IoT Based Intelligent Medicine Tray for ICUs in Multispecialty Hospitals

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***Abstract*—**Medical Sciences has invented many new technologies and are still doing researches in many ways. But integrating Medical Science with Engineering has made a boom in R&D field. These days Automation is going towards the peak point. Thus, when this automation comes into picture in Medical field, this makes the scenario perfect. All parameters of a patient are monitored on its own and so slowly it's becoming no man technology. Only we need to take care of is presence of incharge Doctor or nurse in case of emergency. We have here tried to implement this idea practically by some extent and well this can be brought to betterment in future by applying much advanced technologies.

Keywords*—Arduino; Intelligent Medicine Tray (Trolly); IoT; ICU; Heartbeat; Body Temperature; Emergency*

I. INTRODUCTION

Human tendency is to earn well so that he can secure his future and make his present better day by day. But we humans are so much involved in our life betterment that we ignore our health issues but if ignored this leads to major health issues. Heart related problems are growing tremendously. When we compare our population, the no. of beds in hospitals and the no. of Doctors' present altogether, obviously what we see is our population is too much high. People when run to hospitals in emergency, no vacant beds are seen to get admitted or have to wait for long to get the proper treatment. Here we are trying to say that these many problems can be reduced to some extent with the help of automation. Many researchers are already working on it; likewise we have put on some of our long term efforts to ease this situation.

Need of Intelligent Medicine Tray for ICUs

The main objective behind this need is to give a very time efficient treatment to patient in need in the ICU. It has been seen that in some hospitals, the ICUs are many times filled with the patient's relatives. But they worry if their patient is given proper treatment or not; if any nurse or Doctor is continuously looking after their relative or not. But being an Intensive Care Unit it should always be maintained clean, dust proof and sound proof. Thus if automation grows in these units of hospitals then number of nurses to be present in ICU always will be reduced and relatives won't have to keep worrying. By implementing IoT here, Doctors need not visit patient frequently and check patient's health status from his cabin. Even if the Doctor is out of station, he can check the patient's health status from his android mobile or laptop or PC just with the help of IoT concept.

II. LITERATURE REVIEW

According to the study on existing systems, we come to know that researches have done a great job in this field. Many systems have worked on a concept called medicine box that are stationery and tells us about the availability of medicines in the box. With some of our more efforts into the same field but on a track little different from this, we have tried our best to develop a medicine tray which will be intelligent enough to convey the emergency signal to hospital staff passing outside ICU. The system in [1] is the literature review for our system. Our main idea of an Intelligent Tray comes from [2] [11] Intelligent Medicine Box concept where Medicines that are finished or about to get finished will be known to concerned hospital staff well before time. We have used Arduino in our system as it is inexpensive, easily available but Raspberry would also have done as in [3] [8] with integration of IoT. [3] [4] [5] have all made use of IoT in different manner for Health Monitoring whereas [5] has used RFID along with IoT which was a good concept to know if we can emerge RFID into our work. [6] Gave us an idea to make use of Heart rate and Body Temperature as basic monitoring parameters and additionally we have made use of Saline Level Indicator for our work. Intelligent Medicine Box and IoT are integrated with Bio sensors in [7] but being on small scale we have not made use of Bio sensors as they are expensive. We have made use of Arduino by studying it thoroughly and referring [9] [10] [12] which were very appropriate for implementing our idea practically. [13] This system helped us in knowing that how can we make a system which will automatically remind the concerned person about an emergency via SMSs. [14] This is a basic survey showing integration of Bluetooth with health parameters. But Bluetooth being not able to cover larger area was the limitation for us and thus preferred Wi-Fi over it that comes many advantages.

III. SYSTEM METHODOLOGY AND DISCUSSION

The proposed system is a saga based on four main parts namely:

1) Intelligent Medicine Tray
2) Sensors for monitoring patient's Heart rate, Body temperature and Saline level continuously
3) Emergency panel outside ICU with buzzer and indication in case of emergency
4) IoT for remotely accessing Patient's Health status

Intelligent Medicine Tray: The movement of this tray will be based on IR sensors that will detect the black track on the floor and use precision motors for left or right turn. Patients in the ICU need to be given regular doses of medicines at certain interval of time. This time will be programmed using the compiler and the program for tray. This tray will move to the patient's bed if it is the time to give patient his medicine and will simultaneously display message on panel outside ICU that it is moving. The buzzer will beep for 10 seconds so that the Nurse outside the ICU will come to know about this. Thus, even if no staff is present inside ICU, the staff passing by outside the ICU will come to know this message. By the time tray reaches the patient's bed, the nurse will also come to the patient and treat him using required medicine. This tray will have a display over it showing the patient's name, Medicine to be given to the patient at that time along with the patient bed number. We have established the communication between the tray and emergency panel outside ICU using transreceiver pair of 2.4 GHz. Black track to be followed by tray will be laid on the floor.

Fig. 1. Intelligent Medicine Tray along the Black track to be followed

Sensors monitoring Patient's Heart rate, Body Temperature and Saline Level: These sensors play a very vital role here as they will keep monitoring the heart rate, body temperature and saline level for a patient. We have used these basic parameters at this stage. Thus these can be changed to BP rate, Sugar level and many more in further development. We have studied the min range and max range for each sensor and thus made some values as remarks in this system so that if any of the parameter goes beyond the range set in program, then this signal will be send as emergency signal on the display panel outside ICU with a buzzer which will stop only when the patient will be treated and the acknowledgement button near the patient bed will be pressed. If he is left unattended then the buzzer will keep beeping.

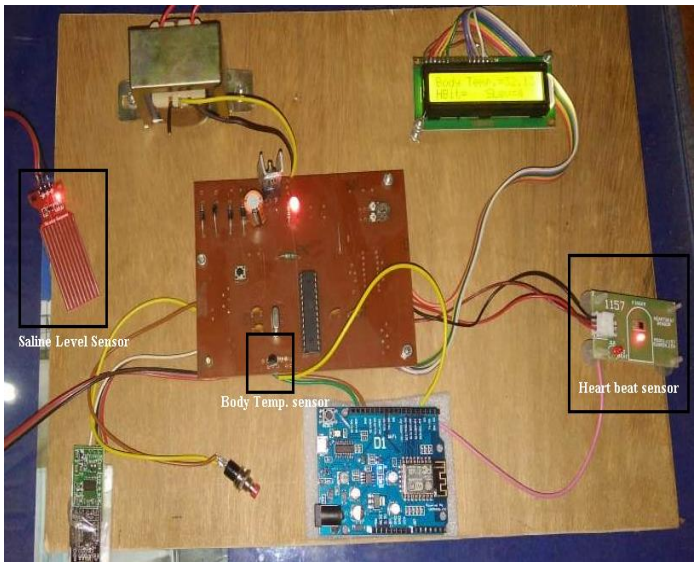

Fig. 2. Figure showing Saline level sensor, Body Temp. Sensor, Heart beat sensor (from left to right with Black Square around them)

Emergency Panel outside ICU: This panel outside ICU unit will be synchronized continuously with the Patient inside using the Transreceiver pair. Thus if any parameter of the patient goes outside predefined range then buzzer will make the sound. Additionally a display has been provided on this panel which will show the type of parameter emergency along with the patient name and bed number which will save time to find out for which patient the emergency is when Doctor or Nurse enters the ICU. Thus this system is said to be a very time efficient system. This emergency panel will also show the message on its display that the tray has started moving using the transreceiver pair between the emergency panel and the medicine tray.

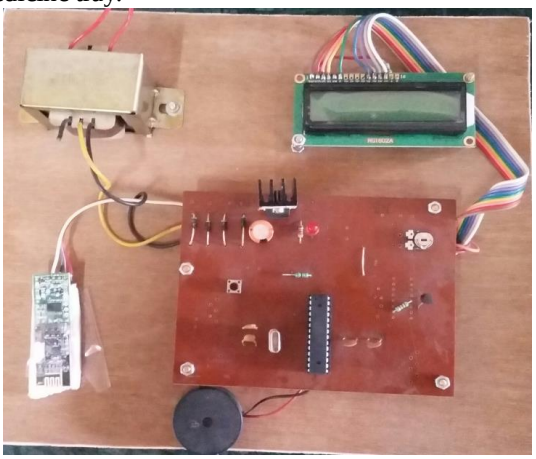

Fig. 3. Emergency Panel outside ICU with Display and Buzzer

Remote Access using IoT: Sometimes due to more number of patients under treatment or visiting patients, Doctor cannot always visit the patient in ICU. In such cases if any of the parameter of patient goes out of range and is left untreated then this situation may lead to catastrophe. So IoT is used here so that the Doctor when is not able to visit the ICU and check the patient on regular basis then he can simply keep his Desktop/ Laptop/ Android Mobile logged in and check the patient's health parameters. Here we have used www.thingspeak.com for IoT implementation. Using this, the parameters will be display on the system every 45s along with the updated values.

System Block Diagram

Currently this system is working for one patient with one medicine tray and further work is going on to make one medicine tray work for two patients. This system basically consists of four main blocks. These blocks are the Medicine Tray, the emergency panel outside ICU with display and buzzer, sensors panel with its information on the patient's respective display and the IoT part. IoT has made this work more efficient as we can access the patient health status remotely on a desktop or android mobile.

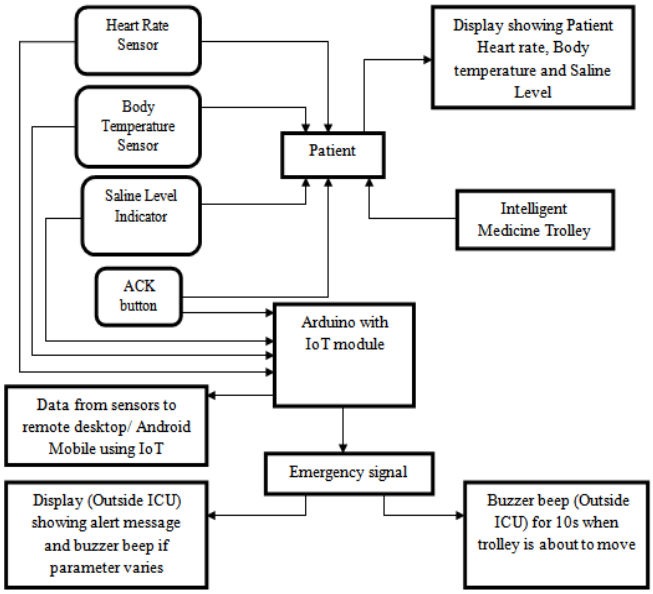

Fig 4. System block diagram

System Flow Chart

The implemented system will work according to the flow shown below.

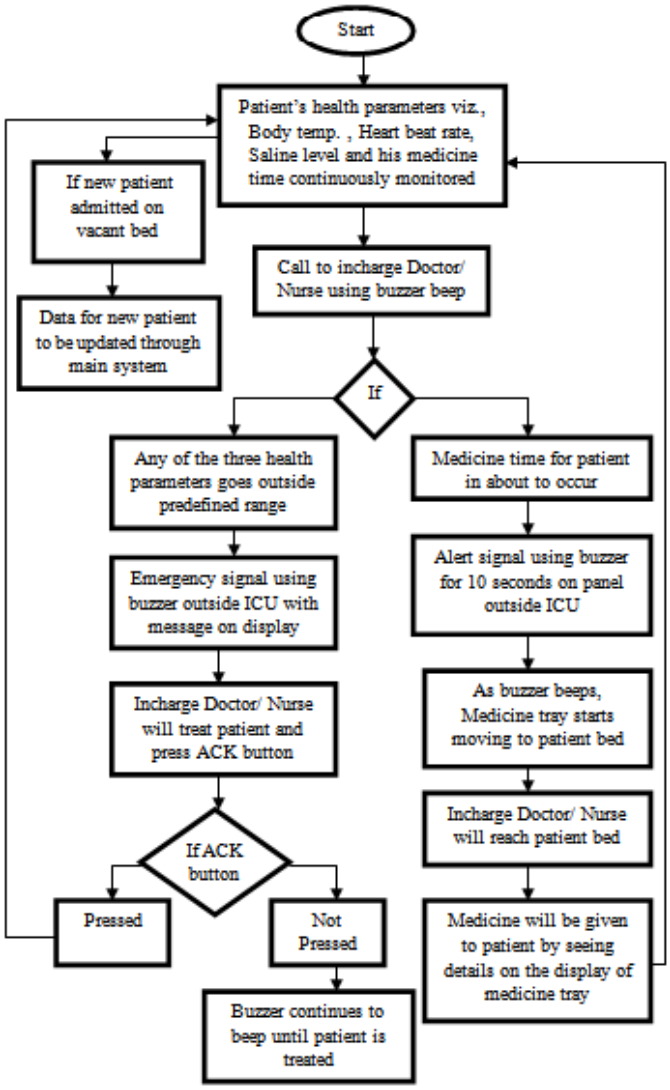

Fig 5. Figure showing system flow

Algorithmic Steps for System

The proposed system will work based on the algorithmic steps below:

1) Patient's health parameters viz., Heart Beat rate, Body Temperature, Saline level and his medicine time will be monitored continuously.
2) Emergency will occur and buzzer will start beeping if
   Case I: Any of the three mentioned health parameters of the patient has reached beyond the predefined range
   Case II: If it is the Medicine time for the patient
   Case I:
   i) Emergency panel outside the ICU will start beeping the buzzer continuously with the name of parameter emergency with the patient name and bed number on display panel.
   ii) The incharge Doctor/ Nurse if available outside ICU r any Staff member passing by outside ICU will see the message on hearing the beep and take immediate actions.

iii) Once the patient is treated the ACK (acknowledgement) button near the patient bed must be pressed for acknowledging that the patient is given the required treatment. If the ACK button is not pressed then the buzzer will continue to beep. Example: In case if its Saline emergency then the Doctor/ Nurse will come and change the saline but if he does not press the ACK button then buzzer will keep beeping even though the empty saline is replaced with the new one.

Case II:

i) If it is the medicine time for the patient then an alert signal will be given for 10 seconds using the buzzer on emergency panel outside ICU. Along with this, the medicine tray will start moving and stop at the patient's bed using the Black track on the floor.

ii) By the time tray reaches the patient, Nurse will reach the patient bed.

iii) For giving the patient his medicine at that particular time, nurse won't need to remember his health history or refer his file every time. This we have made easy by showing the Patient name with his medicine name at that time on the display attached to the Medicine Tray. Thus if the nurse is not available then even other staff member can give the patient his medicine on time.

Once done, again the controller will start monitoring the parameters.

IV. EXPERIMENTAL RESULTS

Initially when working on this idea, some goals were set to be achieved. After the implementation of this goals achieved, some practical results have been explained below. As shown in the fig. 4, initially when there would be no emergency, then "No Emergency" message will be shown on the display of emergency panel outside ICU. We will check the results one by one. Initially as in fig.6, Body temperature is 32.13 degree Celsius, Hbit means heart beat is 72 bpm and SLev means saline level is 151 units. When we consider the Saline emergency, then we have done this by dipping the saline level sensor in a glass of water up to the marked strips of sensor and then when we remove this then the saline level will start to reduce and soon will be zero and show us the saline emergency message outside ICU with buzzer beep. When the emergency will be treated then the ACK button must be pressed and thus this will show the message "ACK accepted" on display outside ICU as shown in fig.8.

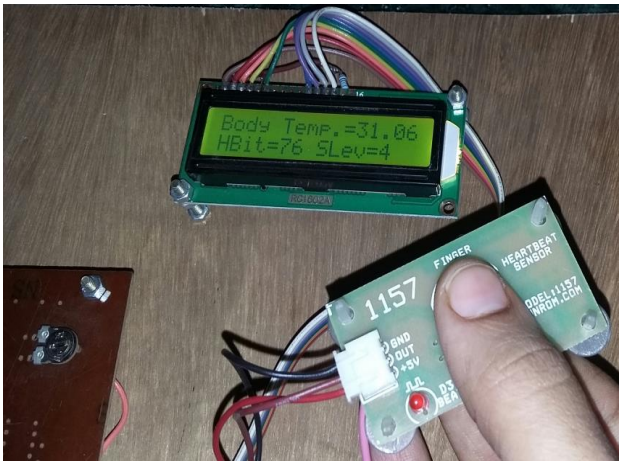

Fig. 6. Figure showing all three parameters that are monitored

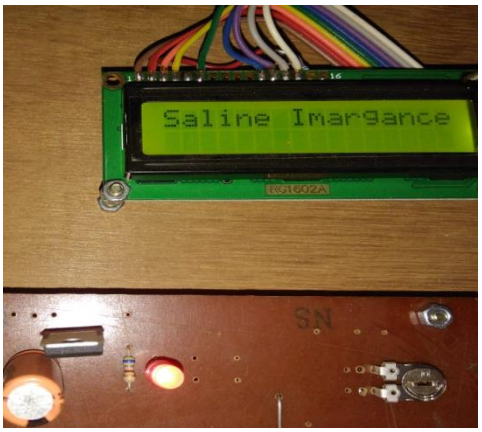

Fig 7. Figure showing Saline emergency on display outside ICU

Fig 8. Figure showing ACK accepted on display outside ICU

Further we have created temperature emergency here by placing a heated soldering gun near the temperature sensor for showing results.

Fig 9. Figure showing Body temp. Emergency on display outside ICU

When the tray is about to move to patient's bed, then it will display message on panel's display outside ICU that trolley has started moving and this will also beep the buzzer for 10s so that if no staff is present inside ICU then any staff passing outside ICU will hear this and come inside to give medicine to the patient.

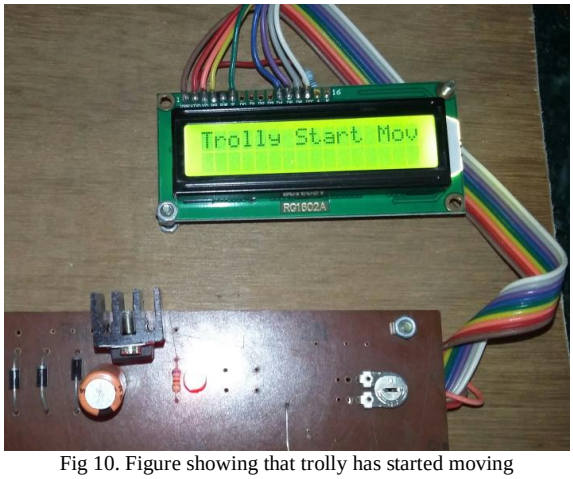

Fig 10. Figure showing that trolly has started moving

The heartbeat rate and body temperature of the patient which is continuously monitored will be updated on our channel of thingspeak every 45s which in shown in fig 11 and fig 12 respectively.

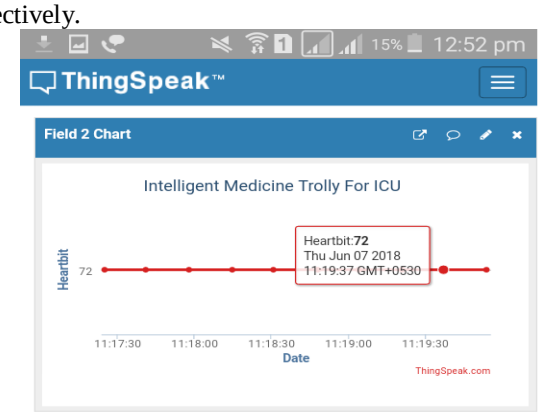

Fig. 11. Heartbeat rate updated on thingspeak

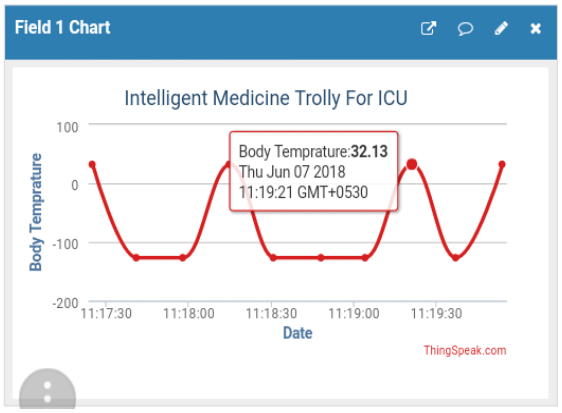

Fig.12. Body temperature updated on thingspeak

Now what comes next is the heart rate emergency which we can't show here because we need a real patient for this and that too whose heart rate is increasing and going outside range but this is working. After this when the medicine tray is about to move to patient bed when medicine times occurs then fig. 13 shows the details of the patient and medicine to be given with the room no. on display of the tray using which any staff available at that time near the patient can give patient his medicines.

Fig 13.Patient name (randomly taken for example) with medicine name on medicine tray display

V. CONCLUSION AND FUTURE SCOPE

In this work we have tried to build up a very time efficient system for giving treatment to patients inside ICU without time delay. This system can now work with ratio of 1:1 i.e. one medicine tray for one patient. The system will continuously monitor patient's health parameters like body temperature, heart beat rate and saline level. Also it will keep checking if the medicine time for the patient is about to occur and take required action as explained in algorithm and system flow. The Intelligent Medicine Tray shows the Patient name with his bed number and the name of medicine

to be given to the patient at that particular time. We have also established communication between the tray and emergency panel outside ICU for the acknowledgement of trolly has started moving. In future this system can be advanced by using RFID tag instead of IR sensors used here. Along with this, this system will be advanced by us to implement return path for the medicine tray from patient's bed to its original position so that when the medicine is given to the patient then the tray will return to its original position on its own.

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