Automated Healthcare Assistant System Using Raspberry Pi, Wireless Communication and Machine Learning

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***Abstract*— The increasing number of population and lack of required assistance is extensively affecting health of the people, especially the ones who stay in the remote areas. Thus, in order to overcome this issue an automated healthcare system is created which will collect patient data and send it wirelessly to a doctor portal, where doctors can analyze, chat and prescribe medicines to the patients. Also, the disease that is suffered by the patient will be predicted using a machine learning algorithm. At the same time each prescription will be provided with a RFID tag which will insure there is no misuse of the prescription or drugs. The module consists of a camera module which is used for patient monitoring. Thus, making it a complete system which is fit for any patient and easy to access, for any authentic doctor.**

Keywords*— *chatbot; disease prediction; ecg sensor; fall detection; health monitoring; heartbeat sensor; internet of things; machine learning; php; raspberry pi; rfid tag; thermal camera.

I. INTRODUCTION

The main idea of the project is to create a wireless system which monitors health parameters of a respective patient and provide him/her with a prescription by an authorized doctor. The system will include sensor harness which will be laid on the patient's body, data collected here will be passed on wirelessly to a site which will be a point of interaction between the doctors and the patients. The site will include portals for different patients and each patient will have a unique ID, based on this ID a prescription will be provided by the doctor for the patient. Each prescription will have an RFID tag so that the prescribed medicines are delivered after scanning the tag. Thus, if the prescription is scanned once, it cannot be reused thus ensuring that it is not misused. The site will also include a chatbot which will help doctors interact with the patients and analyze them on the basis of their medical history and personal sufferings. Parallelly doctors will be having a unique login, thus making multiple doctors available even from remote areas at the same time. Along with all this the system will also predict the disease suffered by the patient or the probability of suffering that disease will be clarified, using all the data collected with respect to the patient's health. At the same time the camera module installed in the system will help with constant monitoring of the patient's movement and temperature which will be very useful in case of patient in a hospital, especially during night time. This will help in body fall detection and in monitoring body temperature.

II. LITERATURE SURVEY

Health assistant systems or generalized health monitoring systems are researched and looked for on a large scale by many scholars and fellow researchers. This a domain which is basically divided in to three categories physical health monitoring, psychological health monitoring and generalize health monitoring.

1. Physical Health Monitoring

In this type of monitoring generally researchers focus on specific parameters or on the whole wellbeing of a patient's body. [1] Specific parameter analysis like blood contents and glucose levels, is done using a microprocessor system which is further used to receive and transmit the data from the specific devices which are used for measuring the respective parameters. This data is further collected as a data base and is analyzed in order to narrow down the data base to conclusions. Thus, giving an observed and analyzed outcome to the patients by letting them know the disease they are suffering from (like with such studied parameters the patient will be informed if he/she is having diabetes or any other blood issues).

2. Psychological Health Monitoring

This a type of mental health analysis where the patient's physical parameters are used to identify his/her mental conditions. [2] The system is basically used to study the psychological parameters of a patient which matter a lot during hype conditions. The measurements include body temperature, skin reactivity, heart rate, eye movements, etc. on the basis of which psychological conclusions are derived for a respective patient. Thus, helping the individual to come up with long term changes within himself/herself making the internal health parameters stable and efficient.

3. Generalized Health Monitoring

This is the type of monitoring where the focus is not on a single parameter affecting health but it looks upon all the factors essential for health improvement and avoidance of health degradation. It is divided as individual solution-based system or generalized solution-based system. [3] The individual

solution-based monitors patients health and provide him/her with the correct diet and physical exercise plan according to his/her comfort and choices. Not exerting a person and going directly against his/her tendencies and thus making an environment where he/she develops effectively by time. [4] Another type is the generalized solution-based system where the system is self-care health monitoring system, where the data from various patients is collected and stored as a data. This data is then linked with the conclusions obtained from the patient's medical history and medical prescriptions, based on which if the data is new it is transmitted to the datalogging system, from where the conclusions for similar medical specifications are obtained directly without doctor's assistance. This makes the medication system independent and efficient.

III. MOTIVATION

There have been numerous cases all over the world of people who lost lives due to heart attack. Life of our loved ones is endangered; our efforts would save lots of lives. Also, medical facilities as well as doctors cannot reach to the needful, the patients need them the most, for all such people our module will play a very crucial role. Many of the rural areas today also face problems of transport which actually is the main cause of death at the time of emergency. As advance technology would reach every Nuuk and corner of India number of such cases will be reduced. Our aim is to make available advance technology in each and every house. India's productive population highly suffers from different diseases because of the changing life style, thus our little step will be of great help for them.

IV. PROBLEM DEFINITION

A. *People cannot avail required medical facilities*

It is an issue faced by many people constantly and has reached to such an extent, that people have started considering it as a fact and have stopped complaining about it. Some of the major reasons for this are as follow,

- Increase in population
- Lack of awareness
- Lesser reachability of doctors and medical facilities

B. *Increase in formation of new diseases or spreading of diseases*

There is a distinct leap in the formation of new diseases or the same diseases but which cannot be cured with the same amount of medication. At the same time the rate at which the disease is passed on these days is quite high. Some of the major reasons for this are as follows,

- Negligence by the patient when the disease is at a smaller scale so as to avoid a long travel for a checkup
- Lack of medical facilities
- Improper usage of the pre-prescribed prescriptions

V. PROPOSED SOLUTION

The Automated Healthcare Assistant system basically includes Raspberry Pi at its core as its working unit, which will help in retrieving data with respect to the patient's body. This data will then be transmitted wirelessly to the portal which will be a doctor-patient interface, here doctors and patients will be having a unique login and data will be accessed by the doctors from this portal in order to provide the patient with a prescription. A RFID tag will be provided with each prescription which will help in avoiding any issues related to drug consumption or drug misuse. A chatbot facility will be provided on this same portal where doctors can interact with the patients and at the same time a disease predictor will analyze the disease which is suffered by the patient based on the data retrieved from the respective patient, this feature will be specifically useful during the times when there will be connection cutoff, thus giving offline prediction.

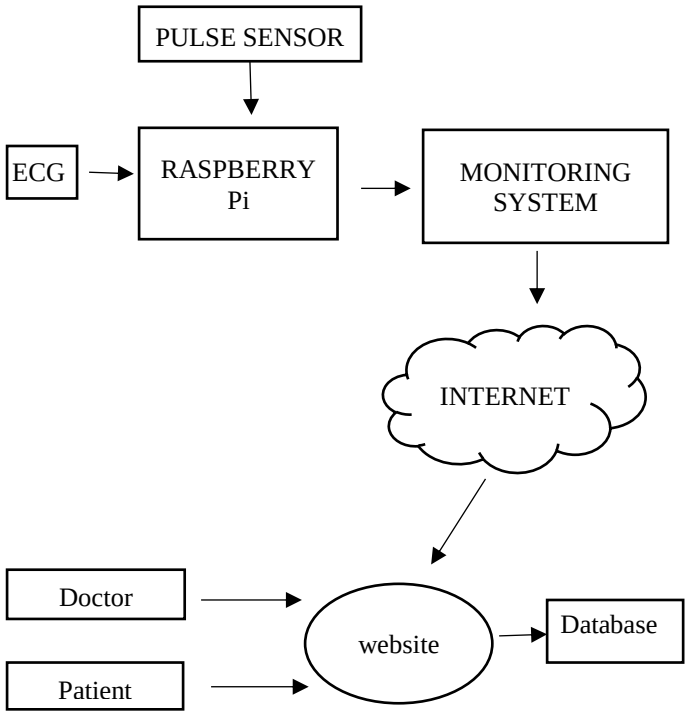

Fig 1. Overview of the system

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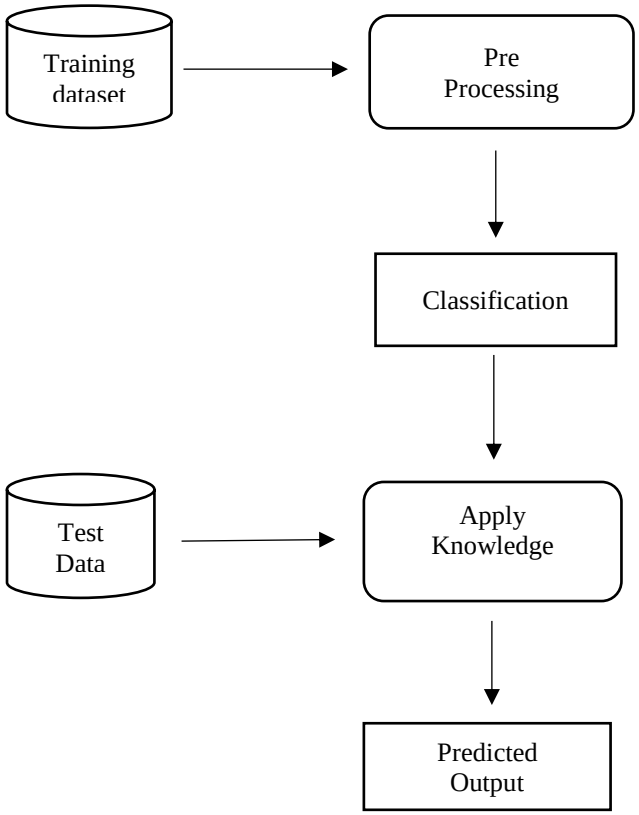

Fig 2. Workflow when system is offline

VI. PROJECT DESCRIPTION

A. Sensors

1. Heartbeat sensor:

[5][6] The principle of psycho-physiological signal uses a stimulus for virtual reality system which is the main idea for the operation of this sensor. Volume of blood in the finger changes with respect to time. It has a very bright small LED which flashes in unison with each heartbeat, when the heartbeat detector is operating. Thus, light intensity changes with respect to time which is measured by a Light Dependent Resistor. The signal gets amplified and inverted, in the circuit. It works on the principle of Photo Plethysmography. The change in volume of blood is measured by change in intensity of light. It operates at 5V. Thus, this sensor gives us information about the functioning of the heart of the patient.

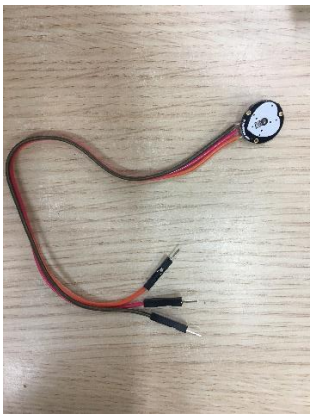

Fig 3. Heartbeat Sensor

2. ECG sensor:

[5][6] Heart muscle depolarizations produces electrical waves which are recorded by this sensor. ECG(Electro-Cardiogram) electrodes are attached to the skin which absorb and amplify these electrical waves[6]. The setup consists of four electrodes which are attached on the chest or on the four limbs according to the standard nomenclature (RA: Right Arm, LA: Left Arm, RL: Right Leg, LL: Left Leg)[5][6]. A conductive gel is used to increase conductivity between skin and electrodes. So, the electrodes used are wet sensors. It operates at 3.3V[5][6]. Thus, this sensor provides useful health parameters of the patient.

3. AMG 8833 Thermal Camera

We have added the feature of heat-vision to our project by using the AMG8833 Thermal Camera. This sensor is an 8x8 array of IR thermal sensors. When connected to raspberry Pi, it will return an array of 64 individual infrared temperature readings over I2C. It is compact and simple enough for easy integration.

- It can measure temperatures ranging from 0°C to 80°C (32°F to 176°F) with an accuracy of +- 2.5°C (4.5°F).
- It can detect a human from a distance of up to 7 meters (23) feet.
- It has a maximum frame rate of 10Hz.

Thus, we have used this device to measure patient body temperature from a distance and also for body fall detection and patient monitoring.

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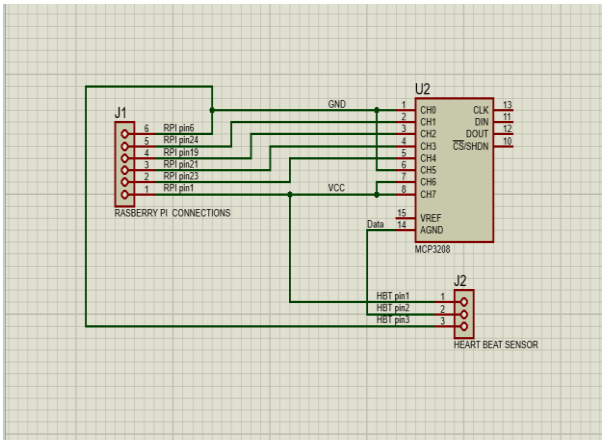

Fig 4. Schematic for heart beat sensor

B. ADC

[7] The Raspberry Pi PC does not have an approach to peruse analog information sources. It's a digital-only computer. Contrasting this with the Arduino, AVR or PIC microcontrollers that regularly have at least 6 simple analog outputs! Simple data sources are helpful on the grounds that numerous sensors are simple yields, so we need an approach to make the Pi analog-friendly. We'll do that by wiring up a MCP3008 chip to it. The MCP3008 demonstrates like a "bridge" among digital and analog. It has 8 analog inputs and the Pi can inquiry it utilizing 4 digital pins. That makes it an ideal expansion to the Pi for coordinating basic sensors like photocells or potentiometers, thermistors and so forth.

C. Raspberry Pi

[8] The Raspberry Pi3 is the latest version of the credit card sized computer from the Raspberry Pi Foundation. The Raspberry Pi 3 is about the 50% faster than its predecessor the Pi 2. It includes built in WIFI and Bluetooth Low Energy connectivity, making it truly an IOT-ready device. The Raspberry Pi 3, with a quad-core ARM Cortex-A53 processor, is described as having ten times the performance of a Raspberry Pi1.

Fig 5. Raspberry Pi3

D. Web Interface

Web interface enables several physicians, doctors, and medical centers to view and diagnose patients' medical status simultaneously. This framework can get significant medicinal guidance from the specialists for the patients and can set alerts or updates to opportune drugs and arrangements and realistic files. To ensure data visibility only to authorized doctor/physician, web portal requires user ID and password. Web interface is implemented using PHP framework. The framework comprises of three sections: patient module, doctor's module server module.

Patient Module: - This module consists of the patient's personal and medical records. Real-time data acquired by sensors has been shown with respect to time. It contains the medical history of individual patient after getting registered at listening port device.

Doctor Module: -Doctor Module allows the involvement of multiple doctors in the web application for diagnosing patients. In case of large data from multiple patients, several doctors can get involved in monitoring and diagnosing processes. User management module can contain 100 users including doctors, patients, and nursing staffs for keeping record of patients.

Server Module: - Server module comprises of two units: local and remote. The remote unit empowers putting away and appropriating the information to specialists and. The local unit manages handling of gathered data from the sensors associated with a patient. It forms the gathered crude information to produce significant data that can be comprehended by doctors. It at that point shows the prepared data and sends it to medical clinic servers, sensor data from hospital sever was continuously upload to webserver.

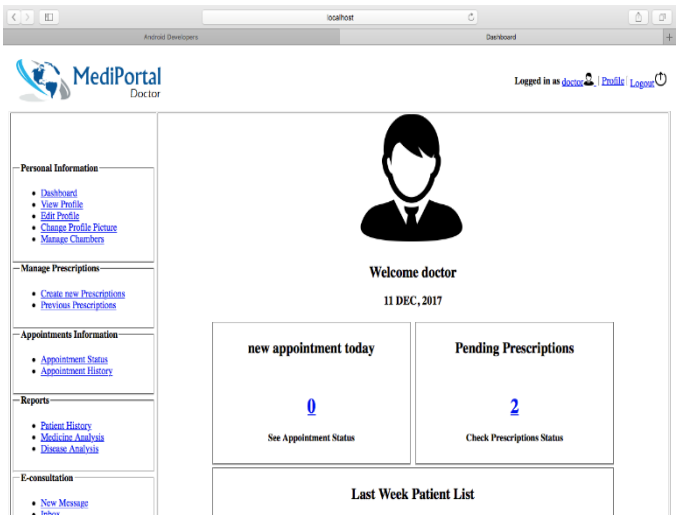

Fig 6. Webpage Interface

E. Chatbot

NEED:

[9] In present world we are majorly dependent upon internet and online services, but in their absence, it becomes very important for us to have an alternative which can fulfill at least our basic needs. A chatbot plays an important role in it. It provides human conversation in its natural format using AI (Artificial intelligence). It features real time response and it is network independent which makes it a major talking point.

DESCRIPTION:

[9] For this we are using a Python package called Chatterbot 0.8.2. This package is easily available for downloading and installing. This chatbot can be trained as per our requirements using the training documents, that is 'chatterbot corpus' used in our case. It is very easy to train for any specific domain. In this module, the chatbot has been trained to answer questions related to health parameters, medicines and other things relevant to this project.
In the figure given below, figure number 7, it represents how the training session looks and the way different in which different data sets (questions and answers) are created while training the chatbot. If an irrelevant question is asked to the chatbot, it will respond with a message stating that the statement (or question) is invalid. Other than collecting health related data entered by the patient, it can set appointments for the patient with the doctors.

Fig 7. Chatbot Training Interface

ADVANTAGES:

[9] In the network cutoff the patient can make the basic use of this chatbot for getting health advisory and disease prediction by analyzing the symptoms told by the patient.

F. Image Processing and Body Fall Detection

[10] [11] The root cause of various injuries and health related issues is falling, sometimes among the cases of seniors it leads to death. It can take place with people from any age group. Especially it takes place in age groups above 60, we all are fully cognizant of the fact that as the age goes on increasing the strength of the bones reduces. Also, the density of bone starts to decline, along with the flexibility of body. Our module will work like a bolster for the people basically, in hospitals. If during late night a patient wakes-up and if is going to washroom and all of a sudden due to some reason, he/she collapse on the floor then this movement will be captured by the camera and immediately message will be sent in form of alarm to the nurses or doctors' room and necessary treatment will be provided to the patient quickly. [11] Firstly, video acquisition takes place in which basically our module captures the video of he/she doing their daily activities this data is then transmitted to computer. It emphasizes to monitor only the image of the person with almost everything in the background being static. Besides, language (python) is used for the designing of the interface. [10] [12] At the time of capturing it looks for the edges of the human body as the basic parameter and accordingly the points are plotted on the x Vs y axis. [13] The overall it is a Real Time process in which the image frames are taken from the video and finally on this image, image processing takes place. Every object has a feature i.e. if we want to identify whether it's a circle, square etc. So, for square it checks whether the object we have placed is having perpendicular corners. [11] [13] This is the first step in which checking was carried out. On similar lines the human fall detection is carried out. Actually, the human fall detection depends on the speed with which the object has fallen. There is a standard value defined based on the x, and y co-ordinates and down fall of the point if the point goes below the defined parameters then it is considered as a fall thus giving an alert alarm . But on the other hand, if the down fall of the point is not within the defined rate then it is not considered as a fall does not giving any alerts.

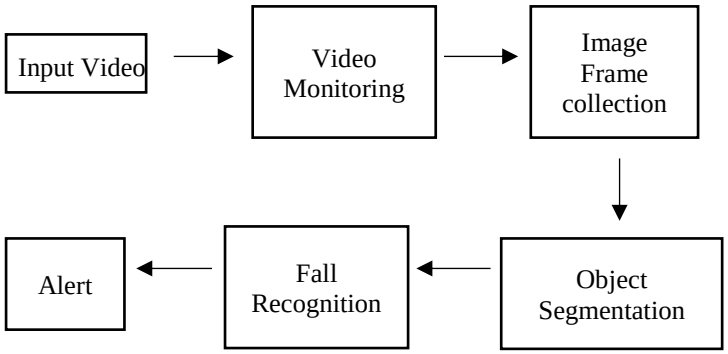

Fig 8. Workflow of Patient Movement Monitoring

G. Disease Prediction

1.Heart Disease

[14] Heart Disease generally refers to ailments of blood vessels, heart's valves, problems with heart rhythm that can lead to severe conditions like heart attack, chest pain – angina and stroke.
Dataset - https://archive.ics.uci.edu/ml/datasets/Heart+Disease (references) UCI Machine Learning Repository

1. Age
2. Sex
3. Chest pain type (4 values)
4. Resting blood pressure
5. Serum cholesterol in mg/dl
6. Fasting blood sugar > 120 mg/dl
7. Resting electrocardiographic results (values 0,1,2)
8. Maximum heart rate achieved
9. Exercise induced angina
10. Old peak = Stress Test depression induced by exercise relative to rest
11. The slope of the peak exercise Stress Test segment
12. Number of major vessels (0-3) colored by fluoroscopy
13. Thalassemia: 3 = normal; 6 = fixed defect; 7 = reversable defect

The above features are used to predict absence (0) or presence (1) of heart disease.

$$K(x,x') = \exp\left(-\frac{||x-x'||}{2a^2}\right)^1$$

A radial basis function kernel Support Vector Machine (SVM) algorithm has been implemented with parameters C=0.1 and gamma =0.1 which were selected by hyper-parameter grid search.

2.Malaria

[14] Malaria is a lethal disease caused by bite due to an infected Anopheles Mosquito. Malaria is an acute febrile illness i.e. symptoms appear approximately 2 weeks after the mosquito bite. So, the person might be affected but the initial symptoms are only fever, headaches and chills making it difficult to diagnose the disease.
Dataset- https://ceb.nlm.nih.gov/repositories/malaria-datasets/ US National Library of Medicine
A convolutional deep learning classification algorithm has been implemented to detect malaria based on cell images of infected and uninfected cells. The images are convoluted to a single vector and provided as inputs to the neural network architecture with labels -Infected (1) and Uninfected (0).
The concept pf Residual Neural is applied wherein certain connections are skipped I order to solve problem of vanishing gradients to achieve maximum efficiency.

VII. LIMITATIONS

The created framework would advise the specialist if there should be an occurrence of crisis through alerts; be that as it may, delay in cautions may happen because of feeble signs of 3G arranges in some remote territories. In spite of the fact that the deferred disturbing time is still inside the brilliant timeframe it ought to be considered in future research. As remote innovation is rising step by step, the utilization of most recent remote innovation may beat these issues which at last expands the pertinence and convenience of the proposed remote checking framework. There are common obstacles that health informatics technologies encounter that applies to Real-Time Health Monitoring Devices. Depending on the comorbidities monitored, Real-Time Health Monitoring Devices involves a diverse selection of devices in its implementation. Standardization is required for data exchange and interoperability among multiple components. Furthermore, Real-Time Health Monitoring Devices deployment is highly dependent on an extensive wireless telecommunications infrastructure, which may not be available or feasible in rural areas.

VIII. FUTURE SCOPE

Data-driven healthcare can revolutionize the future. Patient records and real-time data can be obtained by using wearables, cameras and small sensors. The huge amounts of data thus collected can be used to manage the health and wellbeing of hundreds of millions of patients in an effort to improve quality, viability and cost of care. Artificial Intelligence can harness the power of data mining with digitized medical records and patient monitoring to make healthcare accessible to everybody on this planet. These technological advancements will allow doctors to focus primarily on dimensions of care and give the best medical opinion based on tests and also data collected about the patient.
Availability of doctor is also a major concern. Remote disease diagnosis and treatment of a patient can become a reality. The goal is to assist doctors in curing patients rather than completely replacing human touch from healthcare. In a country like India where a large population lives without quality or affordable healthcare, this step can become revolutionary for the medical industry as well as the large number of patients that will get benefited from this system.

IX. CONCLUSION

We aim to come up with a module which would suffice the need of medical assistance in every corner of the world and overcome the gap between the doctors and patients which causes major hindrance in coming up with better provisions for the patients in terms of medication. Thus, making the process handy for all and at the same time served in a far better manner. We plan to improve our medical assistance using concepts of deep learning and automation, thus making the system easier to handle and more efficient.

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