulates workplace implementation of respiratory protection programs (29 CFR 1910.134) and requires that all respirators used in OSHA-regulated workplaces be certified by NIOSH (42 CFR Part 84).

Federal regulations delineate U.S. respirator performance standards (see Box 2-1). Through the National Personal Protective Technology Laboratory (NPPTL), NIOSH tests and certifies that PAPRs and other respirators meet these standards. Among other requirements, NIOSH PAPR testing includes an assessment of airflow, that measures

1. **Minimum airflow rate:** A tight-fitting PAPR must provide a constant airflow of 115 liters per minute; a loose-fitting PAPR must provide 170 liters per minute.

2. **Maximal operation flow rate**: Tests are done for 4 hours of continuous operation with the given PAPR being set for maximal operational flow, which could be up to 250 liters per minute.

3. Specific characteristics such as inhalation and exhalation resistance.

One part of NIOSH's certification testing for PAPR filters is a silica dust loading test, which is a method used to test for filter effectiveness in work conditions found in industrial settings, principally mining. Mining activities typically expose workers to dusty conditions and require workers to engage in moderate to high physical exertion rates, which means that respirators used in these settings must have high airflow rates to meet worker breathing demands. These workplace environments and conditions differ from those experienced by health care personnel, and therefore it may be necessary to reexamine the requirements and testing processes for certifying PAPRs to be used in health care settings.

NIOSH has the regulatory flexibility under existing authorities to certify PAPRs that have different performance characteristics than those currently in place. For example, NIOSH has made changes to its certification standards in response to a request to approve a breath-response PAPR. This type of PAPR does not have a constant flow rate, but rather it adjusts to the wearer's breathing rate (the greater the demand, the higher the rate of air supply). After developing an appropriate test, NIOSH defined and approved the breath-response PAPR as a new class of PAPR (42 CFR 84.60 and 42 CFR 84.63)

In the future, the performance requirements and certification standards for PAPRs used in health care settings could be altered to account for the light-to-moderate exertion requirements of health care workers. Berry Ann suggested that potential next steps for PAPRs for health care could include

- Assessing the potential for a new respirator class structure that would meet different performance requirements;
- Developing strategies for the selection and use of PAPRs with alternate flow-rate levels that could match the respiratory needs of various types of health care workers and could address comfort and tolerability concerns;
- Conducting workplace studies to determine the work exertion rates for different types of health care workers and settings as well as the "net effect of alternative PAPR flow rates on health care worker protection"; and
- Assessing the International Organization for Standardization (ISO) requirements for respiratory protective devices to see if they could be used to inform improvements in NIOSH regulations. Design

After collecting the required data regarding the basic PAPR standards set by OSHA and NIOSH, it was clear that my PAPR design must fulfill those requirements.

I designed the system in the following two parts:

Head Gear Design

In head gear design, I was having opportunity to design either a lose fit or a tight-fitting headgear. The only requirement was that for a tight-fitting PAPR must provide a constant airflow of 115 litres per minute; a loose-fitting PAPR must provide 170 litres per minute.

So, I went forward to design a lose fit headgear made up of a breathable but highly dense porous membrane. I selected a 0.35mm thick, spun bonded, non-woven, Polypropylene, virus blocking filter sheet for fabricating the headgear. Also, for the front side of headgear, I had to choose between various types of plexiglass face shields available in the market. I selected the one with the largest curvature and view area after proper testing with different types. I used a double side thick bonding material to bond the plexiglass with the edges of the fabric sheet.

The headgear has two air inlets which get connected with medical grade BIPAP air flow pipes and receive the clean filtered air at the rate of 8.93 CFM. The two inputs are placed in such a unique configuration that the air enters the headgear directly near the nose and mouth area of the user and creates a slight positive pressure inside the headgear.

Figure 3: Front View of Head Gear Prototype

Figure 4: Side View of Head Gear Prototype

Figure 6: Front View of Headgear Prototype on Manique

Figure 5: Another Side View of Headgear Prototype

Air Handling Unit Design

The air handling unit consist of a battery pack, air pump unit, air filter and electronic controller. All of these parts are defined below in details. The air handling unit is 20.2 cms in breadth, 18.4 cms tall and 8.8 cms wide. The total volumetric space taken by the air handling unit is 3270.78 cubic cm.

Figure 7: Air Handling Unit Strapped on User

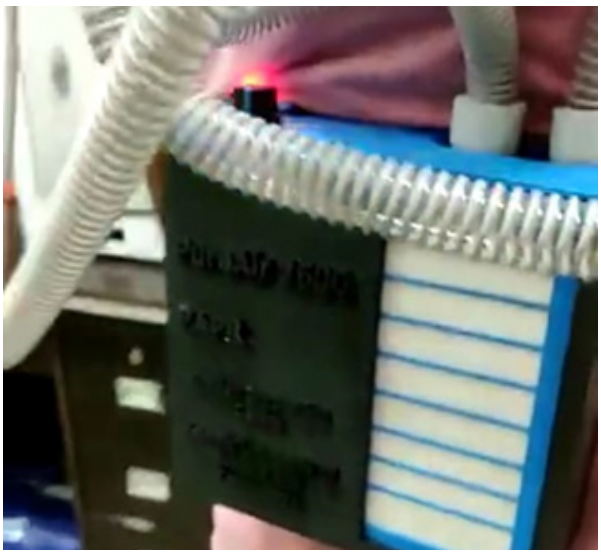


Figure 8: Second View of Air Handling Unit Strapped on User

Air Pump Design

The air pump is designed in such a way that the contaminated air from the surroundings is sucked into the air handling unit through air filters with a specific static pressure. The air is passed through a series of filters which are defined in details as below. The air pump has a 2.7 Amp rated radial fan which is capable of providing air flow of above 2600 ft/min through an area of 6.27 square cms providing a maximum air flow of 8.93CFM. The air pump has two air outlets which are connected to the headgear using medical grade pipes. The air pump is 10.2cms in breadth, 17 cms tall and 5.3 cms wide. The total volumetric space taken by the air handling unit is 919.02 cubic cm.

I used a radial impeller fan for moving the air through the filters as radial impeller fans generate more static pressure than a normal; axial fan.

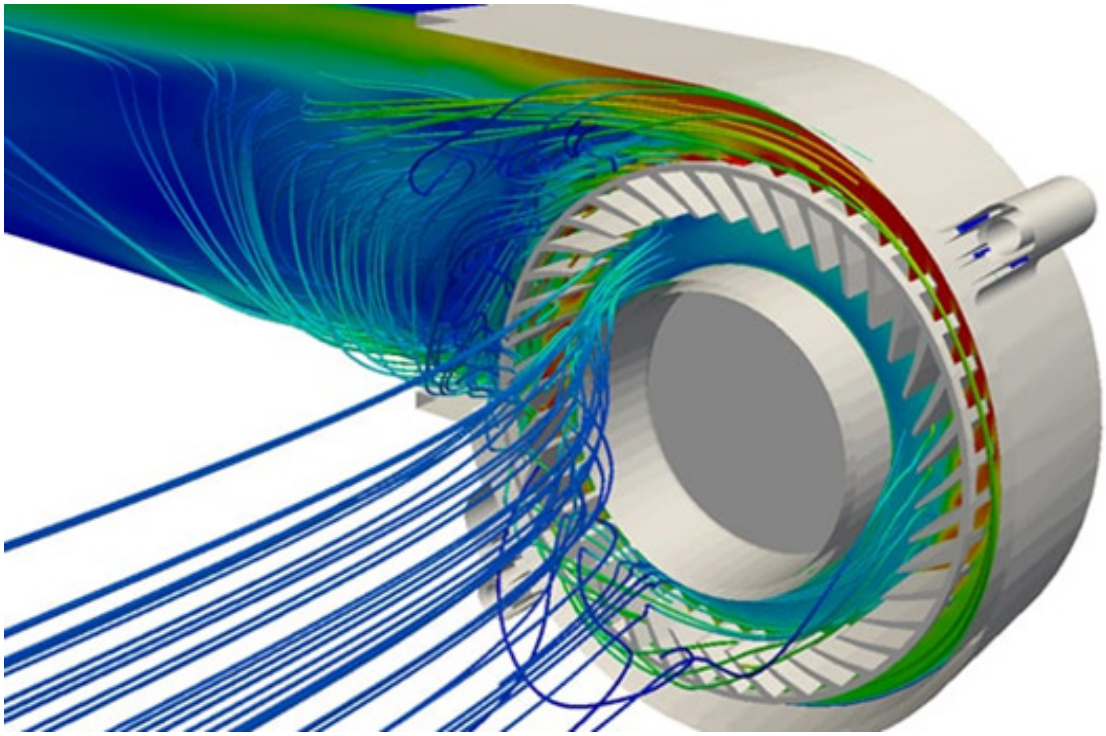


Figure 9: Velocity streamlines of the airflow through the radial fan

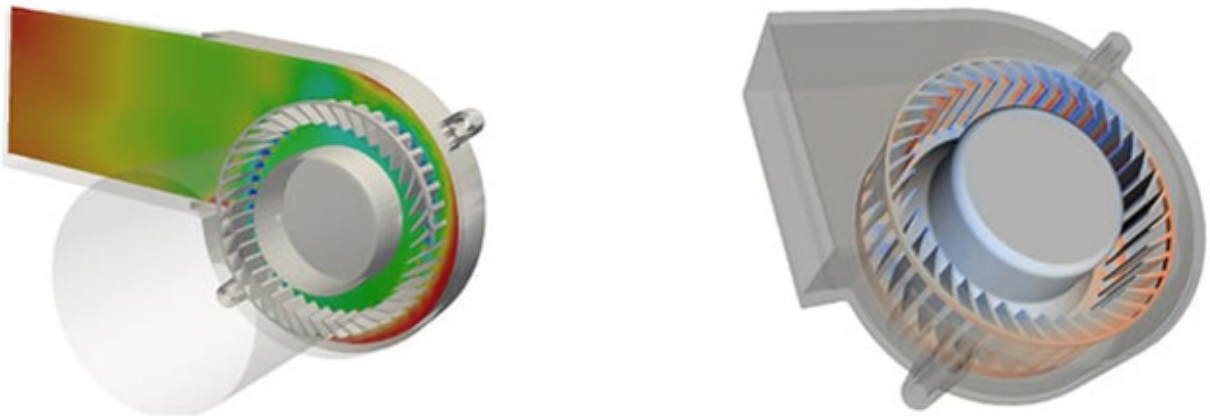
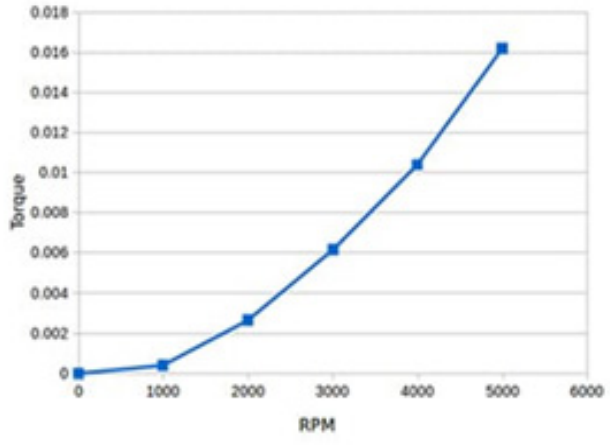


Figure 10: Static pressure (left) and forces acting on the rotor (right)

The contours above show a 3D visualization of static pressure, flow velocity, and the aerodynamic forces acting on the squirrel cage impeller fan rotor. The performance curves obtained from this analysis are key indicators that will inform whether the design meets the requirements or needs further optimization.



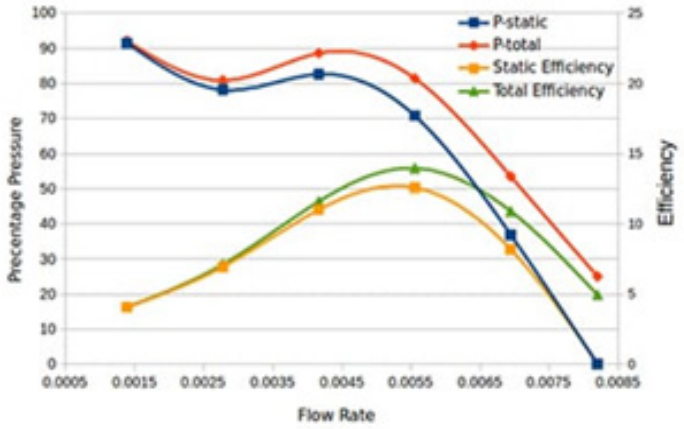
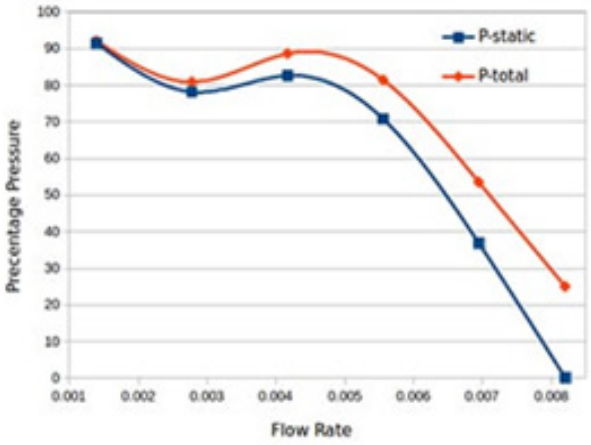


Figure 11: Fan Efficiency Graph



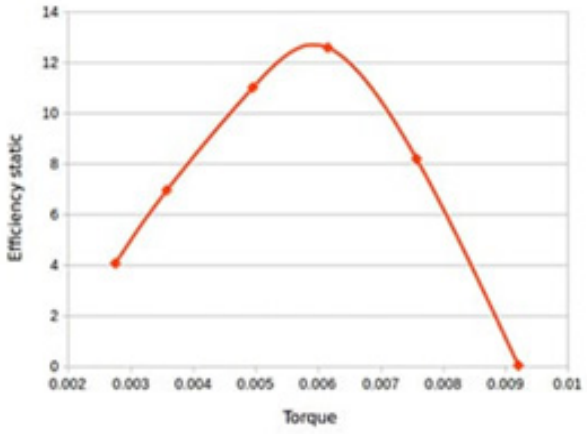


Figure 12: Pressure Efficiency Graph

Figure 7: Air Pump Unit

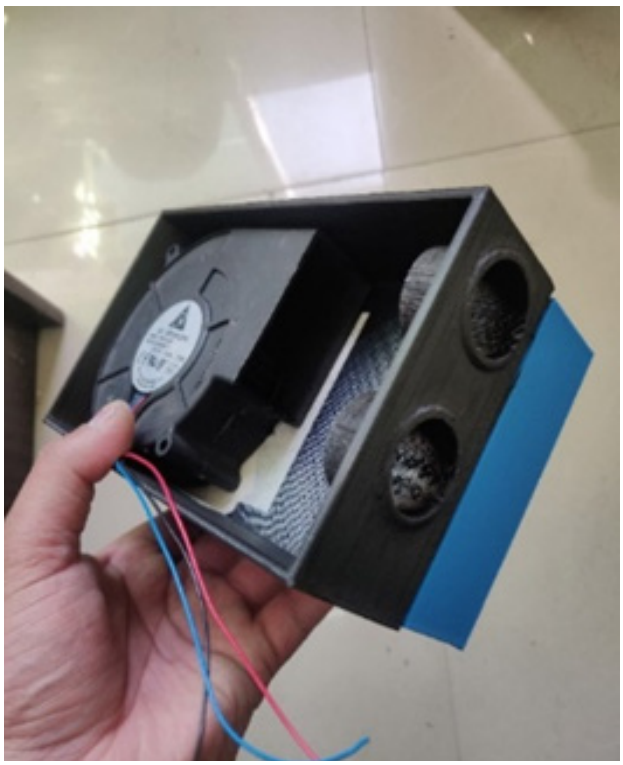


Figure 8: Perspective View of Air Pump

Air Filter Design

The air filters are made up of 4 layers, the first layer is a pre filter stage where large chuck of contamination is stopped like dust particles, etc. In the second layer which is made up of H13 grade HEPA material, virus and bacterial particles are stopped. The third layer consists of activated carbon particles which absorb odor and smell and keeps the air fresh. The final and fourth layer is an additional post filter layer which traps any extra particles which might have crossed the first three layers. All of these layers are made of non-woven materials. The air filter is 9.8 cms in breadth, 17 cms tall and 3.2 cms wide. The total volumetric space taken by the air handling unit is 533.12 cubic cm. Also, the air intake window of the air filter has available air intake area of 102.7 square cms (Height = 14.288 cms , Breadth = 7.188 cms).

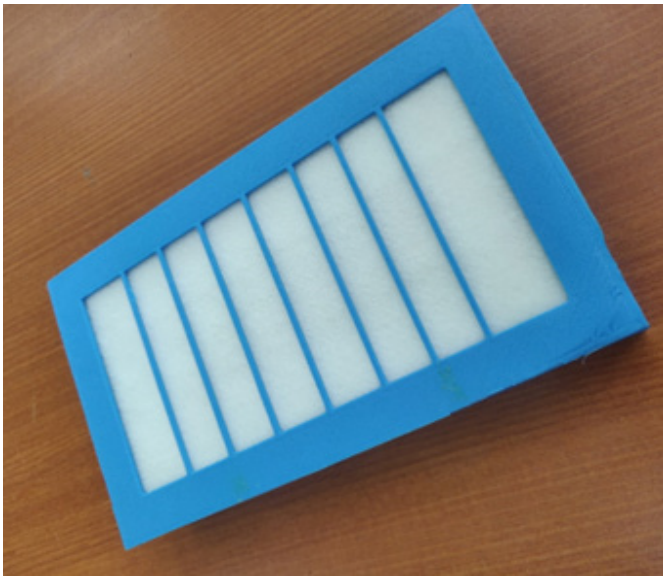


Figure 9: Air Filter Unit of PAPR

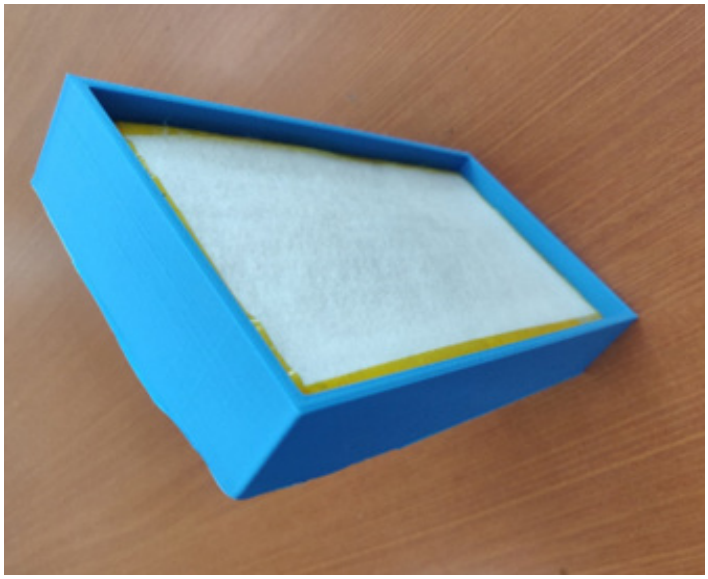


Figure 10: Back View of Air Filter Unit of PAPR

Battery Pack Design

The battery pack used is a Lithium-Ion battery pack consisting of 4 cells in series and in 3 parallel strings each rated at 2000mAh providing a total energy capacity of approximately 6000mAh.The total output voltage of the battery pack is 14.4volts at nominal and 16.8 volts at full charge. The battery pack is 10 cms in breadth, 8.2 cms tall and 8.4 cms wide. The total volumetric space taken by the battery pack is is 688.8 cubic cm.

Figure 11: Lithium Ion Charger with 6Ah Lithium Battery pack

Figure 12: Top View of Battery with Charger

Electronic Controller Design

The electronic controller consists of a Buck Converter circuit and a PWM circuit both rated at 9Amps as well as led indicators for mains on and battery charging.

The circuit works are follows:

The battery pack is connected to the buck converter which converts the variable input voltage from the battery pack to a constant 12 volts output. The 12-volt output from the buck converter is provided to the input of 555 timer based PWM circuit rated at 9Amps.We use a rotary knob resistor to control the PWM output of the circuit. The output power signal regulated at 12 volts with PWM control is fed to a Radial fan rated at 2.7 Amps 12 volts. The radial fan rotates at above 5000rpm creating an air flow of 8.93 CFM drawing 1.82Amps of current at 12volts DC.

Headgear to Air Handling Unit Connection Design

The air handling unit is connected to the headgear using two medical grade 24mm diameter air pipes also known as BIPAP pipes. This is a unique feature which is not provided with other PAPR units available in foreign markets. Each air pipe supplies air into the headgear at the rate of approx. 1300 feet per minute and thus able to create a total air flow of 8.93CFM in the headgear.

Figure 13: Headgear Unit Connected with Air handling Unit Via 2Nos. BiPAP Pipes

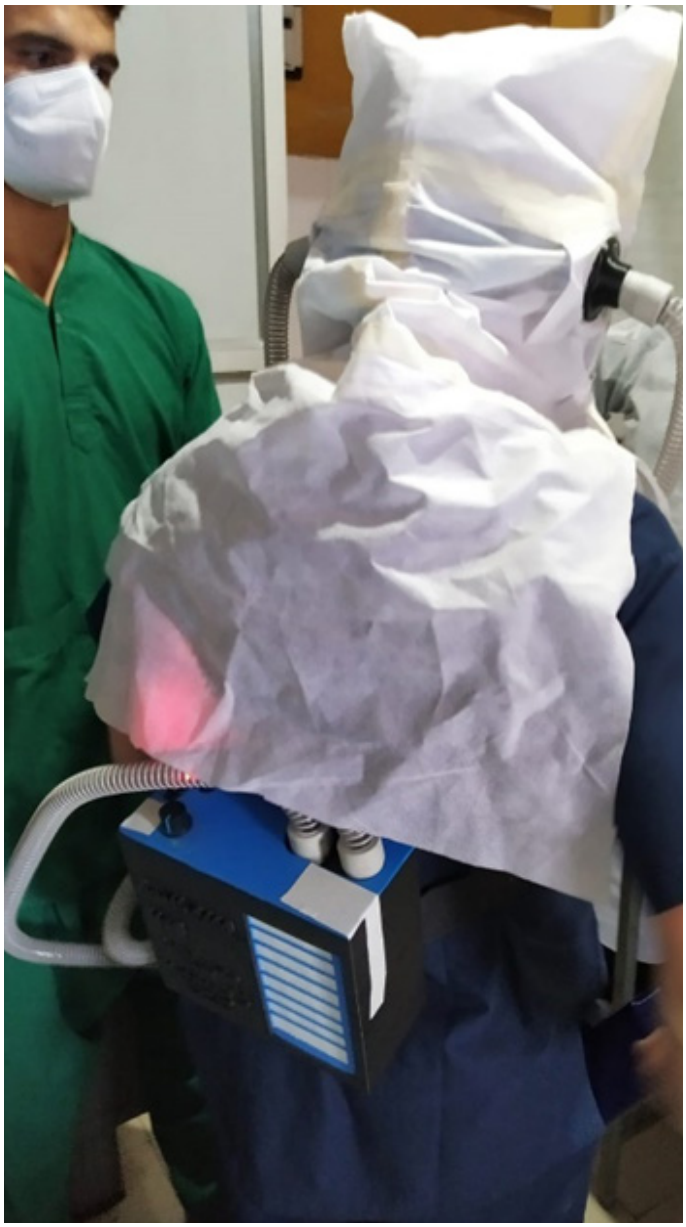


Figure 14: Back View of the Complete PAPR on User Body

Figure 15: Side View of PAPR attached to the User

Figure 16: Front View of PAPR attached to the User

Detailed Methodology Adopted

In the beginning, I did some literature survey on how the headgear for PAPR can be designed. I got to know about various configurations of headgear out of which the Lose fit headgear was the most adoptable and convenient to use as it was one size all fit design and solution. Then I did some literature survey about how various international manufacturers achieve a slight positive pressure inside the headgear.

After that, I designed the headgear in Autodesk Inventor software and started purchasing the raw materials from various vendors across the country for prototyping the headgear. I tested various materials for the frame of the headgear after the raw materials arrived. Finally. I fabricated the headgear using various materials like clear plastic sheet, spun bonded cloth, etc. After the headgear was prototyped, the next step was to design the air handling unit. In headgear, I designed the air flow nozzle in such a way that the incoming clean air would come directly to the mouth and nose areas of the users and create a positive pressure. I used two nozzles from both sides of the headgear to maximize the air flow efficiency.

I did some online literature survey regarding about how international manufacturers achieve slight positive pressure inside the headgear. Since, I had to design an air handling unit, it would contain all the parts like air filter, air pump, electronics, controllers, etc all in one place in a portable fashion. Since, PAPR needs to be moved when the user operates it, it definitely has to remain completely portable. Also, to achieve the minimum requirements set by OSHA, I brought various and different configurations of air motor and tested them all for air moving capabilities.

At last, I shortlisted 2 types of air flow motors. One was a 36-watt 12-volt DC 2.7 Amp rated radial impeller motor and the other was a 72-watt 12-volt DC 6 Amp rated radial impeller motor. I tested them for airflow and got air flows of 4300 ft/min and 7000 ft/min respectively without any filters while with the filters installed, the airflow was 1384 ft/min and 2400 ft/min respectively. The air flow was tested using anemometers.

The filters had to designed simultaneously according to the surface area of the radial impeller fan. I designed the filter and used HEPA 13 rated layer followed by an odor removing layer sandwiched in-between pre and post filters made up of high grade non-woven materials. The pre filter stops the larger dust particles after while the HEPA 13 filter stops above 95% of virus and bacteria. The odor layer made up of activated carbon particles trap all kinds of odor from the sucked in air and the last post filter layer is an additional safety layer. A total of 4 layers are used for filtering mechanism.

I designed this filter in Autodesk Inventor and fabricated

its frame using 3D printing techniques. The radial impeller fan had to be put in an enclosure assembly which was also designed by me in Autodesk Inventor.

I purchased the necessary consumables from market for fabricating the air handling unit. Once, the consumables arrived, I started work on assembling the air handling unit. The air handling unit was designed in such a way that it holds a battery pack, electronic controller, PWM controller, BMS circuit, Air pump and led indicators as well as ON/OFF switch and outlets and inlets for air movement.

The electronic controller consists of a Buck Converter circuit and a PWM circuit both rated at 9Amps as well as led indicators for mains on and battery charging.

The battery pack is connected to the buck converter which converts the variable input voltage from the battery pack to a constant 12 volts output. The 12-volt output from the buck converter is provided to the input of 555 timer based PWM circuit rated at 9Amps.We use a rotary knob resistor to control the PWM output of the circuit. The output power signal regulated at 12 volts with PWM control is fed to a Radial fan rated at 2.7 Amps 12 volts. The radial fan rotates at above 5000rpm creating an air flow of 8.93 CFM drawing 1.82Amps of current at 12volts DC.

I designed a double air flow outlet for maximum air flow to the headgear with reduced flow resistance.

For the supply of air flow from the air handling unit to the headgear, I choose 2 nos of BiPAP medical grade airflow pipes to connect the air handling unit with the headgear unit

Tests & Results

The PAPR was tested for airflow measurements after fabrication and checked if it qualifies the requirements of OSHA.

The airflow tests were done by a digital anemometer.

Following calculations were done:

Calculations

As per the OSHA ratings, I was supposed to create a filtered airflow of at least 170 liters per minute inside the headgear. 170 liters of airflow per minute is equal to 6 CFM and the maximum upper limit set by OSHA for air flow rate is 250 liters per minute which is equal to approximately 8.83 CFM.

Case 1st:

I tested a 2.7 Amp rated 12 volt 36 watts radial DC fan motor with input voltages of 12 volts and 13 volts and got the following results:

Table 2: Air Speed Vs CFM Vs Current Drawn of 3Amp DC Rated Radial Fan Blower

Air Speed	Area of Cross Section	CFM	Input Voltage	Current Drawn by Motor
1321 ft/min	0.00676316438 sq. ft	8.93	12v DC	1.82 Amps
1384 ft/min	0.00676316438 sq. ft	9.36	13v DC	1.97 Amps

As we can see that at 12 volts, the 2.7 Amps rated radial fan motor is drawing only 1.82 Amps and is able to generate airflow of 8.93 CFM which is well above the minimum requirements of 6 CFM and slightly above the required maximum limit of 8.83 CFM as per the OSHA ratings.

After this, the calculation for the battery pack requirement is done using the required backup time of the PAPR system.

The calculations are as follows:

Motor Current drawn (A) = 1.82 A

Motor Voltage (V) = 12 V

Thus, Motor wattage (VA) = 21.84 watts

Battery pack Rated Capacity (Ah) = 6 Ah

Battery Pack rated Voltage (V) = 14.4 V

Thus, the time (T) for which the PAPR will continue to work will be given by = Battery Rated Voltage*Battery Rated capacity / Motor Wattage

Time (T) = 86.4/21.84 = 3.95 hours.

Case 2nd:

I tested the second 6 Amp rated 12 volt 72 watts radial DC fan motor with input voltages of 12 volts and 13 volts and got the following results:

Table 3: Air Speed Vs CFM Vs Current Drawn of 6Amp DC Rated Radial Fan Blower

Air Speed	Area of Cross Section	CFM	Input Voltage	Current Drawn by Motor
2321 ft/min	0.00676316438 sq. ft	15.69	12v DC	4.3 Amps
2384 ft/min	0.00676316438 sq. ft	16.12	13v DC	4.8 Amps

As we can see that at 12 volts, the 6 Amps rated radial fan motor is drawing 4.3 Amps of current and is able to generate airflow of 15.69 CFM which is well above the minimum requirements of 6 CFM and much above the required maximum limit of 8.83 CFM as per the OSHA ratings.

After this, the calculation for the battery pack requirement is done using the required backup time of the PAPR system.

The calculations are as follows:

Motor Current drawn (A) = 4.3 A

Motor Voltage (V) = 12 V

Thus, Motor wattage (VA) = 51.6 watts

Battery pack Rated Capacity (Ah) = 6 Ah

Battery Pack rated Voltage (V) = 14.4 V

Thus, the time (T) for which the PAPR will continue to work will be given by = Battery Rated Voltage*Battery Rated capacity / Motor Wattage

Time (T) = 86.4/51.6 = 1.67 hours.

According to the OSHA ratings, the PAPR must be able to work for 75 minutes. So, we see that the backup time is reduced by using a higher rating motor but with the increase in airflow power.

Technical Results

The following technical results were achieved/observed:

- 8.93 CFM of airflow for a 2.7 Amp 12 V DC radial fan motor was achieved at 12 volts DC input.
- 9.36 CFM of airflow for a 2.7 Amp 12 V DC radial fan motor was achieved at 13 volts DC input.
- 15.69 CFM of airflow for a 6 Amp 12 V DC radial fan motor was achieved at 12 volts DC input.
- 16.12 CFM of airflow for a 6 Amp 12 V DC radial fan motor was achieved at 12 volts DC input.
- Backup time of 3.95 hours was achieved for a 2.7 Amp 12 V DC radial fan motor at 12 volts DC input.
- Backup time of 1.67 hours was achieved for a 6 Amp 12 V DC radial fan motor at 12 volts DC input.

TITLE OF THE PROJECT

Design and implementation of reduced switch count multi level inverter for unified power flow controller solar intermittency and power quality

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Brief Synopsis of the Project:

Because of the increased need for clean energy as well as the rigorous power quality requirements of many sensitive loads, multifunctional systems that can incorporate clean energy generation as well as power quality enhancement is required. This project is concerned with performance and design. The purpose of this project is to develop and analyse the performance of a single stage solar photovoltaic integrated unified power quality conditioner (PV-UPQC). In comparison to shunt and series active power filters, a unified power quality conditioner (UPQC), which includes both series and shunt compensators, can conduct load voltage control while also maintaining grid current sinusoidal at unity power factor. When compared to typical grid-connected inverters, the solar PV integrated UPQC provides various advantages, including improved grid power quality, protection of key loads from grid side disturbances, and increased fault ride through capabilities of the converter during transients.. The PV-UPQC is made up of a power electronics converter with a shunt and series-connected voltage compensators and a common dc-link. In addition to adjusting for load current harmonics, the shunt compensator extracts electricity from the PV array incorporated with maximum power point tracking (MPPT) scheme. The series compensator corrects grid-side power quality issues such as voltage sags/swells. The suggested solution combines the advantages of sustainable energy generation and improved power quality. The reduced device count multilevel converter further minimizes switching losses and allows it to handle more power with limited device ratings and thus improve the efficiency of overall system. The system's steady-state and dynamic performance will be assessed by modeling it in MATLAB-Simulink under a nonlinear load. The system performance will then be validated using a laboratory prototype with a decreased device count multilevel converter topology operating at a low switching frequency.

Work Done Report:

The research project sanctioned has been carefully followed on the prescribed procedure given in the literature and keeping in view the objectives of the research project. The comprehensive literature survey focusing on topological configurations of power converters, solar photovoltaic system and control strategies for unified power controller have been done. The simulation models have been developed with solar PV system alongwith maximum power point tracking algorithm (MPPT) and UPQC to mitigate voltage related power quality issues alongwith power generation from solar system in MATLAB software. The hardware components have been received and the model for reduced device count multilevel inverter has been developed in the laboratory. Based on the results, one book chapter has been accepted and will be published by Wiley, USA, one journal paper in SCI indexed journal of Wiley has been accepted and one IEEE international conference paper is under preparation stage. Another journal paper is also under drafting stage.

Likely Outcome of the Research Project:

Reduced device count multilevel converter for generation from solar system as closed to required sinusoidal waveform as possible without any filtering requirement. The power quality problem is another issue to be tackled for sensitive loads arising because of non linear load. The proposed system combines the benefits of renewable energy generation with enhanced power quality. The lower device count multilevel converter further reduces switching losses and allows it to handle more power with restricted device ratings, improving overall system efficiency.

Colored Photographs with Captions indicating progress of work/activities:

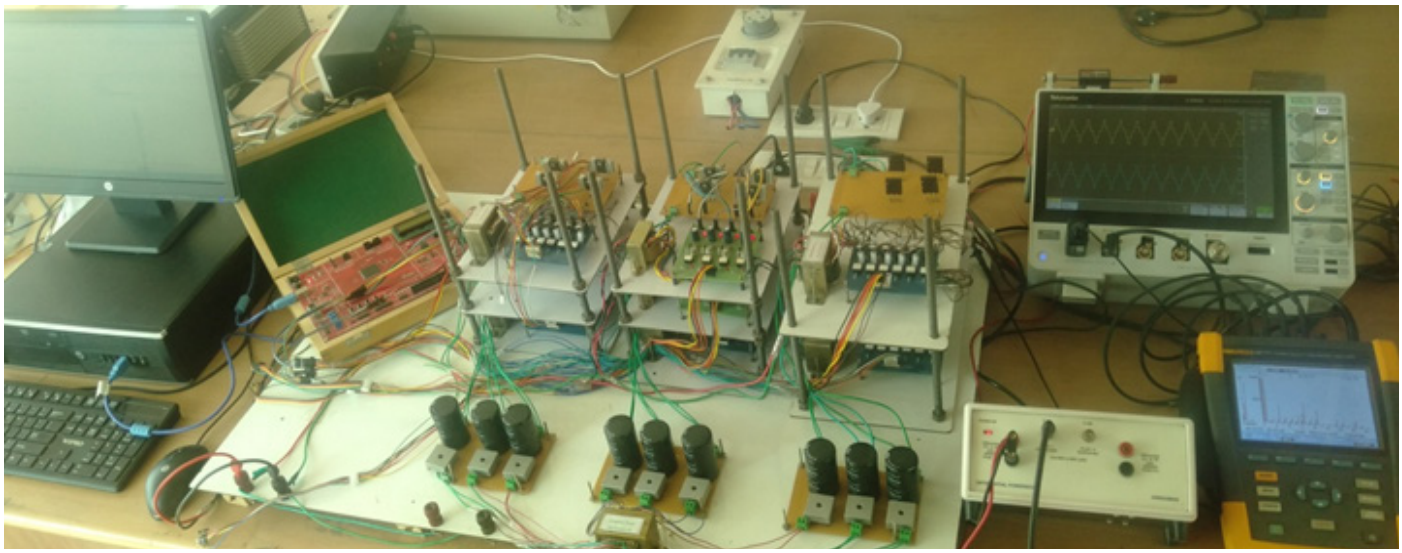
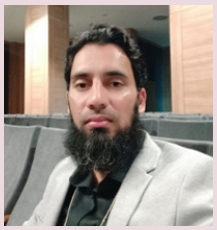


Fig. 1 Photograph of converter developed in the laboratory

TITLE OF THE PROJECT

Effective Thermal Insulation of Contemporary Houses in Kashmir



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Brief Synopsis of the Project:

We say that our homes are our shelters. Shelter is a habitation that offers us comfort from cold, heat, rain, sun and snow. Every home deserves to be called a shelter only and only if meets all these requirements. Our area which is a part of vast Himalayas is particularly cold. The common word on the mouth of every individual during the long winters is that our houses (that make our home) are cold. The brief summers are also hot with the increase in humidity levels wherein the houses cannot ventilate out the humid hot air. We build our houses such that snow and rains are protected against by tin pitched roofing. We all can safely that our houses do not meet the requirements of a proper shelter.

Our house construction has evolved over years from the use of traditional clay adobe bricks modern day use of fire kilned brick. The evolution has also happened in use of rampant concrete and cement in every type of construction. The use of steel rebars and modern day of Alumnimum claddings and Alumnimum and steel window frames is also becoming popular. Our houses are our entities and they need to be visualized from the perspective of proper use of materials. We invest enormous amount of money in their construction in terms materials and still find little comfort in such houses. At the same time, the investment on strength of house is paramount and this would require use of building materials that offer good strength for stability particularly during earthquakes.

So we at IUST Awantipora tried to explore various options that are available in making our housing structures comfortable; moreover adhering to the requirements of stability and strength of the structural housings. The work points out to use of the available materials but with good structural and architectural design.

1. At onset the first word to the Public at large would be to consult a building designer who has knowledge of earthquake resistance as well as thermal comfort in houses.

2. It needs to be clear that house features like house Orientation, amount of shading, type of roof with its roofing material and coatings and its pitch or angle of inclination, type of windows and window frames and window glazing's, amount of reflective paints on walls, size of openings or windows and ventilators and many more things are critical in a proper housing.

3. Our houses need to passively imbibe energy from the atmosphere in proper quantity and at the same time they should not leak out energy to the outside atmosphere in quantities not desired. During Winters, the Sun is south facing or southwards and thereby our windows need to trap maximum amount of solar energy during such season. The windows and their glazing's need south orientation in order to allow the infra-red radiation to be trapped. The inclination of the sun is at an angle of around 33 degrees in Srinagar City and the windows could be inclined at an angle to trap the solar energy. These principles have been adopted in many countries and housings. At the same time the housings need to have less exposure north wards but with proper ventillations. Accordingly, the summer rooms could be north facing which would have good ventilation and shadings as well on that face. The winter rooms could be south facing.

4. The rooms need shading with trees and plantation for hot summers where in the sun radiation falls from the east in morning. The early morning heating is critical during summers. So it is advised to shade the houses on eastern side and limited on the southern side.

5. The windows on western side for summer sun can have louvers or shaders but they need to be rolled up for winter sun. On cold winter days with limited solar radiation, the windows on east, west and north side can be availed with wooden outer shutters as was present in old housings. The same can be provided with simple small ventilators with glazing's for lighting and ventilation.

6. The house windows leak out 30% of the energy from the houses. The air-conditioned room leaks out more energy

with the increase in the thermal gradient between the exterior and interior of the housing. There is a rich wind draft called 'Taer chatt' in Kashmiri that flows from the windows and doors during winters. This happens due to absence of the silicon and rubber sealings on window panes and doors; the cost of which is negligible.

The windows once constructed with wooden frames finds it difficult to open after closing them during winters due to ingress of moisture as we commonly use un-seasoned wood. With the result, we call the carpenter during summers to remould the window frames which fit but actually leave an air gap. This air gap leads to wind draft/taer chatt during winters as well. So, achieving the proper window frames for winters in wood has become challenge. The present day houses are recommended to have UPVC panelled window frames for preventing winter wind draft. Secondly, the window glazing is in a thin glass that is un-reflective. The window glaze conducts all the outer temperature and cools down our rooms during winters. During summer the same window glazing heats up the room and even with the use of air-conditioning in a room, the loss of energy is tremendously high.

7. The houses need to be build with reflective glasses for summer sun only if sun radiation is heating the room in large quantities. However, use of reflective glasses on south side for winter Sun would not be desired in our region.

8. The outer walls of the house are mostly in bricks. The use of cement plaster on outer walls is not desirable as it offers maximum cold contact after aluminium and steel among common building materials. It would have been better to clad our housings on outer face with any thermal insulating material and with sun reflective coatings or colour. The exterior insulation is the best one can offer to a structure. This can be done post construction as well and years after construction as well. It is most desirable for proper housing design for maximum thermal comfort. There are many materials that offer thermal insulation, both engineered and non-engineered. It is advisable to consult the experts before proceeding on the nature of thermal insulation as 'one model does not fit everywhere.'

9. The ground floor is usually layed on mud or brick or stone or concrete flooring. These all offer conduction of cold temperature from the soil underneath and some loss of heat from rooms happens from the base flooring as well. The thermal insulation in base flooring is must with layers of water-proofing/barrier layers and as well as insulation layer.

10. The roof design for pitched roofs needs to be perfectly insulated. It is a general trend in market to use glass wool or some poor quality of mineral wool for insulation. These should be avoided as they hardly offer any insulation. The variety of insulating materials of which Polyurethane based foams are available are seen to among best for roofing insulation. The use of reflective coatings below roof (which is silver coloured foil) is advisable for hot areas and does not contribute to thermal insulation for winter cold. The use of it alone is of no specific purpose in our region but has become a norm. It is advised that all wall insulation's in mineral wool should be avoided from inside as our rooms are humid and closed during winters and there are more chances of condensation and subsequent fungal growth inside.

11. We have observed that the use of wooden panelling has become a norm in all our housings. It is again advised that use of wooden panelling only adds a combustible material which burns rapidly and does not contribute to thermal insulation or thermal comfort. This has been proven in studies performed in our work. It has been seen that the amount of electricity that is required in heating our houses during winters is tremendous given that there is limited availability of other sources of energy like coal, oil for conventional and semi-conventional heating gadgets. The cost of heating and cooling gadgets also increases with their efficiency from blowers, heaters to radiators, coolers, air conditioners, HVAC systems. Still with the increase in efficiency the electricity is required to be pumped continuously in order to run and maintain a comfortable temperature. Without passively designing our houses as detailed above in points, the worth of all heating and cooling techniques is net nil and with the result our houses never seem to heat up during winters. Even if they heat up, even half an hour of putting off the heating appliances pulls off all the heat from such houses. Conventional use of Hamam is not a viable and feasible solution in multi-story house as it does not cater to every room. Besides, it involves burning of wood, the resources of which are not being replenished rapidly.

The building of houses for winters in Kashmir is not difficult if properly supervised and construction is done as per set rules and principles of construction. The involvement of trained supervisors is critical and needs to be encouraged. The project investigates the following:

1. The Project will focus on studying the patterns of Building construction being followed in Himalayas specifically the region of Kashmir over a period of last one century.

2. The Project will focus on the influence of the change of building house materials and their construction techniques on human society and their standard of living over a period of last few decades.

3. The Project will further investigate the flaws in our construction module. It will present the retrofitting module for such building houses and future influence on the living standards of the society.

4. The Project will develop the BIM integration module of the houses in Himalayas specifically Kashmir and present a standardization report to be followed for buildings in Himalayas specifically for houses in Kashmir.

5. The Project will incorporate the instrumentation to model the influence of removal of construction defects in building houses on thermal properties of our building houses.

6. The Project will utilize the insulation layering panels from blend of local and global engineered products for thermal insulation of our building houses.

7. The Project will further correlate the cost of proper construction standardization and insulating materials to long term energy costs for our building houses.

Work Done Report:

1. Survey on determining the level of thermal comfort of houses - Completed

2.Determining the Meteorological data for different stations for Kashmir- Completed

3. Studies on Comparison of thermal insulation (comparison of different elements, their thermal storage, total thermal temperature levels) of three different houses - a. Adobe clay House, b. Dhajji-Dewari House, c. Brick Kiln House with wooden Floor, d. Brick Kiln House with concrete flooring- Under Process

4. Studies on comparison of thermal leakages in different houses – Under Process

5. Data record of one contemporary house for winter - Studies from installing thermal sensors on walls, air temperature outside and inside from DAQ/GSM – Under Process

6. Building of Thermal Comfort room - Building recording data of thermal comfort effect on humans – Next work

7. Developing first report on structural and thermal problems in structure – Under Process

8. Developing second report on guidelines on building houses – Next work

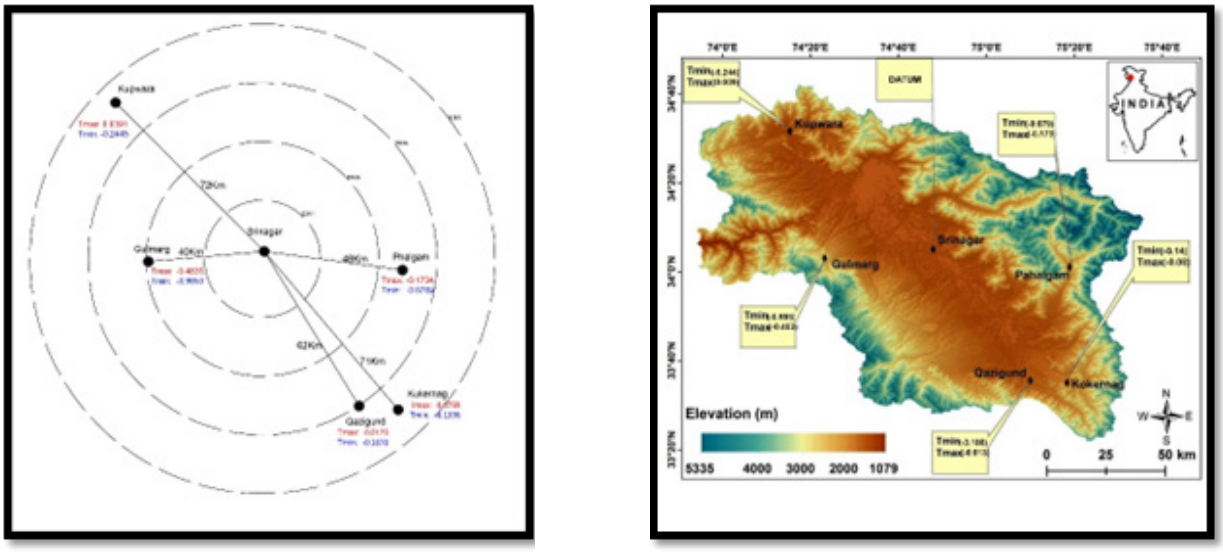

Figure 1: Temperature Profiles and Variations Study for different stations

Figure 2: Thermal Studies on Contemporary Houses

Likely Outcome of the Project:

1. The Temperatures in UT of J&K particularly in Kashmir region and Hilly districts of Jammu Division dip considerably during winters. The energy consumption during winters doubles on account of use of heating gadgets for longer periods of Time (Source: JKPDD). The fir st Outcome of this Project would be to decrease the Power consumption on account of effective heating of the rooms.

2. The Low Temperatures during winters does not offer favorable working atmosphere for people in the UT of J&K and many families move to other locations. The second Outcome would be providing comfortable working and living climate such that duty hours are not restricted and people do not have to take long vacations during winters. The temperatures in UT of J&K are extreme throughout the Year, from -20 degrees Celsius reported to as high as 40 degree Celsius. The Outcome would be to provide moderate room temperatures throughout the Houses at most economical solutions available.

3. There have been reported health issues particularly Orthopedic and Heart Blocks due to exposure to very cold climates and particularly when residing in reinforced concrete structures during winters in UT of J&K particularly in Kashmir division. The third Outcome would be to decrease the adverse health effects of cold climates while residing or working in structures.

4. Fourthly, using the blend of global and local technologies, products and techniques would be developed by analyzing the local buildings for thermal effectiveness. This will cater to effective and economical thermal insulation of contemporary houses in UT of J&K. The final products and techniques developed could be commercialized through Start-ups.

TITLE OF THE PROJECT

Extraction, characterization, and antimicrobial activity of walnut hull: studies on its food and non-food applications

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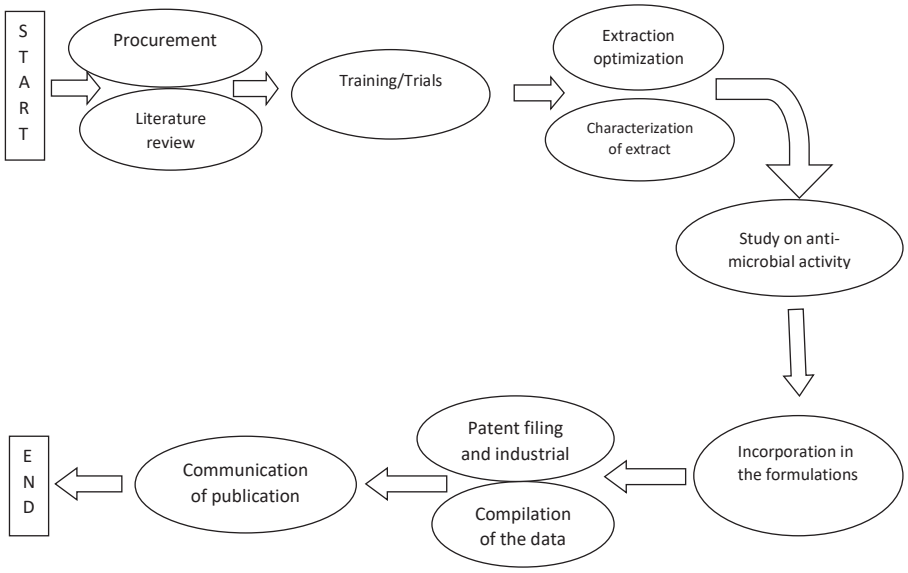
Brief synopsis of the project:

The proposed research evaluates the characteristics of the walnut hull for its industrial application. The high content of polyphenols of the walnut hull having potential antimicrobial and antioxidant capacity is utilized for the use of extract in antimicrobial food packaging film/coating and formulation of the oral cavity disinfectants. The hull is generally wasted during the harvesting of walnuts; therefore, this research proposes waste utilization for the welfare of socio-economic purpose. The project is expected to complete with the following Objectives:

1. Optimization of extraction process of walnut hull extract
2. Characterization of the extract with respect to antimicrobial and antioxidant activity
3. Estimation of antimicrobial activity of wall nut hull extract against food spoilage and dental caries causing microbes
4. Stability of the walnut hull extract in antimicrobial biodegradable food coating/film and oral cavity disinfectant formulations



Work done report:

Procurement and recruitment of temporary manpower. The raw material was studied for preliminary analysis such as titratable acidity, pH and total soluble solids. The study on extraction using different solvents was conducted, the maximum recovery was found in water. However, the water extract was low in total phenolic content and total flavonoids. Further the antioxidant potential of the extract was observed by different methods such as DPPH, ABTS and Reducing power assay. The antimicrobial study was conducted to evaluate the potential of the walnut hull extract against the common food spoilage microbes (Bacteria and Molds). Further the general study was performed to check the activity of the extract against the oral microflora.

Likely outcome of the project:

1. The use of walnut hull extract bearing huge antimicrobial potential can be thus utilized as a vital ingredient in the development of antimicrobial bio-plastic film coating for the application in food packaging.

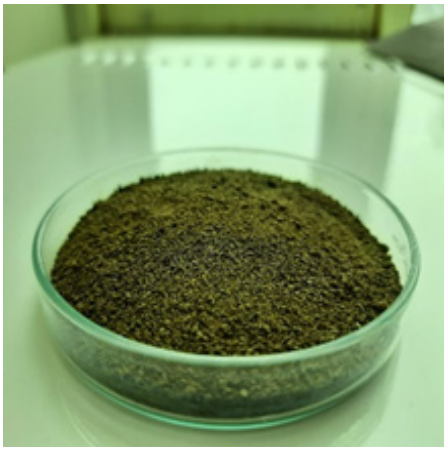
2. Dental caries and oral hygiene is one of the most common problems with human health all over the world thus utilization of this waste in solving such common issues is a great interest and has relevance in industrial applications.

3. Based on the antimicrobial activity, this proposal aims to exploit its potential for combating dental caries with the help of incorporation in oral cleaning formulations

Recommendations

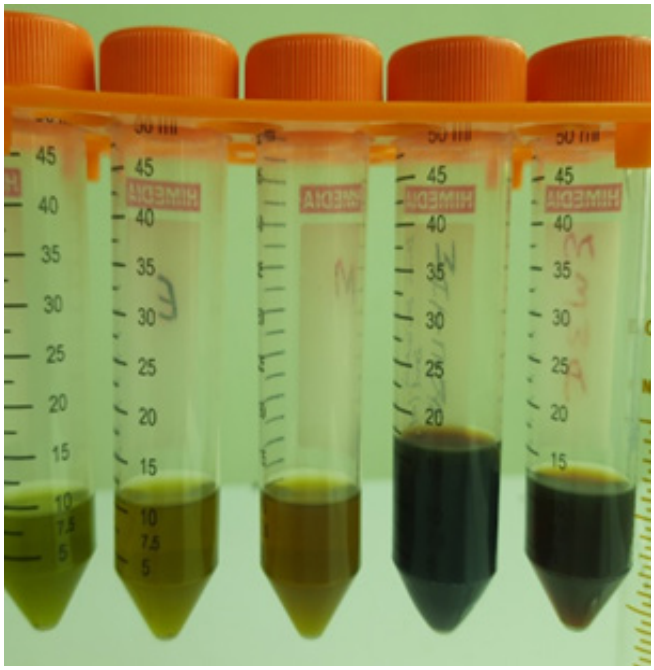
Fresh Walnut Hull

Dried Walnut Hull

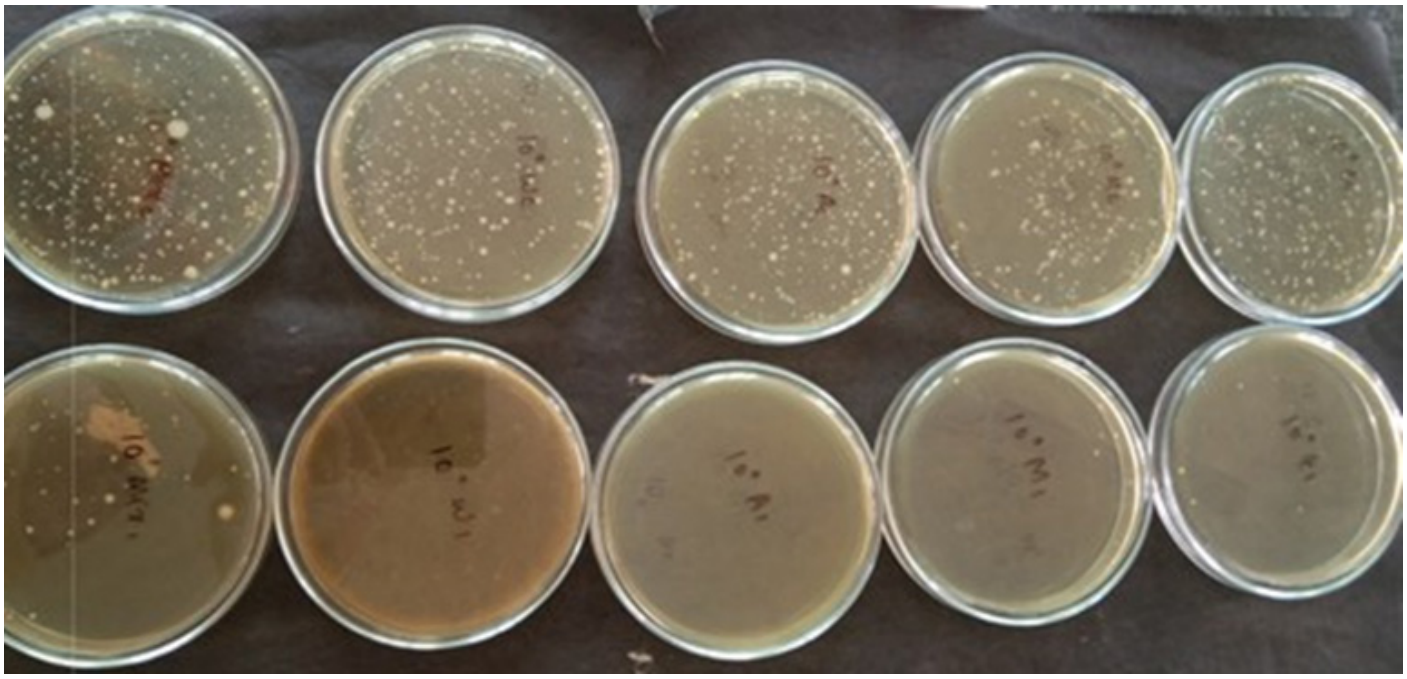


Hull Powder Walnut

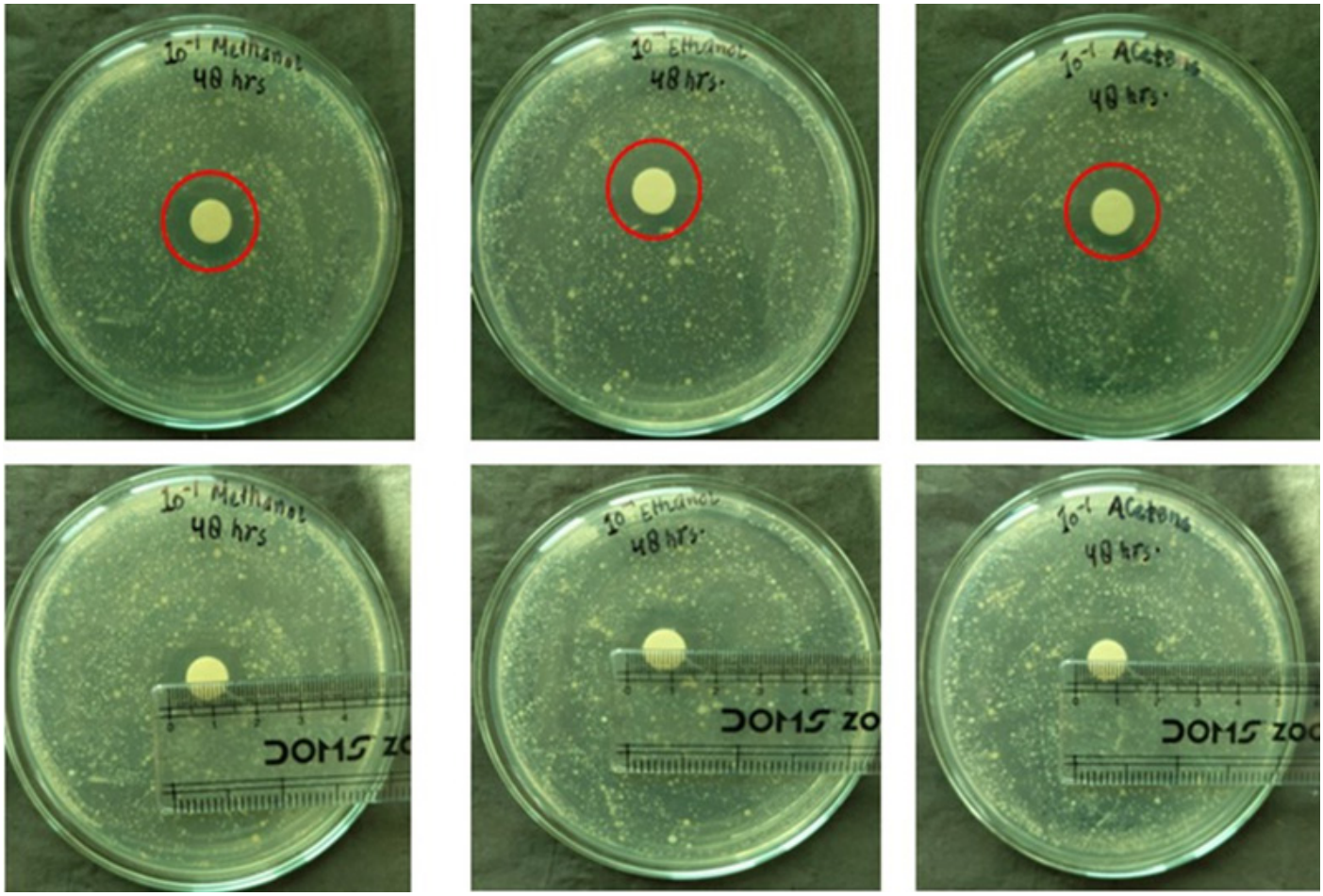
Walnut Hull Extract



Walnut Hull extract with different solvents



Antimicrobial activity against food spoilage microbes



Antimicrobial activity against dental caries causing microbes

TITLE OF THE PROJECT

"Fluorescent and Colorimetric chemosensors for environmental mercury cation (Hg2+) and fluoride (F-) detection

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Project reference No.: JKST&IC/SRE/435-38

Sponsored agency: JKSTIC/DST

Title of the project: "Fluorescent and Colorimetric chemosensors for environmental mercury cation (Hg2+) and fluoride (F-) detection"

The design and development of receptors for the selective recognition of anions especially fluoride anion has gained a lot of attention in supramolecular chemistry. Fluoride anion is unique among its congeners due to its relative size and electronegativity. Fluoride anion has got a lot of importance in many biological and medical processes but at the same time over exposure of fluoride anion had severe consequences on health and environment. A great deal of efforts has been put over the past few years for the development of colorimetric and fluorescent chemosensors for the detection of fluoride anion, with the emphasis to be selective with this particular anion so as to be useful in real time applications. Numerous small molecules based colorimetric and fluorescent sensors have been reported and used in the detection of trace amounts of fluoride anion. Chemosensors which exploit hydrogen bonding capability should have suitable H-bonding moieties like –OH and –NHR (νNH2) groups. Hydrazones with the >C=N-NH-C< skeleton are preferred due to their modularity, easy synthesis, and stability towards hydrolysis. The tendency of the acidic NH proton to form hydrogen bonding is used for sensing applications. Molecules such asanthracene, indole, salicylaldehyde, pyrene, terpyridine, calixarene, and 5-phenylazo-salicylaldehyde containing hydrazone moiety have been employed in anion recognition studies. Chromophores substituted with dinitrophenylhydrazone units have been extensively explored for anion binding studies.1ν11 There is always a need to synthesize receptors for anion recognition that are sensitive and selective and at the same time easy to synthesize. We were interested to develop a simple and inexpensive receptor for fluoride anion detection based on multiple chromophores containing acidic OH and NH moieties within the molecular framework.

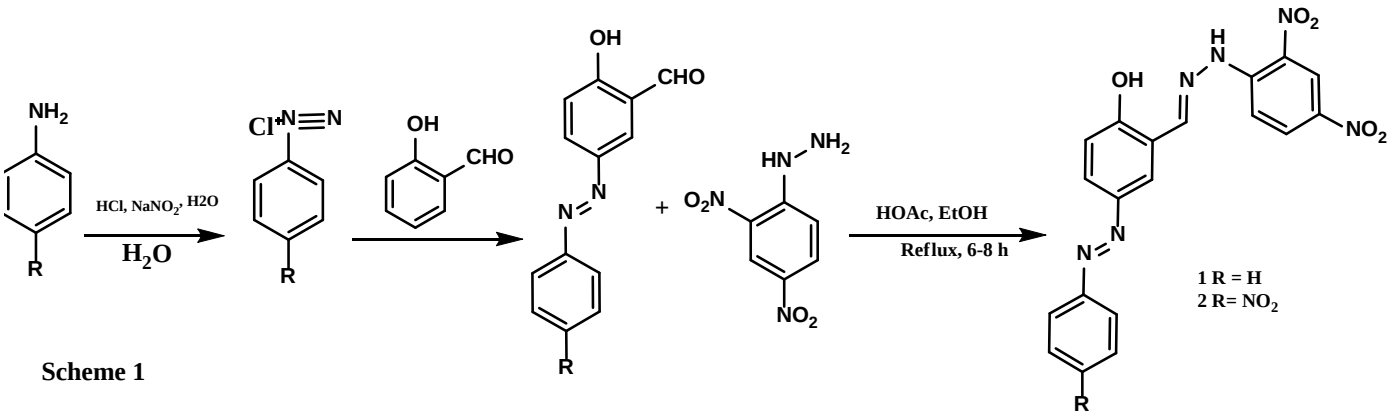
So, the objectives of this project are:

(i) To develop cheap, robust, chemically stable and reliable small molecule sensors that exhibit very impressive toxic ion detection (Fν and Hg2+) either in organic solvents or in an aqueous system and later their removal from aqueous system.

(ii) To utilize the output of this research proposal in fabricating a user friendly prototype for easy and rapid on spot toxic ion detection of fluoride anion and Hg2+.

Work done report:

The diazonium salts of aniline, pνnitro aniline, very important synthetic reagents in the preparation of various aromatic compounds, dyes and drugs were synthesized and later diazo coupling reaction with salicylaldehyde in basic medium results in the formation of 5νsubstituted salicylaldehyde derivatives. These derivatives were further treated with 2,4-dinitrophenylhydrazine to yield corresponding hydrazone based chromophores. The synthesized chemosensors (1 and 2) now have multi chromophores in their structures and also contain acidic OH and NH protons. The synthesized chemosensors were characterized with various spectroscopic techniques to confirm their purity. The synthesized chromophores substituted with dinitrophenylhydrazone units have been further explored for anion binding studies, especially for the detection of fluoride anion.



Scheme 1

The aldehyde derivatives utilized in the synthesis of these chemosensors were characterized by FT-IR and 1H NMR spectroscopy. FT-IR spectra of aldehyde derivatives shows a characteristic –N=Nν stretching band near 1480 cmν1 and a stretching vibration at 1671-1666 cmν1corresponding to aldehyde group (HC=O). In the 1H NMR spectra, peaks at 11.32 ppm, 11.46 ppm correspond to the OH proton, whereas peaks at 10.03 ppm, 10.05 ppm correspond to the aldehyde (CHO) proton. This clearly indicates that the corresponding salicylaldehyde derivatives are formed.

The reactions of aldehyed derivatives with 2,4-dinitrophenylhydrazine in ethanol under refluxing conditions produced compounds 2-(2,4-dinitrophenyl hydrazone)-5-phenyldiazo benzaldehyde (1), 2-(2,4-dinitrophenyl hydrazone)-5-(4-nitrophenyldiazo)benzaldehyde (2), respectively, in good yield (Scheme 1). The 1H NMR spectra of compounds 1 and 2 were recorded in dueterated d6-DMSO. The 1H NMR spectra of compound 2 show two characteristic peaks at 11.08 ppm attributed to the protons of (νNHν), 11.5 ppm attributed to the protons of (νOH) and 9.03 ppm attributed to the imine proton (HC=N). The presence of imine bond (HC=N) formation in the molecules 1 and 2 is further confirmed by the vibrational bands at 1616 cmν1 and 1617 cmν1, respectively, in the FTνIR spectrum.

Visual sensing of anions:

The chemosensors 1 and 2 were used for the visual sensing of anions in CH3CN solution. The observations showed that addition of fluoride ion to the CH3CN solution of the sensor 2 (10 νM) leads to the drastic colour change from yellow to deep purple. The colour change observations can be easily detected under naked eye. The colour of the solution intensified with increasing fluoride ion concentration. Upon addition of solutions of different anions like BF4–, Br–, I–, Cl–, ClO4–, no colour change was observed which shows no interaction of these anions with the chemosenosr 2. These observations were further confirmed by UV/V spectroscopic studies. The further work of this is undergoing.

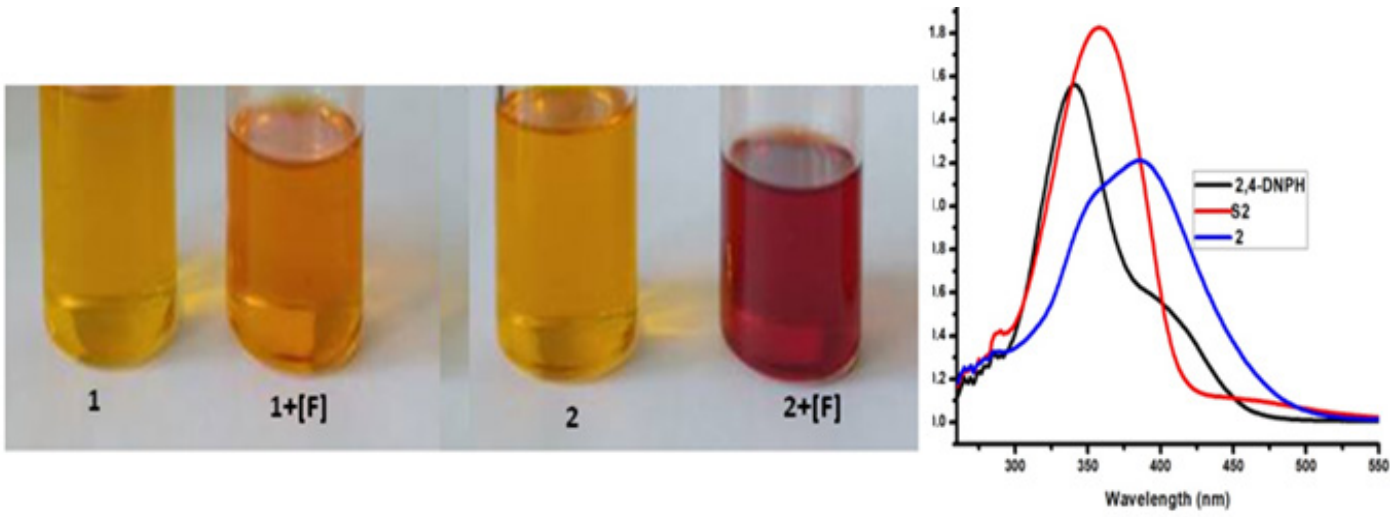


Fig. 1: visual color changes of 1 and 2 upon addition of 5 equivalents of F- anion (left side). Absorption spectra of 2, S2 and 2,4-dinitrophenylhydrazine (10 μM) in CH3CN (right side).

In order to understand the interaction between the anions and the receptors properly, UV–Vis experiment has been performed in CH3CN solvent. Receptor 2-(2,4-dinitrophenyl hydrazone)-5-(4-nitrophenyldiazo)benzaldehyde (2) exhibits a strong absorption band at 386 nm (Figure 2). The starting precursors 5-(4-nitro phenylazo)salicylaldehyde (S2) and 2,4-dinitrophenylhydrazine for the synthesis of 2, show absorption bands at 358 nm and 339 nm (Figure 1, right side). So a larger batochromic shift is observed upon the formation of 2.

Upon adding increasing amount of F– ion to 2 (2.0 × 10–5 M) in CH3CN solution, the peak at 386 nm gradually decreases and a new broad absorption peak at 560 nm appears accompanied by a visual color change of the solution from yellow to purple. Spectral change clearly indicates interaction of receptor with fluoride ion and the obvious choice is the formation of complex between the receptor and the fluoride ion indicated by the presence of a distinct isosbetic point at 457 nm (Figure 2, left side). The appearance of a single isosbetic point upon addition of several equivalents of Fν ion indicates the presence of only two species, neutral host 2 and its anion in the solution. Figure 2 shows the gradual decrease and increase in the concentrations of these two species with increase in equivalents of TBAF.

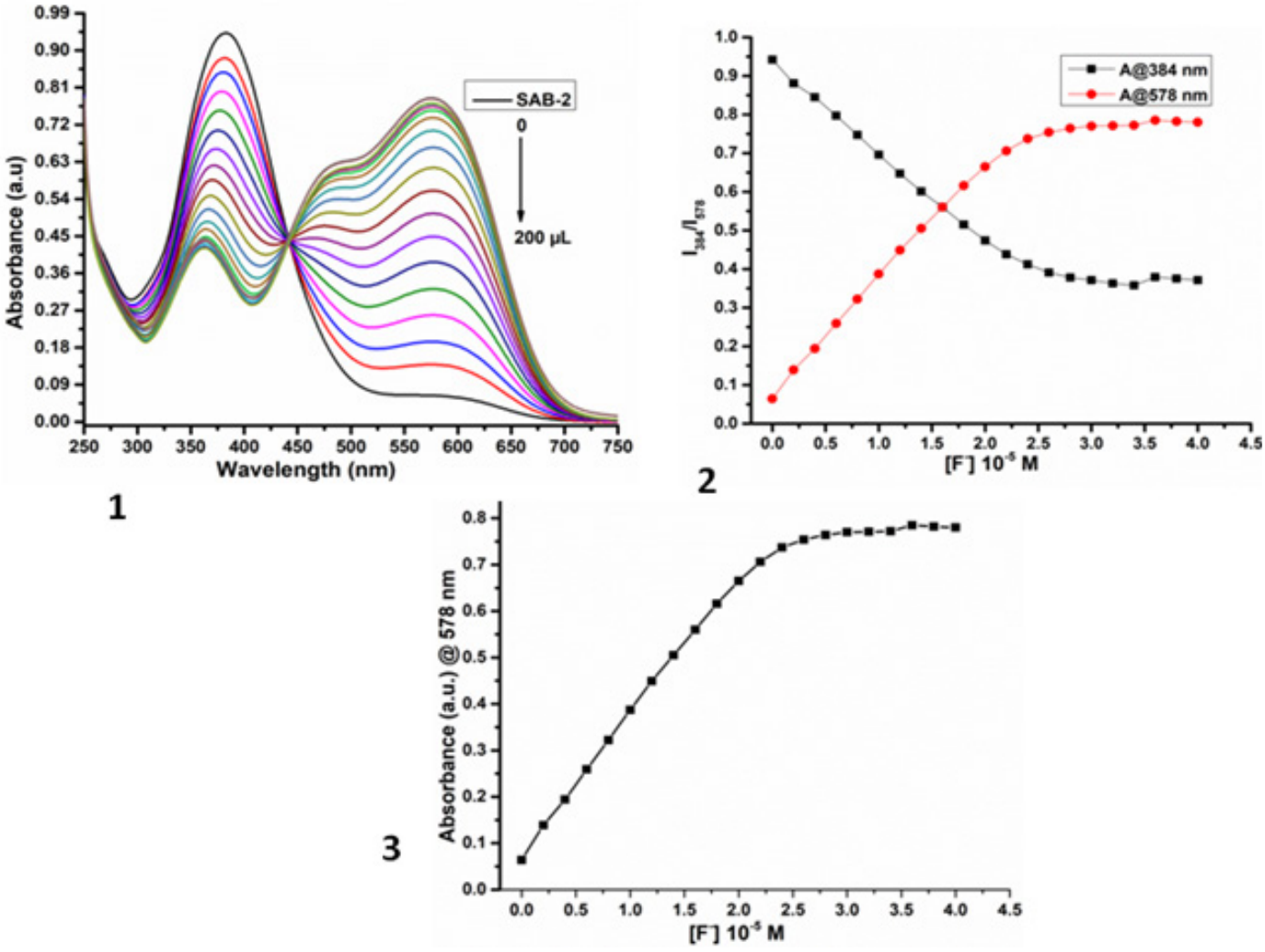


Fig. 2: (1) UV-V spectra of 2 (20 νM) upon titration with TBAF (6000 νM) solution in CH3CN. (2) Plot of absorption of 2 (20 νM) versus concentration of [F-] showing increase and decrease of absorption intensity of 578 nm and 384 nm bands, respectively. (3) Plot of absorbance intensity at 578 nm versus [F-] concentration.

Under similar experimental condition, on addition of other anions such as BF4–, Br–, ClO4–, no notable spectral changes were observed with 2 indicating no interaction or complexation of these anions with 2 (Figure 3). The appreciable spectral change of 2 in presence of fluoride indicates that it can detect fluoride ion selectively.

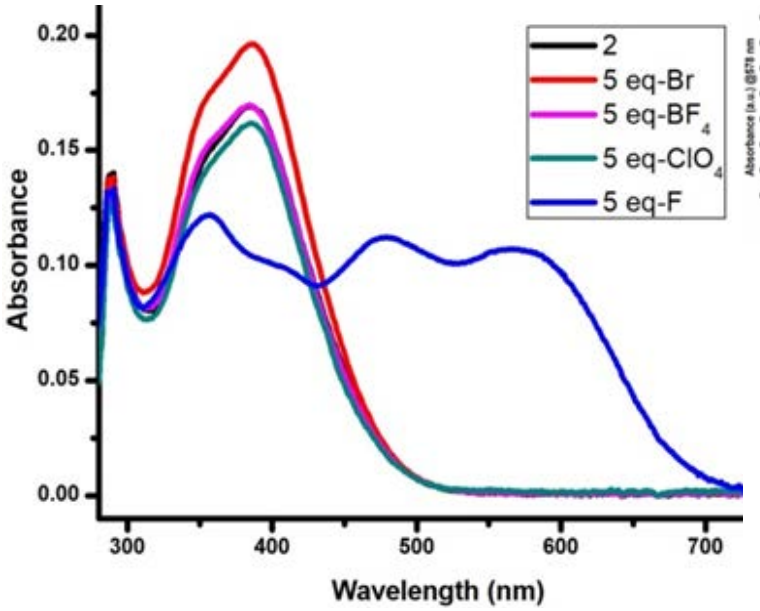


Fig. 3: UVμVis spectral changes of 2 (2.0 × 10–5 M) in CH3CN in presence of different anions Fμ, BF4–, Br–, ClO4– (5 equivalents) in CH3CN solvent.

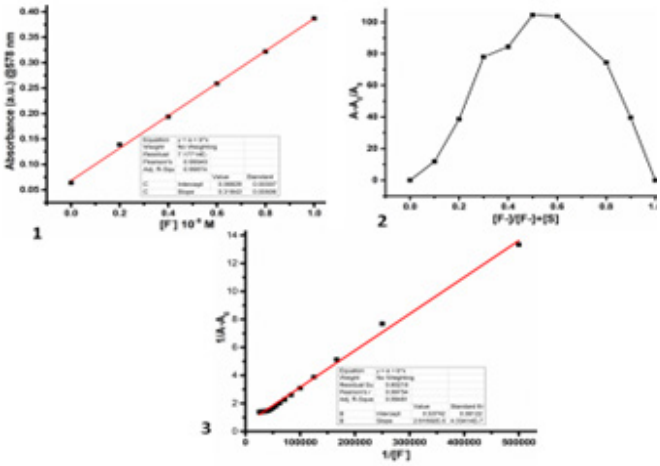


Fig.4: (2) Job's plot of 2 (2.0 × 10–5 M) with fluoride. (3) B-H plot for the titration of 2 with fluoride ion.

The figure 4 (2) shows Job's plot that clearly indicates the formation of 1:1 stoichiometry between 2 and fluoride. The binding constant or association constant K (M-1 or M-2) is determined from the ratio of intercept and slope of Benesi–Hildebrand plot of the optical density.

As shown in Figure 4 (3), the Benesi–Hildebrand (B–H) plot of 1/[AνA0] vs 1/[Fν] for the titration of 2 and F- ion provides a straight line, indicating 1:1 complex formation with association constant (K) value as 2.05×104 Mν1. The higher association constant value clearly indicates that the stability of the complex formed between 2 and fluoride ion. Further, the LOD was obtained from the plot of absorbance intensity versus fluoride concentration. The LOD value obtained 0.285 νM.

In conclusion, we have rationally designed and synthesized a receptor molecule featuring azo dye and 2,5-dinitro hydrazide group and is reported as selective chemosensor for fluoride ion through naked-eye color changes without any spectroscopic instrumentation. Spectral test results showed that the recognition process of receptor 2 for fluoride is less affected by other anions. The limit of detection (LOD) of 2 toward fluoride is found as low as 0.285 νM and the binding constant was calculated to be 2.05×104 Mν1. The Job's plot based on spectroscopic data revealed a 1:1 binding stoichiometry between the receptor 2 and fluoride. To get more insights about the binding mechanism between the receptor 2 and fluoride, 1H NMR, HRMS and DFT studies needs to be performed. Further work is going on to prepare solid supported material (test kit) that can be utilized for the detection of fluoride ion.

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TITLE OF THE PROJECT

A Computer Vision Based Real-Time Portable Fruit Grading and Sorting System Through Quality Evaluation and Classification.

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Brief Synopsis of the project

Fruit grading and sorting process is an absolute necessity in fruit industry. In practice, if a factory grade fruit sorting machine is not available, it is done manually. Manual inspection creates problems in maintaining consistency in grading and uniformity in sorting, while also adding to the factor of human error. To speed up and also automate the process while maintaining the consistency and uniformity of fruits, of a particular class and specification of physical features, an AI based portable machine is proposed. The target has been to design a system that is able to sort fruits according to the color, size, reflectance and texture. The inclusion of taste, as a parameter has also been discussed. The system includes a hopper that would receive fruits in bulk. Then there would be an inspection bed to take sensor values for various physical parameters, following which the fruits are conveyed to the actuation part. In the actuation part the fruits are finally sent to their target physical locations that correspond to respective classes of designated physical or chemical traits, termed as grades, in accordance with the respectively inspected parameters.

Work Done:

Fruit classification algorithm was developed and implemented on Raspberry pi hardware platform. Fruits were identified on real-time basis. It was observed the algorithm performed with high latency on the hardware. In order to address the problem an order is placed for the procurement of high speed board (FPGA board). The equipment due to global shortage in semiconductors is in transit and is yet to be delivered by the supplier.

Publications: A communication block for the project was implemented in CAD tool and is communicated for the possible publication.

Likely Outcome:

1. Low cost, portable apple fruit grading prototype.
2. Analysis of various varieties of apple for system under varying conditions (shape, color, texture etc.)
3. Patents/Publications

Figure: A hardware platform on which the algorithm is implemented

TITLE OF THE PROJECT

Learning drug associations Using Convolutional Neural Networks

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Brief synopsis of the project

1. Project Title: Learning Drug Associations Using Convolutional Neural Networks.

2. Project Summary:

The utopian world envisaged by machine learners is a partial reality now. We live in a world that is interacting with us in a way we had not perceived few decades before. Email filtering, product recommendations, traffic routing apps are few examples which employ machine learning (ML) algorithms to solve our daily problems. The nascent field of ML has now taken a big leap with the advent of sub-field called Deep Learning (DL). Deep Learning acts as a multi – layer filter that aids in understanding better 'representations of data' which is fundamental to solving some classical problems like image classification; where ML algorithms fall short.

Machine and Deep Learning algorithms have found their utilization in many fields be it wireless communications, IoT , Healthcare etc. Talking of healthcare, ML algorithms are being used for early predictions of diseases like cancer, Alzheimer's etc. Polypharmacy has also caught the attention of researchers recently. Polypharmacy connotes drug-drug interactions. It can have adverse effects on the health of the patients suffering from co morbidity i.e multiple diseases.

The aim of this project is to propose a novel design framework that models the drug-drug interactions using a knowledge graph, developing and training a Convolutional Neural Network (CNN) to learn new associations that may exist. Mapping of side-effects relationship boils down to link state prediction problem and we will employ Tensor Factorization for developing our network model. We will analyze the accuracy of our model with experimentation on varying datasets with a case study on the patients of JAMMU and KASHMIR where co-morbidity in the form of Diabetes, Hypertension, Hypo/ Hyper Thyroids are common. Finally, in order to establish the efficacy of our proposed model, a comparison with other baseline models will be presented.

3. Keywords: Knowledge Graph; Drug Associations; Convolutional Neural Network(CNN); Polypharmacy ; Link State prediction; Tensor Factorization.

4. Introduction

Definition of the problem:

The motivation to undertake this research stems from the fact that a patient's life can be jeopardized due to unfavorable interaction that may occur due to polypharmacy i.e negative effects on patients health due to concurrent intake of multiple medicines. Although most of these effects are discovered prior to drug introduction on the market during pre-clinical and clinical trials, certain potentially significant adverse effects only become identified after the drug is already in use. According to a recent study of European epidemiological research, 3.5% of hospital admissions are due to adverse drug reactions and 10% of patients experience adverse drug reactions during hospitalization. Owing to this, knowledge of drug interactions is pivotal and demands in depth study and extensive research on varying drug data sets. However, due to little work carried out so far, limited clinical testing and the complex relationships that drugs may exhibit; polypharmacy turns out to be a daunting task. Thus unraveling any side effects remains an important research challenge with significant implications.

Objective:

The aim of this project is to propose a novel design framework that models the drug interactions using a knowledge graph and then develop and train a Convolutional Neural Network (CNN) using Tensor Factorization to learn new associations that may exist.

	Tasks	Q 1		Q 2		Q 3		Q4		Q5	Q6
1.	Literature Review										
2.	Collection of drug datasets										
3.	Analyzing existing solutions based on chosen objective										
4.	Understanding TensorFlow and Keras Library										
5.	Analyzing Keras Functional API										
6.	Modeling the Drug interactions using Knowledge Graph (KG)										
7.	Developing and Training CNN on KG using Keras										
8.	Results / Performance analysis of Model										
9.	Comparative analysis of existing models with designed model										
10.	Papers and conferences										

Work done report:-

In depth Literature survey has been carried out understanding polymarphacy side effects using deep learning models like convolutional neural network, Recurrent neural network, Long short term memory model, graph neural network etc. and a paper has been communicated in Chemometrics and Intelligent Laboratory Systems journal. Currently, we are doing comparative analysis of various models on name of drug datasets with reference to metrics viz . ROC, AUC, F- Score and AUROC

Likely outcome of the project:-

1) Understanding adverse reaction between drugs (polypharmacy) taken for multiple medical conditions (co-morbidity) common to elderly patients of UT of J&K eg: hypertension, Diabetes, Thyroid.

2) Developing a CNN-model specifically trained on the patient health records with reference to above ailments.

3) Unraveling new adverse reactions that may exist between these drugs (either directly or indirectly) thereby affecting health of patients

TITLE OF THE PROJECT

Nanomaterials Reinforced Trizaole Based Hydrogel For Effective Removal Of Antibiotics

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Brief synopsis of the project:

Synthesis of Nanomaterials reinforced Smart Triazole based Hydrogel Systems for removal of Antibiotics, Polyaromatic Hydrocarbons and Toxic Heavy Metal ions will be explored by harvesting click chemistry through azide–alkyne reactions resulting in efficient triazole based hydrogels. Natural polymers like Chitosan, Guar-gum, PEG, CMC will be modified into their azide and akyne derivatives and then using the click chemistry a efficient hydrogels will be formed by inclusion of species like Graphene oxide and metal Nanoparticles. Nanoparticle incorporation will increase the density by changing the mechanical properties of Hydrogel, control the diffusion and/or partitioning in such systems and induce differential degradability into the Hydrogels. The structural characterization will be then carried out using different instrumental techniques like FTIR (for functional make up of Hydrogels), TGA-DTA (for thermal stability) SEM and TEM (for surface morphology and pore size). Rheological experiments are also important in characterizing the mechanical properties of Hydrogels. The strength of Hydrogels with changing frequency and strain condition will also be focused on to check the Hydrogel mechanical stability. Finally there is high probability to obtain high efficient nanomaterial reinforced Smart Triazole based Hydrogels for removal of Antibiotics, PAHs and Toxic Metal ions.

Work done report:

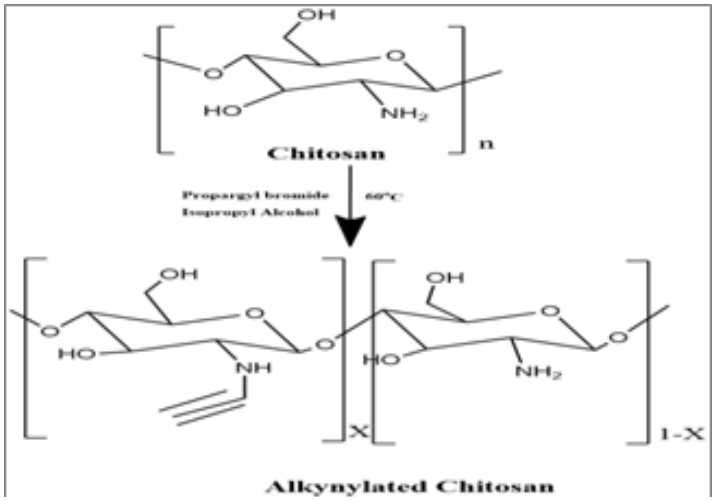
The project is being carried out in consistent with the objectives specified in the proposal that was submitted, and we have purchased the most of the chemicals and equipment needed for the successful completion of the practical work. The polymers purchased include polyethylene glycol, chitosan, guar gum, and others along with the other chemicals synthesizing Alkynes and Azides derivative of polymers. We have successfully converted Chitosan and Guar-gum into corresponding Azides and alkynes and then used click chemistry to form the 1st hydrogel and then reinforced that with nanomaterials to improve mechanical strength

Further we have successfully synthesized the iron, silver and graphene oxide Nanoparticles.

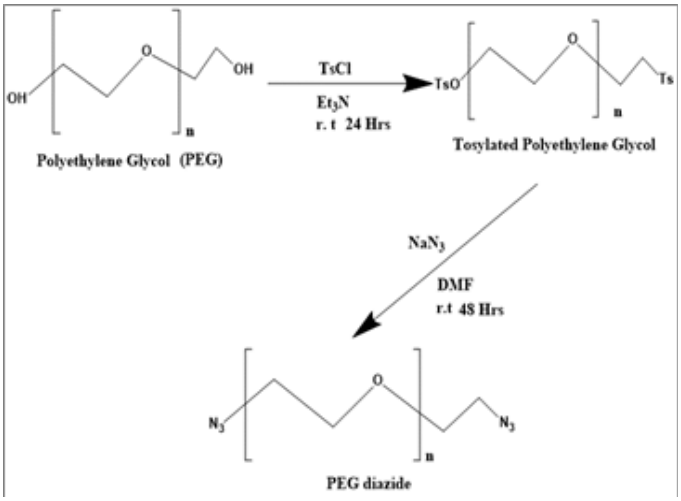
The triazole compound was chosen for its characteristic structure containing C=Nν(azomethine group, known as Schiff base) and νNHν (imino group) groups, which werecapable of chelating metal ions.

Synthesis of Alkylated Chitosan

Chitosan is treated initially dissolved in iso-propylalcohol in presence of NaOH, followed by drop wise addition of Propargyl bromide. After neutralization of the reaction the solution was filtered and collected precipitate was dried in vaccum.



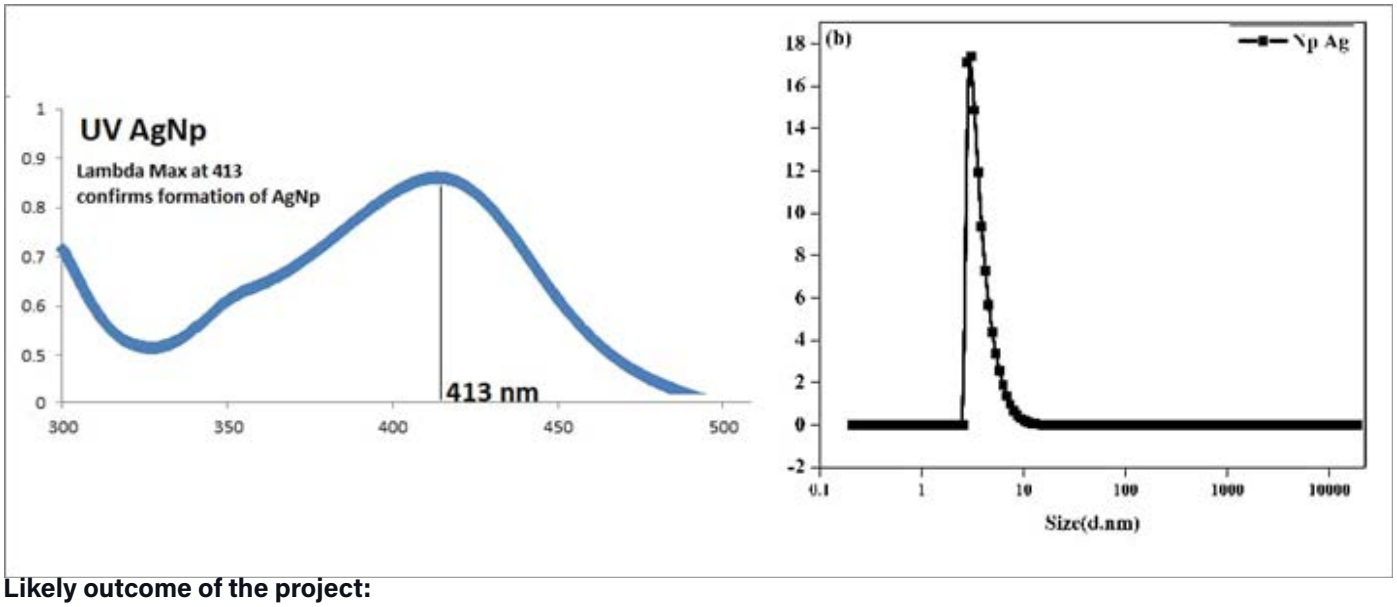
Synthesis of PolyethyleneGlycol di-azide From Poly-ethyelene glycol.



Preparation of silver nanoparticles using modified method reported elsewhere.

Initially Tosylation of PEG was carried in presence of Triethylamine base; this was followed by substitution reaction replacing tosyl by azide in DMF.

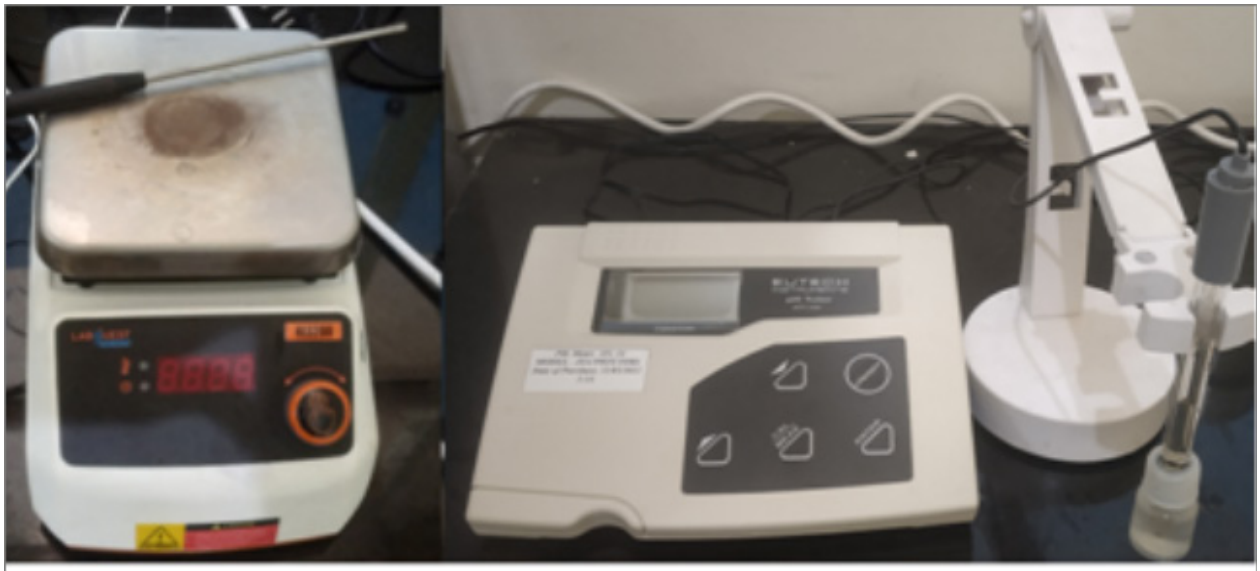
Briefly 1mM solution of silver nitrate was prepared followed by reduction with Quercetin Dihydrate (Strong antioxidant). The resultant brown colon colloidal AgNPs formed were characterisation by particle size analyser



Likely outcome of the project:

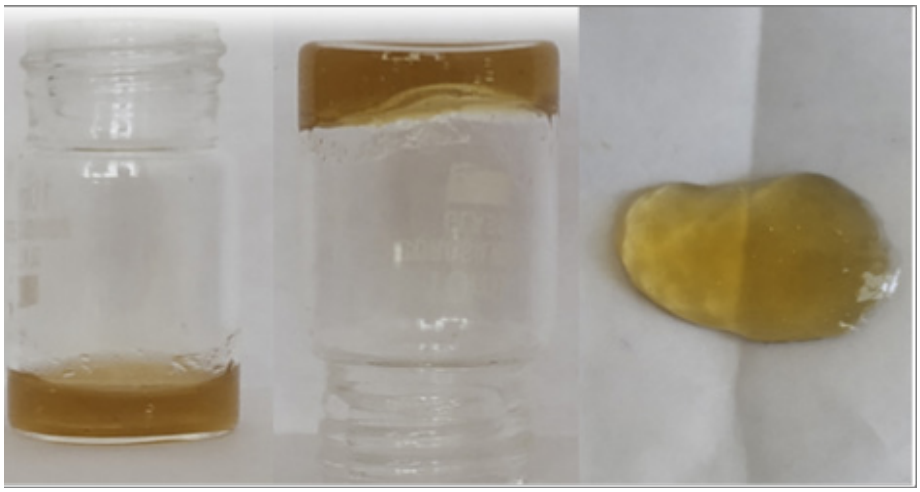
As proposed an efficient traizole based hydrogels will be synthesized and explored in different field of applications. Reports will be published in journals of international repute and also presented in conference focusing on the Polymeric or material chemistry**.**

Recommendations: Increase the Project Assistant's Stipend to encourage qualified individuals to apply and contribute to the successful completion of the project.



Hot plate Stirrer pH meter

Vaccum Oven



Hydrogel confirmation by tube inversion method

TITLE OF THE PROJECT

Passive Noise Control - Acoustical properties of material and its application

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Brief Synopsis of the project:

Introduction

Noise is unwanted sound and like any other sound energy noise is a form of acoustic energy with varying effects on the activities of human and animal lives, most of them being detrimental to a great degree. Epidemiological studies have found that environmental noise is associated with an increased incidence of arterial hypertension, myocardial infarction, heart failure, and stroke [2]. In many countries, noise is a low priority issue but in the 'developed world' legislation dictates that noise needs to be dealt with.[1] Outdoor noise is mainly caused by transport, machines and other propagation systems where as indoor noise include noise in residential and industrial buildings caused in residential areas. Residential noise is the noise within the buildings i.e. noise in halls, rooms, corridors etc.

Effective noise control requires thorough understanding of phenomenon of sound production, propagation and detection. The sound is produced by sound source which is a vibrating body producing the mechanical wave .This wave is transferred by the medium such as air and is finally received by the detector such as ear. Accordingly three methods can be employed to control noise production that is either by alternating noise sources or by making modifications along the propagation path or by dealing with receivers. The method of noise reduction at source(produced due to air pumping) i.e. at source noise reduction is generally employed in pavements while as the method of making modification along the transmission path which is relatively practical and cost effective [4] is employed in buildings. Noise control techniques include Passive Noise Control and Active Noise Control. In passive noise reduction technique several methods are employed to isolate from the ambient noise while as in active noise control a second sound is added with phase equal in magnitude and opposite to that of the original noise and is designed in such a way that it cancels the noise produced by first sound. Passive control of noise can be achieved by noise barriers, noise absorption, dissipative silencing etc and active noise control is generally achieved through the use of analogy circuits or digital signal processing. The study focuses on passive technique of noise control using acoustical properties of materials

The acoustic energy that is incident on the object is converted into reflected acoustic energy, energy loss, and transmitted acoustic energy.[4].Reflectivity may be defined as the ratio of reflected acoustic energy to incident energy while as acoustic absorption is the sum of the energy loss and transmitted energy to incident energy. The ratio of transmitted energy to incident energy is defined as acoustic transmissibility.(Lee et al. 20009).

Materials with better ability to reduce ambient noise by absorption are much considered. These materials dissipate the sound wave energy when it passes through and convert some of the energy into heat, thus making them suitable for noise control. In case of buildings glass fibres and mineral fibres are used for sound absorption while as in pavements OGFC, HMA,SMA etc are used to generate quieter pavements . Although all materials have capacity of absorbing some sound but the term" acoustical material" is primarily used for those materials that are provided for sound reduction having high valves of sound absorption. Research is continued in finding materials with better acoustical properties, sustainability , lower emission of CO_2 .

Literature review

BUILDING ACOUSTICS.

Before 20th century barely any consideration was given to the scientific acoustical design of rooms, halls etc.by the architects and building engineers and sometimes a building did not serve the purpose for which it was constructed for example the Fogg Art Museum hall of Harvard University when built was found to be acoustically so much so defective that the

speaker could hardly make his words intelligible to his audience. By then a lot of investigation has been done for planning a building or a hall with a view to provide best ,audible sound to the audience It was W.C. Sabine, Professor of Physics, Harvard University, who in 1911 first undertook the problem of acoustics scientifically and gave certain essential features about the good acoustics. According to him (i)the sound produced in a hall/room should be of sufficient loudness and no echoes should be heard, (ii)total quality(relative intensity of several components) of speech and music must be unchanged,(iii)there should be no overlapping of syllables,(iv)the reverberation should be neither too large nor too small,(v) there should no concentration of sound in any part of the hall,(vi)the boundaries should be sufficiently sound proof to exclude extraneous noise,(vii)there should be no Echelon effect and (viii) resonance should be within the building[3].

Reverberation and reverberation time: As we know sound has reflective and absorptive properties. Acoustics of room will be considered effective if a proper balance between sounds absorbing and sound reflecting material is created. For achieving this reverberation as a factor is taken into consideration. The prolonged reflection of sound by walls, ceiling and floor results into reverberation. Reverberation can be defined as persistence of audible sound after the source has stopped emitting it.[5]The duration of time for which the sound persists is called as reverberation time. Sabine found that the time of reverberation depends upon the size of the hall, loudness of the sound and upon the kind of music or sound for which the hall. For of hall of frequency 512 vibrations per second, the best time of reverberation was found to be 1 to 1.5 seconds and 1.5 to seconds for halls of 50,000 and 400,000 cubic feet respectively [3]. Reverberation can be controlled by the following factors:

(i) By providing windows and ventilators that can be opened and closed in order to optimize reverberation time

(ii) Using heavy curtains ,tapestries,

(iii) By decorating the walls, covering floor with carpet

(iv) By providing acoustic tiles.

(v) By lining walls with the absorbent material such as felt,celotex, fibreboard, glass wool etc..[3]

Absorption Coefficient and its measurement: The absorption coefficient could be defined as the relationship between the acoustic energy that is absorbed by a material and the total incident energy impinging upon it. This coefficient should be limited between 0 (not absorbent at all, i.e. reflective) and 1 (totally absorbent). However, one can find absorption coefficient values greater than one [7]. There are various methods of measuring absorption coefficient of various materials such as measurements in a reverberant chamber following ISO 354:2006, measurements using an impedance tube following ISO 10534-2:1998[7]etc. However it is possible find a relationship between these two measurement methods based on a set of experimental data we can trying to derive an empirical transfer function that allows us to convert the results of one method to the other while minimizing the error.[7]

PAVEMENT ACOUSTICS

The introduction of motor able vehicles called for the development of better roads with adequate stiffness but high speed vehicles accompanied with smoother roads have caused a considerable increase in noise thus polluting the environment and damaging the psychological and physical well being of humans and animals. However porous road pavements that have been used for their driving qualities and drainage capacities during rainy seasons have also been found to reduce traffic noise considerably.[8] Open graded Friction Course(OGFC) pavement is the quietest pavement surface producing noise less than conventional HMA and PCC surfaces. In OGFC air voids are created by using gap graded aggregates. These air voids or small holes provide sound absorbing negative texture. Diamond grinding is another such techniques that use the concept of providing sound absorbing negative texture. This is one of the great pavement preservation treatments that not only absorbs sound but is very much effective in providing skid resistance. The important acoustical parameters of pavement include: Flow resistivity, Absorption Coefficient, Acoustical Impedance, Tortuosity, Pavement texture. Absorption coefficient of sound absorbing materials used in pavements can be found by employing the same technique as in buildings but the difference lies in the fact unlike buildings no panel is made and no reverberation room is set. Here Marshall type drill core samples are prepared and tests are carried on them.

SOUND ABSORBING MATERIAL IN CASE OF BUILDINGS

The special materials used to increase absorption of sound waves or to reduce the reflection of sound waves in a room or hall unknown as sound absorbing material [3]. The material should be cheap, easily available, easy to fix, good looking, durable, and lightweight, of sufficient structural strength, waterproof, economical in maintenance, fire resistant, efficient over a wide range of frequencies and of high sound absorbing efficiency. Accordingly the Acoustic materials are categorized into four types

(I)Sound absorbents (II) Sound diffuser (III) Noise barriers (IV) Sound reflectors

The sound absorbing materials are broadly classified into following four categories:

(I) Porous absorbents,

(II) Cavity resonators

(III) Resonant absorbers or panel absorbers and

(IV) Composite a type of absorbents

SOUND ABSORBERS IN PAVEMENTS.

Various absorbents that can be used for noise control in pavement include Switzerland Quarried Sand Stone, Rubberized Asphalt Concrete, Plastic modified mixtures etc. Unlike building acoustics sound reflection property is no where used in pavements noise easing, they only used only sound absorption property is used. The most effective method used to reduce pavement noise is use of crumb rubber which is produced due to mechanical grinding of waste truck tires Crumbed rubber when incorporate about1.5% of the total weight of mix can absorb sound of frequencies ranging between 630Hz and 2kHz .Laboratory experiments have shown that bituminous mixes with crumb rubber show improvement in physical, chemical, and performance properties of asphalt also. Shredded plastic or recycled plastic is also very effective in producing quieter pavements.

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Work Done Report:

Various methods concerning passive noise control in pavements and buildings have been studied. It has been realized that with proper usage of material noise can be controlled to a considerable level. The selection of material is at final stage also methodology has been finalised. Most of the acoustical noise reduction is done using asbestos absorbers which can provide a potential threat in polluting the environment. Kenaf and many other materials of biological origin can be used in sound mitigation and are more effective and sustainable than conventional sound absorbers. These materials fall in category of green methods and can be used in structures like hospitals, but use of such materials is restricted to use in buildings only because they are biodegradable and cannot find application for use in pavements. However usage of shredded plastic and crumb rubber in pavements are opening new horizons of using wastes as construction materials. This will reduce environmental degradation to a great degree and also the construction cost.

Likely outcomes of the project:

(i) Categorization of materials for indoor and outdoor noise reduction

(ii) To explore some cost efficient and Green Methods to reduce noise pollution in important public structures like hospitals etc.

(iii) To analyze the ill effects of noise on the teaching learning process.

(iv) To derive some effective methods for safe noise level exposure in order to protect human health.

Recommendations.

1) Further enhancement of funds for proper insight and deep investigation.

2) Left over grants to be carried forward for next year.

TITLE OF THE PROJECT

Smart And Secure Healthcare System For Patient Monitoring And Diagnosis Of Diseases In Integrated Iot And Fog Computing Environments

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Details of Staff Engaged:

1. Mr. Aabid Rashid Wani (Research Assistant) - January, 2022 to April, 2022.
2. Ms. Irtiza (Research Assistant) – September, 2022 to present

Brief synopsis of the Project:

The healthcare industry is very dynamic and incorporates technologies to their processes so as to improve the quality of life of patients and to increase efficiency. Smart healthcare is a health service system that uses technology such as wearable devices, Internet of Things (IoT), and mobile internet to dynamically access information, connect people, materials and institutions related to healthcare, and then actively manage and respond to medical ecosystem needs in an intelligent manner. IoT development in healthcare reduces cost and increase the quality of user's life as they can monitor their everyday activities such as dietary habits, sleep cycles, and exercise routines to produce specific tips that help maintain a healthier lifestyle. It also assists in monitoring patients remotely, manage health emergency and the medical information of patients. IoT devices and sensors generate enormous volumes of health data that needs processing and analysis which is either done at the device level or forwarded to cloud services for storage and processing. However, cloud computing has some limitations which can't be avoided in case of healthcare sector. For example, the cloud demands high bandwidth requirements, induces intermittent delays, and above all raises security and privacy concerns. These issues are critical to healthcare where a correct and timely response is needed to save a life. A variant technology known as fog computing provides better solution to quick processing of complex data. IoT driven fog computing is developed in the healthcare industry that can expedite facilities and services among the mass population and help in saving billions of lives. This project works on developing an efficient framework for the integration of IoT and fog computing environments for healthcare application. Furthermore, the healthcare data is very sensitive in nature and any mishandling of the data can create troublesome situation for the patients. The complete adoption of smart healthcare system is only possible if the concerns related to security and privacy of user data are addressed. The traditional security protocols are infeasible for smart healthcare system as these protocols are highly complex and may drain off the limited available battery of miniature smart medical wearables quickly. Therefore, either a tailored version of existing security protocols or new lightweight protocols need to be developed which is the main aim of this project.

Work Done Report:

The literature survey of integration frameworks for Fog computing and IoT has been completed. An exhaustive study has been done to understand the integration pros and cons and it was found that the benefits of integration weigh more. Moreover, the literature survey on security and privacy issues in data retrieval from patients, transmit and storage of healthcare data has been completed. A draft review paper is being prepared and will, be submitted with two week's time.

Likely Outcome of the Project:

The research work done in this project will be published in reputed journals and conferences. The likely outcomes of the project will be:

- The project aims to develop a smart healthcare system, specifically considering the necessity of such a system in UT of J&K, in order to monitor patients remotely (in-home) and also enable doctors and medical professionals to carry out diagnosis of ailments using data collected from patients via smart wearable devices and at the same time minimize multitude of people in hospitals to emergency cases only.
- The proposed project shall provide automatic medical assistance to the patients even in the remotest areas with no hospitals in their areas by connecting over the internet and grasping information about their health status in a secure way.
- The project aims to provide mobility support to the patients which improve patient's quality of life by mitigating the negative effects of being hospitalized or staying at one place inside home during illness. Providing patients with the possibility to walk around the medical environments knowing that the monitoring of their health condition is not interrupted is an important feature.

Colored Photographs with Captions indicating progress of work:

Since the project is based is simulation only and no physical work can be photographed.

TITLE OF THE PROJECT

Using Longitudinal Data for Early Detection and Progress Monitoring of Alzheimer's Disease

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Brief synopsis of the project:

Abstract

There are many kinds of brain abnormalities that cause changes in different parts of the brain. Alzheimer's disease (AD) is a chronic condition that degenerate the cells of the brain leading to memory asthenia. Cognitive mental troubles such as forgetfulness and confusion among simple things are the features that determine condition of patients suffering from Alzheimer's disease. Other early signs include difficulty in remembering recent events or conversations. The most unfortunate thing about this disease is that it is irreversible and hence demands early detection. The exact causes of AD aren't fully understood. However, at a basic level brain proteins fail to function normally thereby disrupting the work of brain cells (neurons) and hence triggers a series of toxic events. Ultimately, neurons are damaged, lose connections to each other and eventually die.

Neuroimaging data (e.g., MRI) has been widely used to predict clinical scores for automatic diagnosis of AD using Deep Learning (subset of Machine Learning). Most of the previous studies involved in the prediction of AD were based on implementation of 3D convolutional neural network. However, using a 3D CNN implies we need to deal with a large number of parameters involving very complex network architecture. In this project, our aim is to predict AD from 2D slices extracted from the 3D MRI's using Convolutional Neural Network (ConvNet2D). We put forward a framework that leverages deep CNNs pre-trained on large image data sets via Transfer Learning approach. These pre-trained networks learn cross-domain features thereby improving the low-level interpretation of imaging data. Upon experimentation, our results showed quite evident improvement in performance accuracy with the use of pre-training approach and deep residual networks.

Keywords: Deep Learning, AD, Neuroimaging Data, Classification, CNN.

Objectives of this Project

- To collect high resolution longitudinal (time series) imagery dataset of MRI medical images for early detection and progress monitoring of AD.
- To identify the best deep learning approach for designing an optimal Convolution Neural Networks (CNN) that fits our dataset(s).
- To use pre-trained CNN's (proven to be excellent for various computer vision tasks) for prediction of AD.
- To analyze diagnostic accuracy of our model by experimenting with varying number of 2D input slices, so as to find the optimal number of slices for the network.
- To examine the performance of our model on multi-class classification task (AD vs MCI vs CN).

- To further, analyze the performance of our model on binary classification tasks (CN vs AD / CN vs MCI / MCI vs AD).
- To further increase our model performance we can use Long Short Term Memory (LSTM) model for our longitudinal subject wise dataset to detect early stage of AD.

Work done Report

Till now we have explored 2D slice level approach where the 2D slices/images are extracted from the processed MRI scans. In our first experiment, only the middle slice is extracted from the MRI's, then 5 middle slices and then extraction of middle slices from the MRI's with a step size of 5 up to until all the slices are extracted. By continuously experimenting with different slices, we came to the conclusion that network gives good performance accuracy predictions (86%) in two experiments: when using 10 middle slices or when using all (62) of the slices from MRI's.

Our experimentation showed that the slices from the middle of MRI are most informative with more dense features and these dense features show decreasing effect towards the starting and ending slices. With the use of all MRI slices there is a guarantee in no loss of features, however needs high model capacity and processing power requirements. Therefore, by using 10 middle slices from MRI's has been found an optimal option in our experimentation. It has been analyzed that the proposed approach have good competency with state-of-the-art techniques as reported in the literature.

Since using 10 middle slices is the optimal option, so we used 10 middle slice approache for binary classification tasks (CN vs AD, CN vs MCI and MCI vs AD). With this approach our model has yielded best results for classification tasks CN vs AD followed by Cn vs MCI followed by MCI vs AD.

Publication Status

We have submitted our paper in Arabian Journal of Science and Engineering and till now paper is under review process.

Likely outcome of the project:

- Our AI based diagnostic algorithm will be helpful in narrowing down the spectrum of investigations necessary to classify various stages of AD.
- The study can prove helpful in enhancing the model performance on multi-class classification task (AD vs MCI vs CN) and binary classification tasks (CN vs AD / CNvs MCI /MCI vs AD).
- The study will help in continuous monitoring and progression of the disease utilizing the Temporal/Longitudinal information.
- The development of our novel DL model can routinely be used in the clinical settings for effective diagnostic tasks.

Recommendation:

Coloured Photographs with captions indicating progress of the work/activities:

Following photographs/figures show the results achieved during our experimentation process.

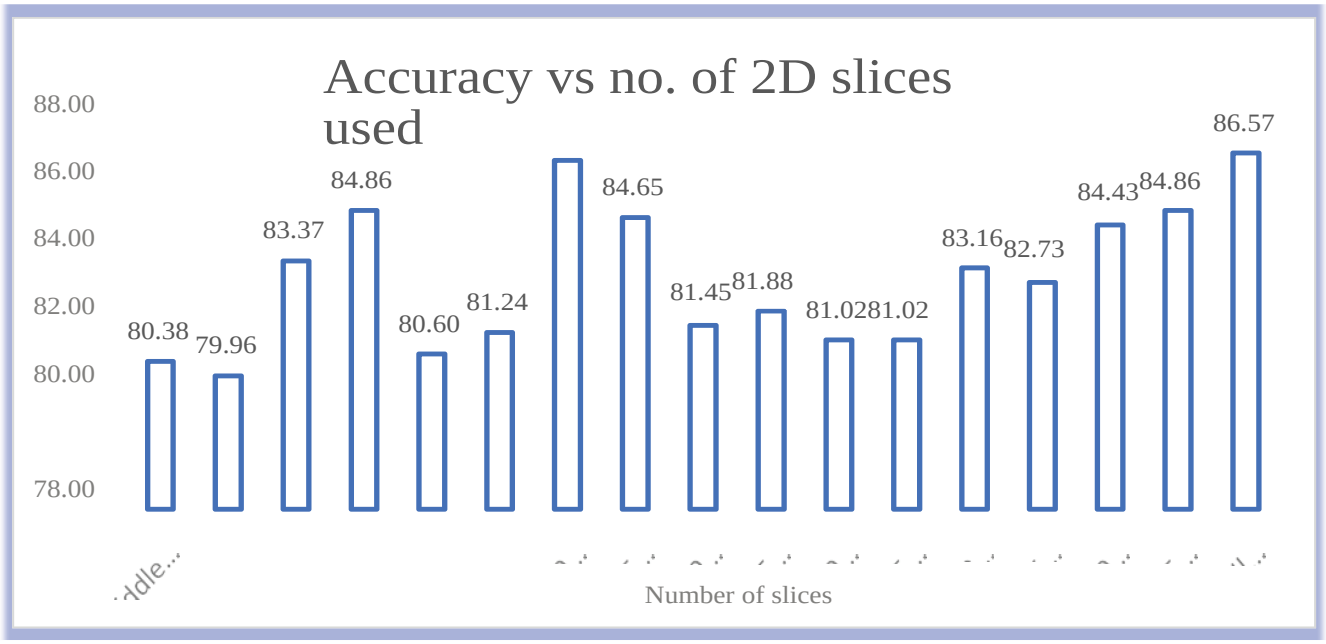

Figure1: Graph displaying multiclass classification task

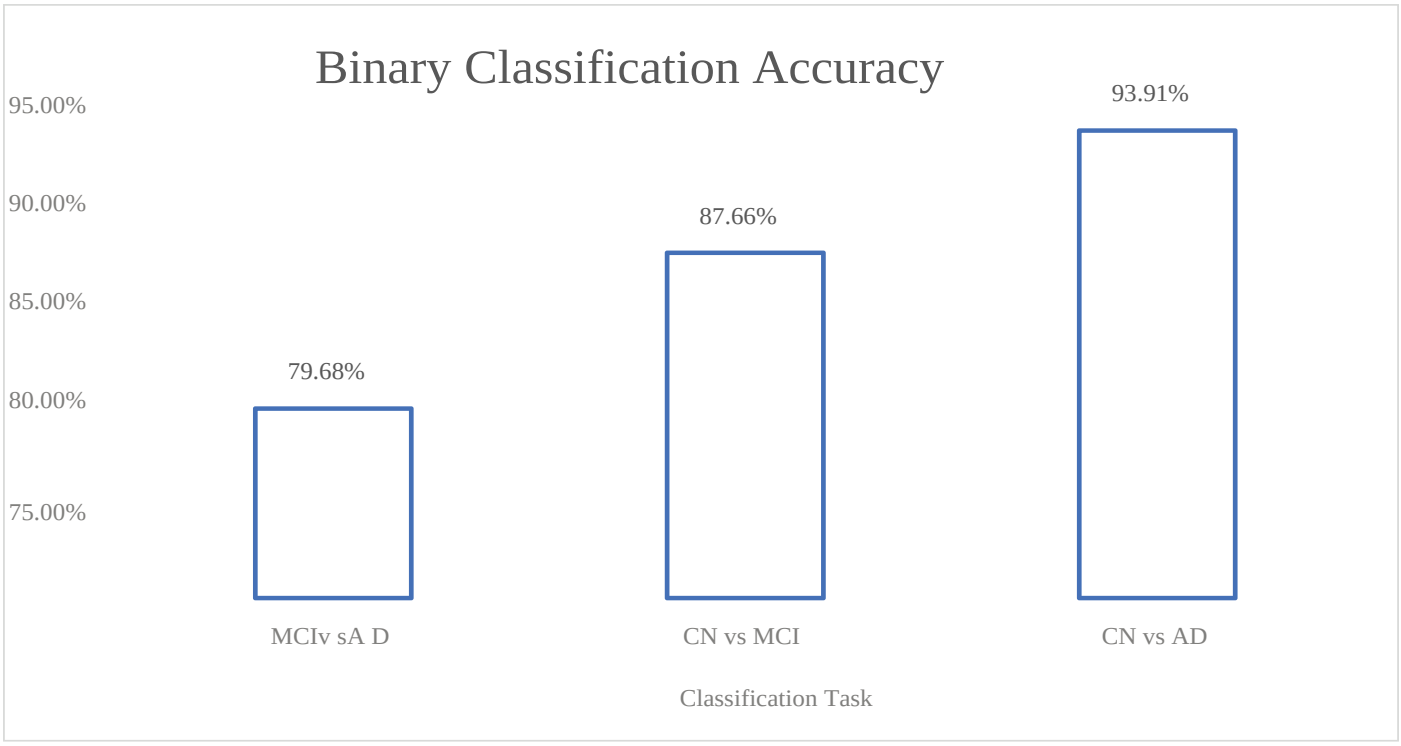

Figure2: Graph Displaying Binary Class classification Task

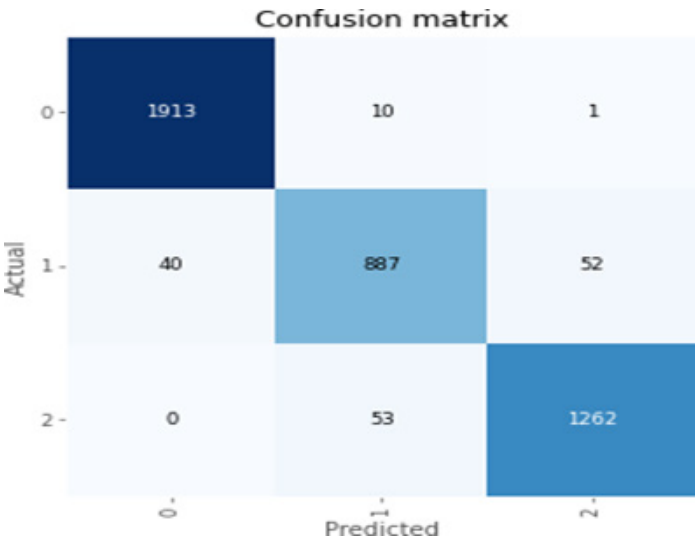

Figure3: Confusion Matrix and ROC curve using 10 middle slices from the MRIs

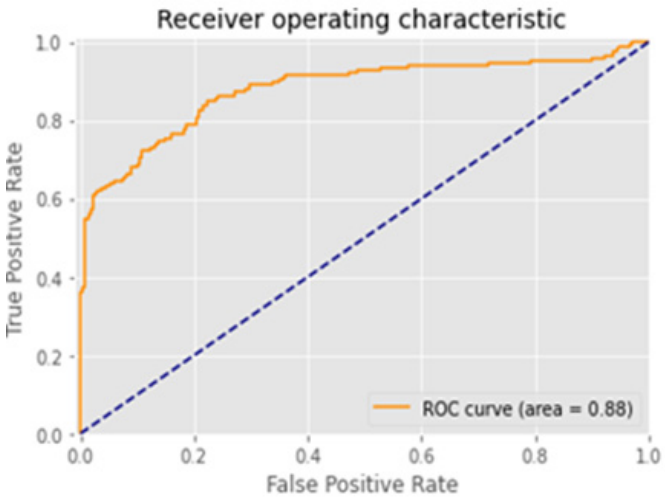

Figure4 :RoC curve showing model performance accuracy

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