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Robotic Assistance and Patient Monitoring in Hospitals using IoT

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Abstract - *Health & medical care involves maintenance of quality mental and physical health by taking preventive measures and treatment after the actual illnesses. It includes all reasonable and necessary medical aid, medical tests and examinations, medical treatments, medical diagnoses, medical evaluations and medical services to ensure that the disease does not strike back again. In this paper, an idea to improve the current status of health care worldwide through automation and robotics has been propounded. Health Care & proper monitoring is the most integral part of medication as it is the recovery stage of the patient. Any kind of negligence during this tender stage can lead to fatal consequences. Here we propose a multifunctional automated medical assistant system with data recorder to enhance recovery speed of the patient with the help of Internet of Things (IoT).*

Key Words: Health care, Internet of Things (IoT), Quality services, Eliminating loneliness, Pulse rate, Blood pressure

1. INTRODUCTION

With the advancement of technology, as the life span of people is expected to increase, it will also lead to increase in population in the older age category. With older age, it becomes a necessity to monitor health accurately for healthy life. Without proper and quality healthcare it is practically impossible for patient to recover. This has been one of the leading problems in the field of medicine. According to 2013 civil registration data released by Census directorate, nearly 27% of the total deaths in India happen with no medical attention during time of death. Though there are thousands of community medical centres across the country many of these do not have facilities for proper medical attention to each and every patient. According to recently conducted research operations, 6 almost 122 Indians per 100,000 die due to poor quality of care each year, showing up India's death rate due to poor care quality as worse than that of Brazil (74), Russia (91), China (46) and South Africa (93) and even its neighbours Pakistan (119), Nepal (93), Bangladesh (57) and Sri Lanka (51).

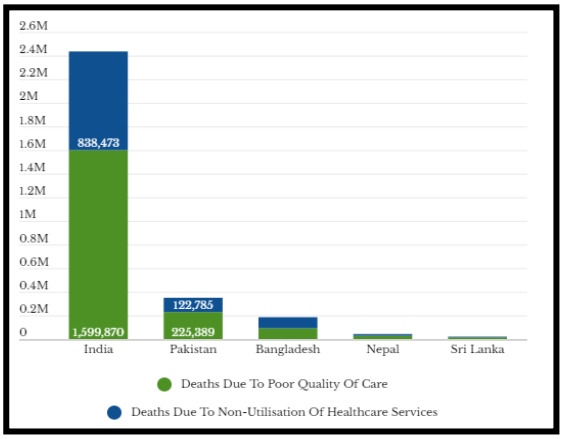

Fig 1-Deaths amenable to health care in various countries

Poor quality health care not only increases the mortality rate but also leads to unnecessary suffering and persistent symptoms.

Efforts have been made to enhance these conditions with the use of computerization and robots to replace nurses yet they are to reach out the masses and most of them are not efficient enough to provide effective care to patients.

1.1 Problems Focused

Following are some of the potentially harmful problems in health care and medication-

1) Improper monitoring of patients health parameters

2) Unavailability of timely medical attention during emergencies

3) Negligence or possible human error by care taking authorities

4) Loneliness of patients

5) Lack of quality data analysis from past records of patient health

6) Improper and time consuming maintenance of paper records.

These problems need to be focused upon to amplify the quality of health care and reduce the deaths due to laxity.

2. PROPOSED SOLUTION

The idea proposed consists of two stage implementation system for advanced health monitoring and care taking of patients. Stage 1 consists of a health monitoring wearable device which would record important parameters of patient's health such as temperature, heart rate and blood pressure. The second part of the proposed solution consists of an internet enabled self-regulating "MEDICAL ASSISTANT" which will interact with patients and deliver medications at regular times acting as a substitute nurse.

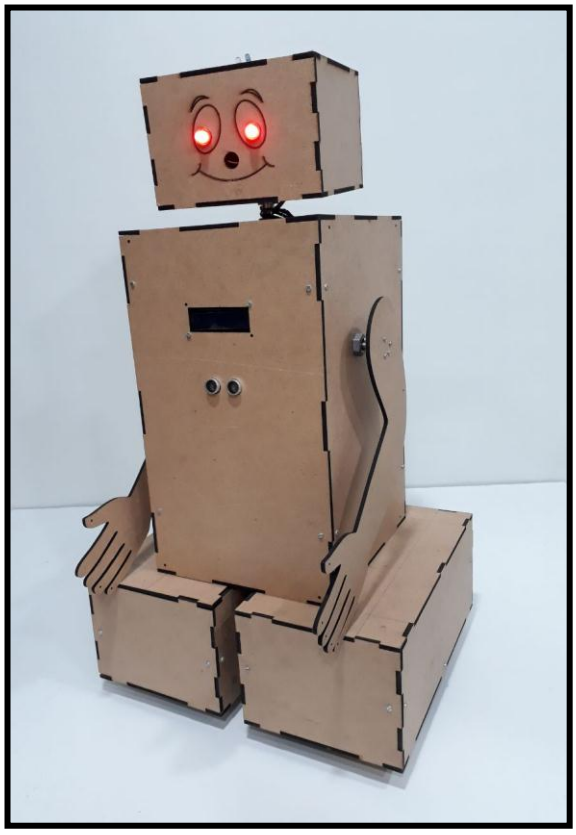

Fig 2 – Proposed Prototype

The existing medical robots are mostly surgery based but there fewer to take care of patients. Thus, this assistant was designed.

This robot is an internet enabled autonomous machine with features such as lifting arms to carry objects and food packages, delivering medicines, avoiding collisions and interacting with patients to overcome feeling of loneliness.

3. METHODOLOGY

IoT (Internet of Things) is the network of physical objects-devices, vehicles, buildings and other items embedded with electronics, software, sensors, and network connectivity-that enables these objects to collect and exchange data. Exchanging and storing data via Internet provides flexibility in easy data transfer, as well as reduce the time and effort in maintaining paper records.

Stage I – Patient Health Monitoring

In health care and cases of emergencies, each second is important for patient's life. Maintenance of paper records for each patient is a time consuming process. Also, in case when patient has to shift to different hospitals, having digital data helps in faster exchange of information and understanding of the patient's medical history leading to faster examinations. Also, records in digital form make it easier to analyse details and come up with quicker solutions.

Hence, a wearable device with sensors (for heart rate, blood pressure and body temperature, three of important parameters frequently tested) which continuously sends data over the internet and maintains real time record of patients could help in understanding condition of patients.

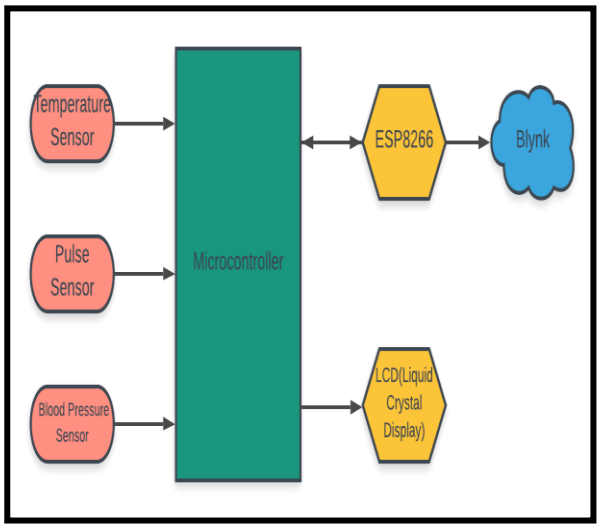

Fig 3 – Block Diagram of Monitoring Phase

An attachment in the form of a band is tied to each of the patient's hand for diagnosing the temperature, pulse rate and blood pressure constantly. The recorded data will be sent through the internet to the doctor's mobile on the app. What the patient has to simply do is lie on his bed and

rest to recover quickly. All of the facilities will be provided to him without any of his movement. All of the real time data related to the patient like his timely intake of medicine, pulse rate, blood pressure will be received by the doctor on his mobile phone through Internet of Things (IoT).

Stage II – Robotic Assistance

The robot has a voice system which communicates with the patient by establishing an internet connection. This prevents the patient from feeling lonely in the absence of a doting care taker. The assistant is a complete self-directing machine which has four basic features for serving patients-

1) Providing timely medicines to the patient

2) Providing food and other necessities to patient

3) Communication with patient to prevent loneliness

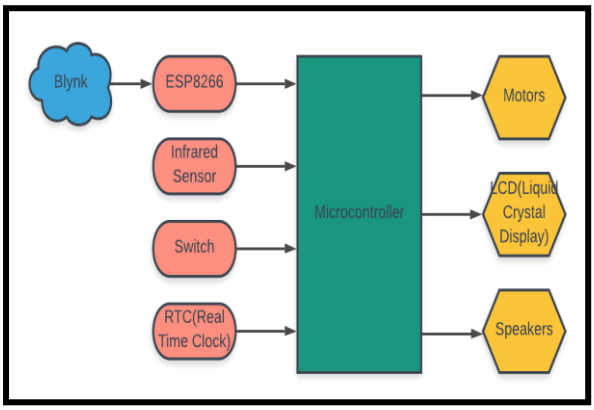

Fig 4 – Block Diagram of Robot

3. COMPONENTS USED

Microcontroller – A microcontroller consists of the main processing and controlling unit of the system. All the input and output devices used in the system are interfaced to the Input / Output (I/O) pins of the microcontroller and the program for execution is stored in the memory of the microcontroller. The microcontroller used in the project is ATMEL ATMEGA256.

Fig 5 – Microcontroller

Pulse Sensor – The Pulse Sensor has an LED which transmits light reflected by the blood cells. It has an LDR which calculates the Pulse Rate upon the intensity of received light. It has been used to measure patient's pulse rate when required and is attached to the band.

Fig 6 – Pulse Sensor

Blood Pressure Sensor – It measures systolic, diastolic and mean arterial pressure utilizing the oscillometric technique. The systolic and diastolic readings are read from the maximum fluctuation in the cuff pressure. It is used to measure the patient's blood pressure and is attached along with the band on the patient's finger.

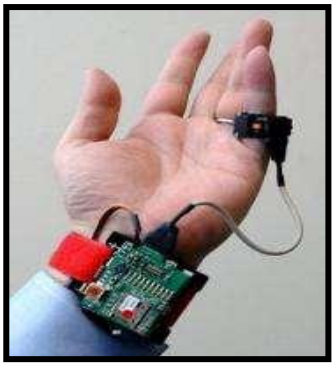

Fig 7 – Blood pressure Sensor

Temperature sensor - The LM35 is used to measure temperature with an electrical o/p comparative to the temperature (in °C). This sensor generates a high output voltage than thermocouples and may not need that the output voltage is amplified. It is used to measure patient's temperature and is records its reading through the band.

Fig 8 – Temperature sensor

Infrared Sensor – In IR sensors, there is an IR LED which transmits IR Light and a Photo Diode which receives light. When the light hits an object it is reflected back and based on the amount of reflection, the reception varies with the distance. This difference causes change in input voltage through IR input. It is used to detect the black lines on the robot's path and give an indication to follow it.

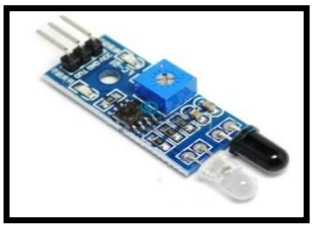

Fig 9 - Infrared Sensor

DC Motors - An electric motor is an electrical machine which converts electrical energy into mechanical energy. When armature windings are connected to a DC supply, an electric current sets up in the winding. The current carrying armature conductors experience a force due to the magnetic field, according to the principle stated above. The motors have been used to move the robot across the room to each bed and to reloading stations following the lines and also to move its hands attached to the tray.

Fig 10 – DC Motor

LCD (Liquid Crystal Display) - A liquid crystal display (LCD) has a thin layer of crystals. When electricity is passed the crystals bend upon the amount of electricity passed. It has been used to show the current time and date sent by the RTC. Also it displays the name of the medicine to be consumed when it is time to do so.

Fig 11 – LCD I2C (Liquid Crystal Display)

Wi-Fi Module (NodeMCU ESP8266) - The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained Wi-Fi networking solution offering as a bridge from existing micro controller to Wi-Fi and is also capable of running self-contained applications. It has been used to send all the patient data to the doctor for continuous monitoring. It is also used to connect to the Internet to communicate with the patient through artificially intelligent algorithms from the Internet. It also gathers timings from the Internet to compare with the set time.

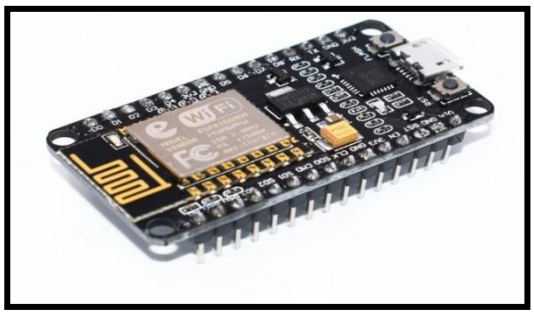

Fig 12 – Wi-Fi Module (NodeMCU ESP8266)

4. IMPLEMENTATION & RESULTS

The mobile app we have used is Blynk. Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard

where you can build a graphic interface for your project by simply dragging and dropping widgets.

Monitoring Phase – An attachment of a band containing temperature, pulse rate and blood pressure sensors is tied to the patient's hand to measure the respective parameters. All this data is transmitted to the doctor's mobile through IoT for data monitoring on the Blynk server. When the app is accessed by the physician the data is ready for him.

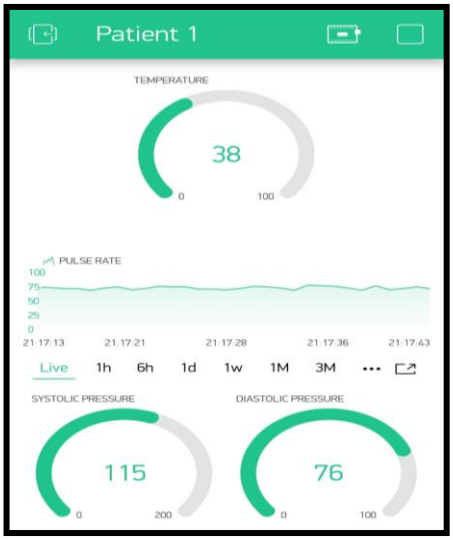

Fig 13 – Patient 1 Records

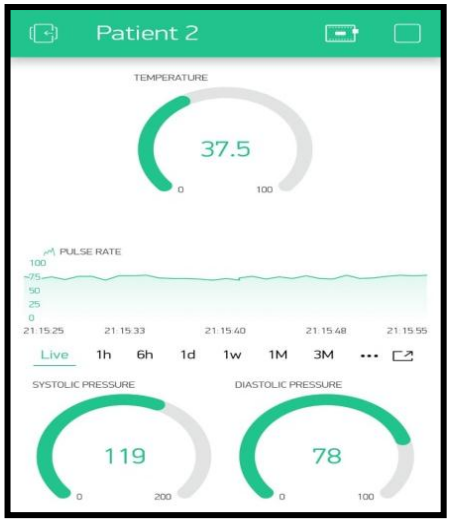

Fig 14 – Patient 2 Records

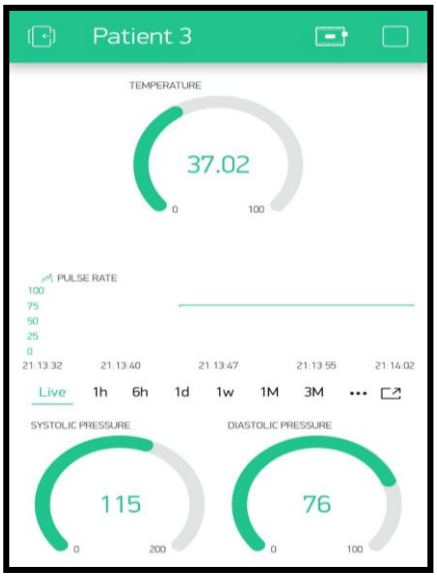

Fig 15 – Patient 3 Records

The robot is so designed that each robot can be placed in a ward of the hospital. There are four phases of the functioning of the robot –

1) Admission Phase – When a patient is admitted to the ward, the timings of his medicine are set through the app and are saved in the microcontroller. The robot is placed at the corner of the room and a black lined path is defined across the room, with a junction at each patient's bed. The timings of all the patients are set. The readings of time are taken from the Internet. The current timings are constantly compared with the designated timings.

2) Delivery Phase – When it is the time for a particular patient to devour his medicine, the robot reaches to his bed all along the path. The robot holds a tray in its hand which is raised. The tray is divided into various sections according to the patient's convenience. It also has glasses of water. It also delivers food supplies at regular timings. As soon as the robot approaches the patient what he has to do is just pick the medicine, water and engulf it.

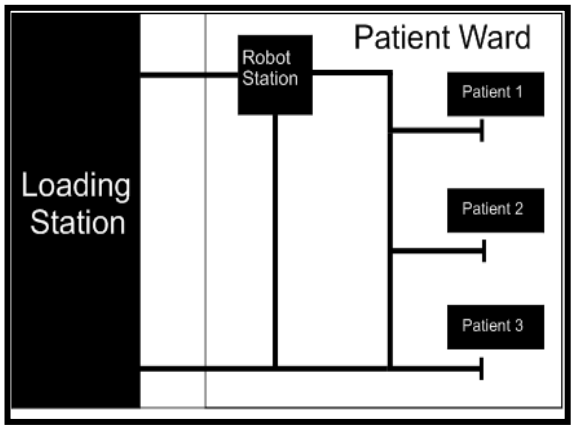

Fig 16 – Path Followed by the Robot

3) **Loading Phase** – When there is a shortage of medicine the robot follows its way to the reloading station where the medicines are arranged on the tray. It also traverses to the station for collecting food supplements for delivery to patients.

4) **Communication Phase** – The robot at regular intervals goes to each and every bed and communicates with the patient to avoid loneliness.

5. FUTURE ENHANCEMENTS

In future we can have an intelligent system in the "MEDICAL ASSISTANT" which could perform problem solving tasks such as diagnosing the patient in the doctor's absence and if anything suspicious is detected it would provide required solution. The robot can be so designed that it can monitor as many patients admitted to the particular ward. The database of the hospital can be linked with robot to track and register the entry and exit of patients.

6. CONCLUSIONS

Hence, this report provides a detailed insight on a medical assistant robot which when implemented in hospitals will enhance the existing quality of health care and will help doctors to a great extent. The target of this robotic solution is to provide comfort and best of facilities to patients without human intervention.

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