IOT & ML SOLUTION
TO
ALLERGIC RHINITIS

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***Abstract*—In this project a preventive rehabilitation is proposed for allergy patients using neural networks, IoT and the newly emerged blockchain technology. A wearable device which senses temperature,humidiity and the AQI of the patients surroundings continuously keeps track of these parameters and through cloud computing the chances of an allergy to happen is predicted and the output is then sent back to the device , which in turn either warns the user for an allergy to occur. A mobile connected with the device is used for giving the warning to the user coming from the prediction model. Also in this project there is an attempt to inlcude the blockchain technology for tracing back the cause of the allergy that occured to solve the problem of not knowing the causing factors of the allergy, thereby aiding allergy patients to recognise the allergens that they need to be careful from. This project tries to solve problems of allergy patients of not being able to recognize the allergy causing weather conditions and food, it tries to remove the patient's disablity to predict an allergy (as these allergens can be very very small and unnoticible by the naked eye), with the help of a neural network which predicts the presence of allergy causing allergens using the meterological paramters.**

***Index Terms*—allergy,neural netwrok, IoT, blockchain,rehabilitation**

I. Introduction

Allergy occurs when a person reacts to substances in the environment that are harmless to most people. These substances are known as allergens and are found in dust mites, pets, pollen, insects, ticks, moulds, foods and some medications.

This can cause symptoms in the:

Nose and/or eyes, resulting in allergic rhinitis (hay fever) and/or conjunctivitis.
Skin resulting in eczema, or hives (urticaria).
Lungs resulting in asthma.

These symptoms often reduce the energy of a person, it exhausts them completely and also it creates embarassesment for them sometimes. These allergies interfere with the patients daily activities and reduces their work efficiency, also makes them irritable. Sometimes also the sleep pattern of the patient is disrupted. Allergies may occur just at the wrong time, for example , while giving a speech, while giving an important examination, while attending an important meeting, while playing a sport, and hence it can just spoil the event. Such patients are seen to have low self esteem and are always scaredof an allergy.
These allergies can also be life threatening if it crosses a certain level of severity. Food allergy is one type of allergy which is seen to be life threatening and should be prevented from happening.

There are many types of allergies. Some allergies are seasonal and others are year-round. Some allergies may be life-long. Our aim is to create a aiding device which tries to avoid all types of allergies. Drug Allergy
True allergies to drugs (medicines) occur in only a small number of people. Most drug reactions are not allergic, butare side effects of the properties of the medicine.
Food Allergy
There are different types of allergic reactions to foods. There are differences between IgE-mediated allergies, non-IgE mediated allergies and food intolerances.
Insect Allergy
Bees, wasps, hornets, yellow jackets and fire ants are the most common stinging insects that cause an allergic reaction.
Latex Allergy
A latex allergy is an allergic reaction to natural rubber latex. Natural rubber latex gloves, balloons, condoms and other natural rubber products contain latex. An allergy to latex can be a serious health risk.

Mold Allergy
Mold and mildew are fungi. Since fungi grow in so many places, both indoors and outdoors, allergic reactions can occur year round.
Pet Allergy
Allergies to pets with fur are common. It is important toknow that an allergy-free (hypoallergenic) breed of dog or cat does not exist.
Pollen Allergy
Pollen is one of the most common triggers of seasonal allergies. Many people know pollen allergy as "hay fever," but experts usually refer to it as "seasonal allergic rhinitis."

Our project is closely related to solving the last type of allergy , that is the pollen allergy but over the course of time we believe we can also add some more techniques to solve most of the other types discussed above as well, that is where the blockhain technology is thought to be helpful.
Allergy affects the lives of probably close to one million worldwide. In India,rough estimates indicate a prevalence of between 10 percentages and 15 percentages in 5-11 year old children.

II. Different approaches used in different papers

In the following section a literature review is done on all work that has already been done in the domain related to the abstract of the project.

A. Literature review on Allergic Rhinitis prediction, symptoms analysis and treatments

Xenophon Aggelides et al in [1] have created a Bluetooth wrist worn device equipped with accelerometer and gyroscope is used to detect the gesture of a patient by collectingthe velocity and position data and using a pre-trained Machine Learning model (trained on filtering these data and categorising each signal for such gesture) which can detect over 15 different gestures (categorized into three categories – gestures for eyes, ears and nose) with an accuracy of 93%.

A personal forecasting system for people with allergic rhinitis in response to pollen season is done in [2] byD. Voukantsis et al, with the help of data of Patient Hay fever Diary (PHD) from the European Aeroallergen Network (EAN) and using four different Machine learning algorithmsto create a ML model to be incorporated into personal use scenario.

An algorithm model is made by M. HÚGMAN,et al [3] to distinguish the site where Nitric Oxide is produced in our body in order to be helpful in differentiating the NO produced in the alveoli (COPD), the respiratory tract (asthma), the

sinuses (Allergic rhinitis) in our body by calculating the components of exhaled NO and analysis of data from studying the subjects (by regular iterative Nitric Oxide analysis).

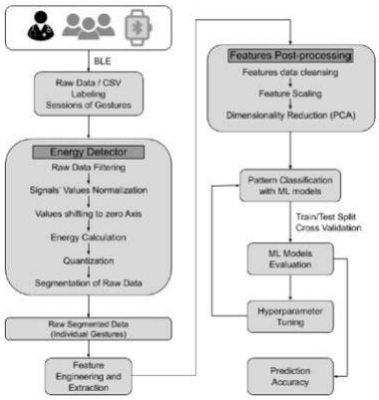


Fig. 1. Flow chart of the system proposed in [1]

Ming-Hsein Yeh, et al in their paper [4] choose 20 differentacupuncture points in a human body to be monitored by Electro dermal screening devices for data of 178 different subjects (111 – AR affected and 67 – Non AR affected people) and use Machine learning algorithms (k-nearest neighbour algorithm) to detect the presence and severity of Allergic rhinitis.

David P et al,[5] in their research review the ways by which allergic rhinitis is diagnosed. Allergic rhinitis is generally diagnosed by Laboratory tests of presence of IgE antibodiesto specific allergens in our blood. The preferred way to test the IgE count is the puncture skin test and considering the overall medical history of the patient.

Ko-Hsin Hu and Wen-Tyng L carried out a study[14] on about 30 AR pateints by treating them with FIR (Far Infrared) light for a week everyday for 30 minutes , to see if that reduces the symptoms of AR. The methodology used was,an FIR light emitter was placed right in front of the patientsnasal region for 30-40 minutes every morining for 7 days and the patients would record their symptoms and rate them on a scale of 4.

Tetsuzo Inouye in his study[15] used laser for patients with allergic rhinitis to see if it can treat allergic rhinitis patients. To objectively evaluate short-term improvement of nasal obstruction by laser surgery, a nasal ventilation test was performed before and after surgery.

A study was conducted by Chunhua Wang et al,[16] to determine how much is the allergic response increased when the patient along with pollen is exposed to diseal exhaust particles(DEP). The study was conducted on BAL mice. Some were made sensitive to both pollen and DEP, some only to pollen to understand the trend and study the differences in the allergic response which is charaterised by the IgE content in the blood.

B. Literature review on the use of machine learning in Rehabilitation

Michael Tschuggnalla ,et al,[6] use machine learning to predict the success of the rehabilitation process.
A common way to treat hip, knee or foot injuries is by conducting a corresponding physician-guided rehab over several weeks or even months. Health professionals are often able to estimate the treatment success beforehand to a certain extent based on their experience, it is scientifically still not clear to what extent relevant factors and circumstances explain or predict rehab outcomes. We apply modern machine learning techniques to a real-life dataset consisting of data from more than a thousand rehab patients and build models that are able to predict the rehab success for a patient upon treatment start. By utilizing clinical and patient-reported outcome measures (PROMs) from questionnaires, we compute patient-related clinical measurements (CROMs) for different targets like the range of motion of a knee, and subsequently use those indicators to learn prediction models. While weat first apply regression algorithms to estimate the rehab success in terms of percental admission and discharge value differences, we finally also utilize classification models tomake predictions based on a three-classed grading scheme. Extensive evaluations for different treatment groups and targets show promising results with F-scores exceeding 65% that are able to substantially outperform baselines (by up to 40%) and thus show that machine learning can indeed be applied for better medical controlling and optimized treatment paths in rehab praxis.

Zhang, Wentong; Su Caixia and He, Chuan proposeda Smart Sensor-based Rehabilitation Exercise Recognition (SSRER) system[7] using a deep learning framework. For the recognition of rehabilitation exercise with sensor information, a convolutional neural network (CNN) has been used on dynamic platform(D-CNN) where it has sensory data for physical rehabilitation exercise body movement by Gaussian mixture models (GMM). The input signals and GMMs are in various segments contains shapes for many CNN routes. To retrieve the state transition likelihood of hidden states, the Sensor (S-CNN) utilizes the algorithm of improved lossless information compression as discriminant features of various movements. Therefore, the hybridized CNN of the Sensor (S-CNN) and D-CNN are combined with a deep learning classifier to assess every rehabilitation class exercise at different levels. The categorized deep learning methods show improved performance.

Atif Alamri, Jongeun Cha, and Abdulmotaleb El Saddik[8] propose a unique method based on augmented-reality (AR) technologies which can boom a stroke-affected person's involvement in the rehabilitation method. It presents herbal-force interaction with the daily surroundings via adopting a tangible-object concept. The patient manipulates during the remedy session a tangible object this is tracked to measure

her/his performance with out the direct supervision of an occupational therapist. We called this framework AR-based totally rehabilitation. We additionally present two exercises, a shelf exercising and a cup exercise. We introduce assessment measurements inclusive of venture-of completion time, compactness of venture, and speed of hand movement by means of taking pictures the patient's hand actions with the tangible object.

Catherine Adans-Dester,et al[9] .created machine learning-based algorithms to derive clinical score estimates from wearable sensor, data collected during functional motor tasks. Score estimates of upper-limb impairment severity and movement quality were marked by a coefficient of determination of 0.86 and 0.79, respectively. The application of the proposed approach to monitoring patients' responsiveness to rehabilitation is expected to contribute tothe development of patient-specific interventions, aiming to maximize motor gains.The need to develop patient-specific interventions is apparent when clinical studies often report satisfactory motor gains only in a portion of participants. This observation provides the foundation for "precision rehabilitation". Tracking and predicting outcomes defining the recovery trajectory

[10]Mu Zhu1, Zhanyang Zhang, John P Hirdes, and Paul Stolee used machine learning algorithms to guide rehabilitation planning for home care client.This study is a secondary evaluation of records on 24,724 longer-term clients from eight homecare applications in Ontario. information have been gathered with the RAI-HC evaluation gadget, whereinthe activities of each day residing scientific evaluation Protocol (ADLCAP) is used to identify customers with rehabilitation ability. A customer is described as having rehabilitation capability if there has been: i) development in ADL functioning, or ii) discharge home. SVM and KNN effects are as compared with those received using the ADLCAP. For assessment, the gadget studying algorithms use the identical practical and health popularity signs because the ADLCAP.

Divya Madhuri Pavuluri et al [19] cretaed a mobile app which can be used to click images of fruits and vegetables or packaged items and the app will tell you the allergen contentin it and weather or not you are suitable to consume it based on your history of allergies. The app uses deep learning asthe back bone to analyse the input and extract the allergen content. The app also takes input of the packaged items by making use of OCR for reading the ingredient content image and then send the data to the deep learning model.

C. Review on papers related to blockchain implementation forrehabilation/prediction problems

[11]Tasatanattakool, Pinyaphat and Techapanupreeda, Chian in their research try to explain the technology of blockchain in a detailed and simple manner and they try to show the potential of blockchain in other fileds, and how various other domains are using this technology through examples.

Matthias Mettler in his paper [12] analyses various healthcare applications of blockchain technology. The paper explains about 3 use cases of blockchain in healthcare: 1) using blockchain in healthmanagement. Its a system where medical data of patients are used by health professionals with the help of a blockchain which can be used to storethe entire history of the patients.2) Using blockchain to create a health data bank. Basically a storage of health data from various people coming from various health apps , wearables etc. for research purposes. and the last but the most important use case 3) Using blockchain to fight counterfiet drugs.

Radu Miron,Mihai Hulea,,Silviu Folea in their research[13] they have used a blockchain in which the food products details are stored. The details of the food products storedare: its loctaion,its ingredients etc. Then with the help of gluten sensors these food products are tested at the field for gluten presence and then the test results are stored into the blockchain. This way food products contaminated with gluten is detected in a food product which was claimed to be gluten free. So the companies can then track the product and all other products which were delivered along with that product and can take those products back on grounds of being contaminated by gluten.

D. Review of Using IoT in rehabilitation

Riazul Islam et al. [21]this paper analyzes distinct IoT security and privacy features, including security requirements, threat models, and attack taxonomies from the health care perspective. The paper proposes an intelligent collaborative security model to minimize security risk; discusses how different innovations such as big data and wearables can be leveragedin a health care context.

Ahmadi, Hossein et al. [22] did a study of the use of Iot in healthcare and from the paper we can anlayse thathome healthcare service was one of the main application areas of IoT in healthcare. Cloud-based architecture, by providing great flexibility and scalability, has been deployed in most of the reviewed studies. Communication technologies including wireless fidelity (Wi-Fi), Bluetooth, radio-frequency identification (RFID), ZigBee, and Low-Power Wireless Personal Area Networks (LoWPAN) were frequently used in different IoT models. there is a growing interest to use sensors that perform food allergy detection, pregnancy monitoring and cholesterol level monitoring, as well as Deoxyribonucleic Acid (DNA)-based electrochemical analysis.

Baker et al. [23] identify all key components of an end-to-end Internet of Things healthcare system, and propose a generic model that could be applied to all IoT-based

healthcare systems. This is vital as there are still no known end-to-end systems for remote monitoring of health in theliterature.

Qadri et al [24] do a survey of different technologies related to Iot in and around healthcare.This paper delves into the ways these technologies are transforming the H-IoT systems and also identifies the future course for improving the Quality of Service (QoS) using these new technologies.

Ruby Dwivedi et al [25] identify the pivotal role of IoMT applications in improving healthcare system and to analyze the status of research implementations demonstrating effectiveness of IoMT benefits to the patient and healthcare system along with a brief insight into the technologies supplementing IoMT and challenges faced in the healthcare system.

E. Review of work already done related to what our project aims to do

Lampros A. Kalogiros et al. [17] created a mobile application to solve the allergy problem.The methodology adopted is that using a mobile app patients with allergies are connected to the app and their everyday symptoms etc. are feeded into the application database and also with the help of local sensors of air quality temperature,humdity etc are taken as input to the app. These data from all the allergy patients are then analysed and a map is created which defines the allergen outbreak in different areas, also the app can be used by users to know when and where did they had an allergy in history. The app also predicts an allergy outbreak using data analysis techniques.

Ami Ooi, Toshiya Iiba, and Kosuke Takano[18] developed an allergy free ingredient subsitute recommender mobile application for recipes. The methodology used is that the recipe is compared with known allergy free food recipes to find the food context(what type of food it is) and then forthe allergy causing ingredients the appropriate substitute is recommended based on the food context recognized.

Gutierrez Rivas et al. [20]dvelop a real time allergy detection device for children , which is a device which analyses the ECG signals from the heart to detect any changes in the ECG pattern and hence detect a life threatening allergy. This device promises to avoid the timethat traditional allergy tests take.

III. Methodology

This project has 3 components.

1) Hardware- the wristband

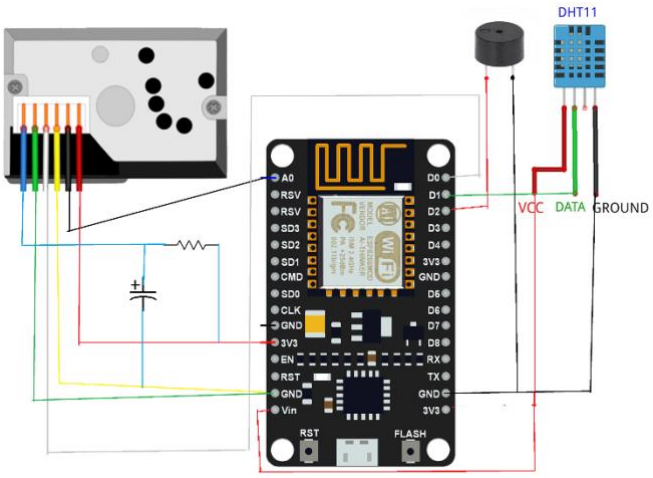


Fig 1.1 Hardware Schematic

2) Cloud- storing sensor data coming from wristband

3) Backend- machine learning code which predicts the allergy by taking the wristband inputs from the cloud and the result is again stored into the cloud database.

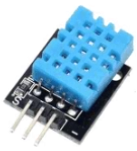
The wristband then fetches the result of machine learning from the cloud database.

If the result says that there is going to be an allergy then an led will start blinking.

Sensors used:

-AQI (dust) sensor- GP2Y1010

-Temperature and humidity sensor- DHT11



All these will be connected to the nodemcu development board.

The code for the nodemcu is written using the Arduino IDE in which inputs from the sensors are acquired and sent to the cloud.

Cloud:

Firebase cloud service which is a google service is used for the data-storage.

In this database the sensor data will be stored which will be given to the backend ML code and the output will be stored in this same database which will be accessed by the nodemcu.

Backend:

A python code for the machine learning on google colab platform.

The machine learning algorithm used is the 'RANDOM FOREST CLASSIFIER' because apparently for disease prediction classifier algorithms are preferable and random forest also has a good accuracy compared to other algorithms.

The inputs for this machine learning model (random forest) are AQI, atmospheric pressure, temperature, humidity, latitude, longitude, windspeed. Based on these input values the Random forest Classifier will predict allergy. The output can be '1' or '0'

'1' means allergy will happen

'0' means allergy won't happen.

APIs:

For the input of latitude,longitude,atmospheric pressure and windspeed the help of APIs has been taken.

The Geolocation API fetches the latitude and longitude while the visualcrossing weather API fetches the atmospheric pressure and windspeed for the above latitude and longitude. These are open source APIs available on the internet.

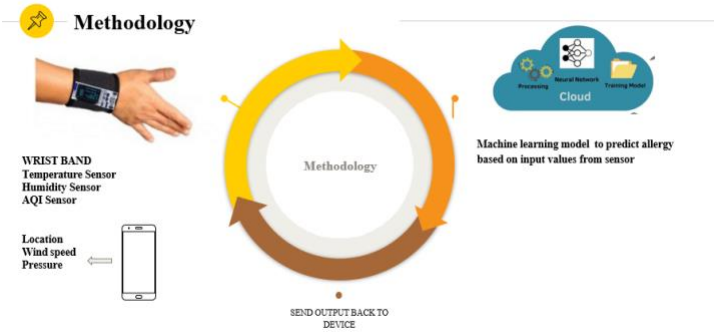


Fig 1.2.Methodology

IV. Conclusion

After reviewing about 25 papers related to the problem statement mentioned in the abstract a lot more understanding about different types of allergy, their treatments, detections ,prediction and how technology is being already used in solving the same problem statement. Thus it was realized that still there is a lot of research scope in this domain of helath rehabilatation. And our problem statement stands still unsolved as it has still not been able to create a device that can give real time warning of allergies. Also the use of blockchain is very much new in helathcare , and our aim to use blockchain for detecting the cause of the allergy will be a great challenge to implement and hence we would just try to add blockchain into our project but if it becomes really challenging which it seems we would have to drop the idea of using blockchain completely.

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