SMART HOSPITAL MANAGEMENT WITH HEALTHCARE MONITORING AND WORKFLOW OPTIMIZATION

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***Abstract*—In this paper, we discuss the approach of a real-world scenario of smart autonomous hospital management integrated with the IoT. However, integration is not a trivial feature when dealing with a variety of electronic systems and healthcare components. This project aims at explaining in detail the technology drivers behind the IoT and health care with the information on system architecture, system implementation, workflow or the process flow behind the technical operations of the remote device coordination, the architecture of the network, middleware, databases, application services. With the rapid development of the mobile Internet, Internet of Things (IoT), and wearable devices, health monitoring has shown an intelligent trend in recent years. Many hospitals have already made use of mobile phone apps for appointment registration, inquiring electronic medical records, and examination results. A possibilistic algorithmic approach is propounded to find solutions to the multi-objective problem and an illustration is also enumerated.**

Keywords: Internet of Things(IoT), Smart Hospital management(SHM).

I. INTRODUCTION

The main aspect of designing this infrastructure is to identify a group of new facilitating aspects like the arrival of patients with various symptoms. The patient's symptoms are updated into the database. And an Expert system is used for optimum analysis and disease prediction. The health care Industry faces several challenges in real-time such as acquiring data, transmission and visualization of data over the Internet. Peddicord et al (2012) show a system for monitoring the medical condition of several individual patients from a centralized location. The system includes a plurality of remote monitoring units that each includes both a wireless transmission device and a conventional modem for communicating over voice telephone lines. The dual modes of transmission allow the remote monitoring unit to communicate either over a wireless communication network, if available or over conventional telephone wires. Yuan-Hsiang Lin et al (2004) have developed a mobile patient monitoring system. The system has been evaluated by technical verification, clinical test, and user survey. which integrates current personal digital assistant technology and wireless local area network (WLAN) technology.

In order to design patient monitoring network, the factors which were taken into account in this paper helps to reduce hospital utilization and improve clinical outcomes. Subsequently, decisions regarding workflow are made in two phases. In the first phase on arrival of the patients to the hospital the expert system gets the symptoms from the patient and makes an appropriate disease prediction and analysis is done and the respective ward number is generated based on the symptoms. In the second phase, On being admitted, the patients are assigned a card with an RFID is generated to track their movement. The Objective of this system is to enable the doctors to be connected to the health care system through the Internet of things, patients get more engaged in their treatment, and doctors improve diagnosis accuracy since they have all the necessary patient data at hand.

II. RELATED WORK

The hospital system consists of various coordinated entities that work together in an integrated environment. The existing system that is used for monitoring of patient information mainly depends on manual procedural based data collection which consists of several paper forms spread throughout the hospital and integrating it. The manual method of data mining and collection is based on different workflow methods. Here a sequence of actions $ai \in A$ that are executed to complete a workflow, $\tau A = (c1, \ldots, cn)$. When workflows are instantiated, they may follow different paths consisting of varying actions. These paths manifest themselves as a sequence of observed events, $(ev0, \ldots, evn)$. It may be possible for each event to describe more than one workflow. It aims at data standardizing, data collection, data mining to make it efficient and remove the replicants and differences. It aims at maintaining the information regarding the patient's symptoms, admission or discharge summary, lists of available doctors and report generation.

patient and it is removed once the patient is discharged. [2] proposed a novel method for secure transportation of railway systems has been proposed in this project. In existing methods, most of the methods are manual resulting in a lot of human errors. This project proposes a system which can be controlled automatically without any outside help. This project has a model concerning two train sections and a gate section. The railway sections are used to show the movement of trains and a gate section is used to show the happenings in the railway crossings. The scope of this project is to monitor the train sections to prevent collisions between two trains or between humans and trains and to avoid accidents in the railway crossings. Also an additional approach towards effective power utilization has been discussed. Five topics are discussed in this project : 1) Detection of obstacles in front of the train;2) Detection of cracks and movements in the tracks;3) Detection of human presence inside the train and controlling the electrical devices accordingly 4) Updating the location of train and sharing it with other trains automatically 5) Controlling the gate section during railway crossing. This project can be used to avoid accidents in the railway tracks.

A. SYSTEM OVERVIEW.

The integrated information service platform is to make polymerization for distributed and heterogeneous applications in the hospital, to achieve seamless access and integration of every application system, providing an integrated environment supporting information access, transmission and collaboration.

Management service includes information system of financial management, registration and charge of outpatient and emergency, admission, discharging and transferring of patient, drug storehouse management, pharmacy management of outpatient and inpatient and so on, treatment service includes application system of outpatient doctor workstation, hospital doctor workstation, clinical nurse workstation and embedded mobile electronic, medical records platform, virtual hospital includes consulting and booking services of outpatient , department and expert , and external interface includes medical insurance interface to medical insurance office and medical dispute consulting interface to legal aid center.

In particular, each kind of person has different permission on this platform because of their different identities, so the user is required to access the integrated information service platform only by the unified identity authentication platform. The hospital management system consists of both software and hardware components over a heterogeneous application. It consists of a three-tier architecture over a distributed database. The first tier is the application layer which consists of the expert system analyzer and the system interface which is used for making disease prediction and displaying the sensor values and readings. The second tier consists of the database and knowledge base. This is connected to the cloud storage to allow access from multiple locations. This enables doctors to access the patient data anywhere and take necessary actions based on it.

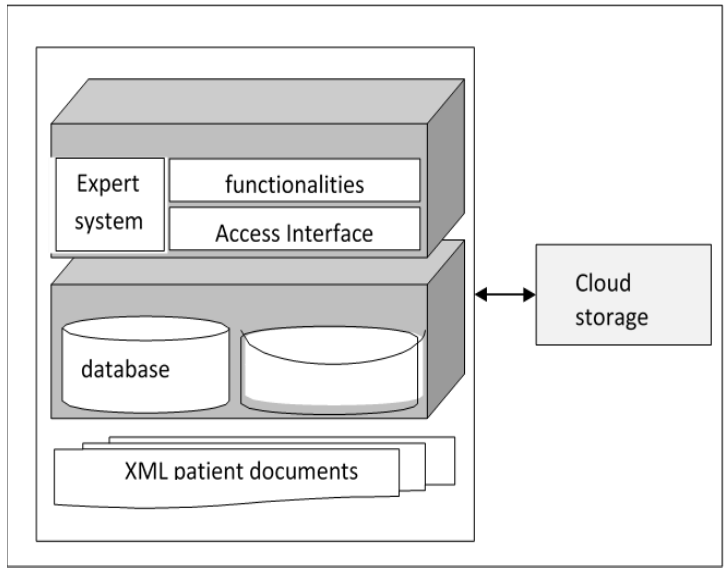

Fig 2. The architectural overview of tiers of hospital management system

III. OPTIMIZED WORKFLOW

After the expert system analysis, the next step is the workflow optimization. As the number of doctors available decreases and the patients in the waiting list increases. There is a need for an optimized workflow algorithm. Let us consider a scenario which has n deterministic jobs and m resources that has to be Scheduled among multiple servers or people. The goal is to schedule all jobs non pre-emptively such that the total machine time is minimized.

A. LIST SCHEULING

List scheduling in Algorithm is a modified version of the ASAP scheduling algorithm. The difference is that in each iteration, only a subset of nodes can be scheduled depending on the availability of resources at the current control step. The availability information is maintained with a "reservation table" at line 5 of Algorithm. We define a Boolean vector *restab*, in which each entry indicates the availability of a unit. At each control step, *restab* is initialized to be all false. Whenever a resource *u* is available, one of the instructions is selected for assignment to the current step. The case in which a unit can only implement a subset of instructions can be trivially handled by an additional test *impl.* Meanwhile, *restab(u)* is assigned to true, indicating it is "occupied." This ensures constraint (b) is always satisfied.

Algorithm listsched(L:(VxV)[],S:V,t:v)
Returns V->Z

```
1. var    Ready,NextReady : V[];
2. var    step: Z;
3. var    counter:V->Z;
4. var restab U->{true,false};
5. Step=0;
6. Ready={s};
7. foreach (v ∈ V)
8. counter(v)=|{u|(u,v) ∈L}|;
9. while (Ready ≠β) do
10.  NextReady = β
11.  foreach (u ∈ U)
12.  Restab(u)=false;
13.  while(∑y and ∑ x∈ Ready )
14.  V=choose(Ready,u);
15.  restab(u)=true;
16.  S(v)=step;
17.  Ready=Ready-{v};
18.  foreach ((v,w) ∈E) begin
19.  Counter (w)=counter(w)-1;
20.  if (counter(w)==0)
21.  NextReady=NextReady ∪ {W};
22.  end foreach
23.  end while
24.  Step= step+1;
25.  Ready=Ready ∪NextReady
26.  end while
27.  return S;
```

Note that at each scheduling step, the number of ready nodes is often more than the resources available to implement them. Therefore, we need to decide which subset of nodes should be chosen for scheduling, in other words, how we implement the *choose* function in line 14 of Algorithm. It is this key step that impacts the quality of the solution.

IV. DEVELOPMENT OF THE SYSTEM

The development of the HMS system consists of integrating a wide range of sensors over the microcontroller. Different sensors are used for measuring different values. The IoT which is used for monitoring the sensor values is raspberry pi. The different sensors used for measurement are the temperature sensor, ECG sensor, Heartbeat sensor, Motion sensor, Blood glucose sensor. These sensors are connected to the relay which is connected to the raspberry pi. The microcontroller is connected to the Bluetooth module and the RFID is also integrated to get the patient identifier data. This is connected to the wi-fi module. A mobile app is created using firebase for both patients and the physicians through which the sensor data can be viewed. The development module for SHM is shown in figure 4. The sensors continuously collect data from the patient's body to get the patients details. In case of emergency these devices can distantly report the physical conditions of the patients to doctors or relatives. In such conditions the hospitals can respond with necessary medical services. In figure 2 different sensors are connected to the patients body to measure different parameters like ECG, blood pressure, temperature, Motion, blood glucose. These signals are in analog form and they are converted into digital form with the help of an ADC converter. All these operations can be done in different layers.

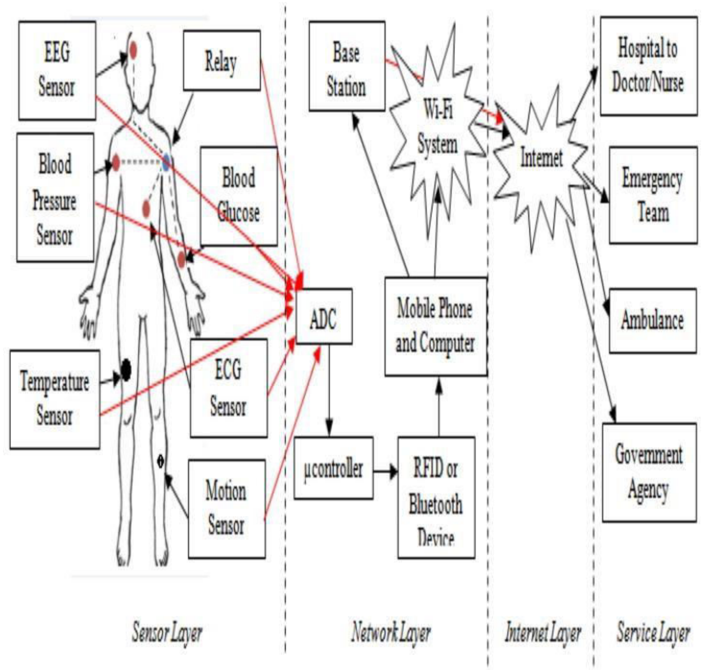

Fig.4 The overview of the different layers in the development system

Internet Layer: The internet layer is used to establish connection between the service layer and the network layer. It works as a transmitter to send the values over the internet to different devices.

Service Layer: The data transmitted over the internet is accessed by several entities such as the physicians, doctors, nurses to calculate the datasets and formulate results.

sensors	Low	Normal	High
Heartbeat	**<60 pm**	**65-120 pm**	**>130 pm**
Temperature	**<96°F**	**98.4°F**	**> 99°F**
Blood pressure	**90/60 pm**	**120/80 pm**	**140/90**
Blood glucose	**<70mg/dL**	**>100 mg/dL**	**>125mg/dL**
ECG	**<0.05/s(QRS)**	**0.08-0.10/s (QRS)**	**>0.20/s**

A study is made on the different healthcare values and their range in which they should lie.

The above table tells us the range of values that must be observed in monitoring the healthcare readings. These data set is fed into the microcontroller and if the value falls above or below the Normal range then it is indicated by sending signals over the internet to the service layer. So that immediate actions could be taken. All the sensors laboured provide the values to the mobile phone using ADC. The mobile app can invoke the health administrator to perform the required action.

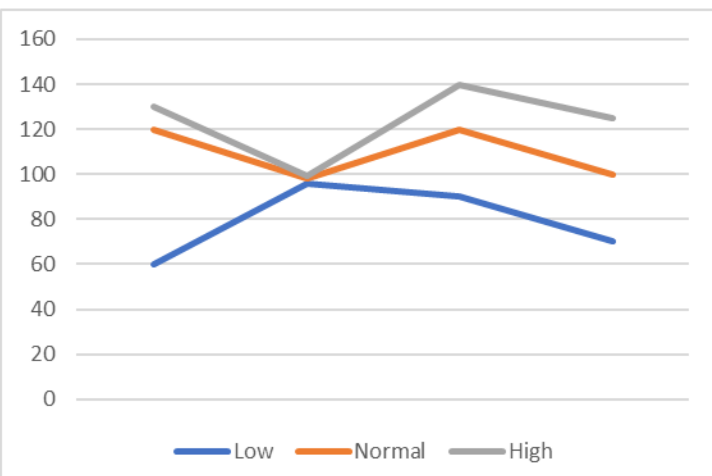

Fig. 4.1 An illustration based on the healthcare Values.

The degree of success depends on the rate we are able to address the fluctuating rate of the sensor readings and identify different methods of change.in 1993, the senior manager of the IS department mentioned repeatedly the growing problems with the integrated hospital information system. In his view, the system would not be able to deliver the information services needed by Management decided not to focus on information services, and made the IS department, including further development of the integrated hospital information system, a sub-unit of the facilities department.

V. RESULTS AND DISCUSSIONS

This section deals with the experimental results of the smart hospital management system with workflow optimization using IoT. The expert system analyzer is used for medical diagnosis and it is created using visual studio. The system accepts inputs in the form of physiological, radiological and clinical parameters from the user. Moreover, the user can select general as well as specific symptoms from the prebuilt symptom library. The expert system is equipped with an interface and require knowledge to be entered according to a specified format. The object-oriented expert system shells are also developed to link the external databases with expert systems.
The figure 5.1 shows the implementation of expert system using Visual studio. A web interface is created to send the data over the web site using HTTP client- server protocol to allow information exchange. It is very economical and the performance is highly efficient and scalable.

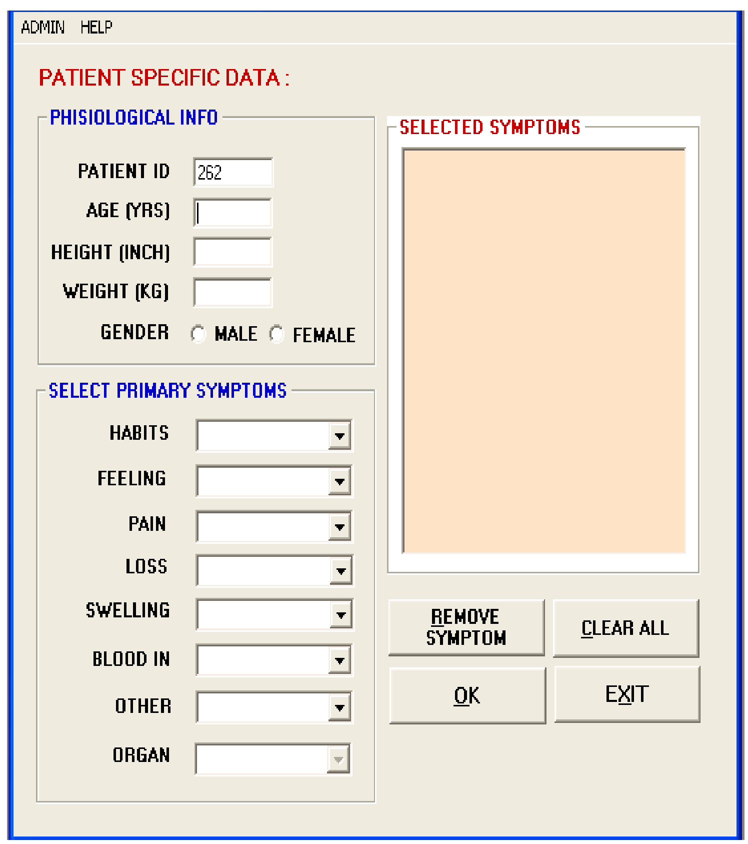

Fig. 5.1 A illustration on Expert system analysis of the disease using Visual studio

The Next step is the workflow optimization. The number of doctors and patients is calculated using the list scheduling and an app interface is created to access it. The figure 5.2 shows an app created using android studio which helps to access the data.

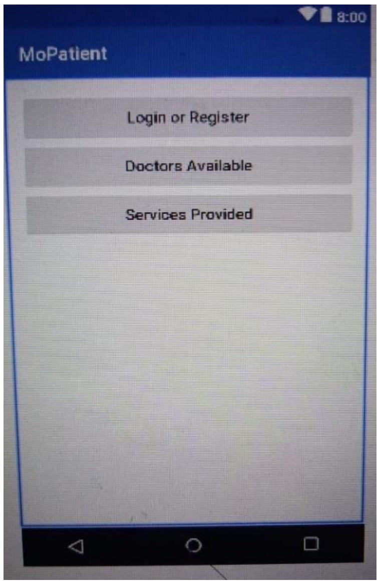

Fig.5.2 A mobile app to view the doctors available and the services provided using IoT.

The next module consists of the health care monitoring using sensors that are used for measuring different values. [4] discussed about an eye blinking sensor. Nowadays heart attack patients are increasing day by day."Though it is tough to save the heart attack patients, we can increase the statistics of saving the life of patients & the life of others whom they are responsible for. The main design of this project is to track the heart attack of patients who are suffering from any attacks during driving and send them a medical need & thereby to stop the vehicle to ensure that the persons along them are safe from accident. Here, an eye blinking sensor is used to sense the blinking of the eye. spO2 sensor checks the pulse rate of the patient. Both are connected to micro controller.If eye blinking gets stopped then the signal is sent to the controller to make an alarm through the buffer. If spO2 sensor senses a variation in pulse or low oxygen content in blood, it may results in heart failure and therefore the controller stops the motor of the vehicle. Then Tarang F4 transmitter is used to send the vehicle number & the mobile number of the patient to a nearest medical station within 25 km for medical aid.

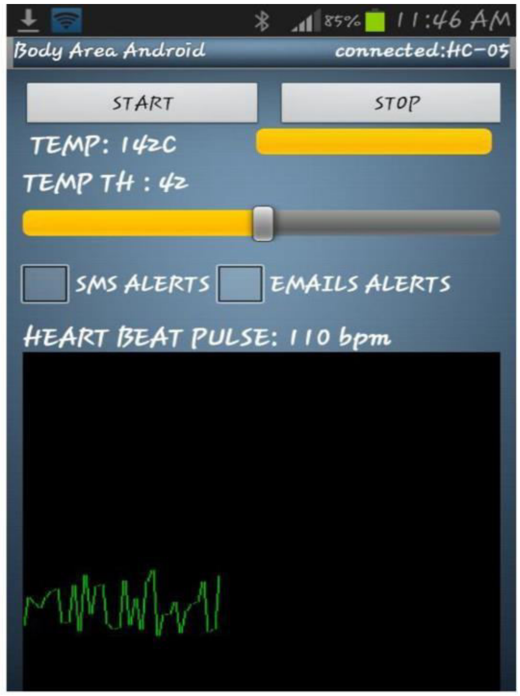

Fig. 5.3 A Mobile application to view the healthcare values.

The threshold values are updated into the system based on the dataset and if there is any difference between the observed and the normal values then a SMS alert is send to the medical observers. So that the necessary actions could be carried out.

VI. CONCLUSION

This paper deals with the architecture of the HMS with the integration of various entities. The healthcare system is hospitals is very essential as it can have a huge impact on the patients.
This model consists of different modules such as the expert system analyzer, Workflow optimizer and Health care Monitor implemented with the help of the IoT. The main purpose of this paper is to eliminate the drawbacks of manual HMS based system which is tedious, error prone and time consuming and to design and automated approach which would be optimized, economical and user friendly.
This system helps all the entities of the hospital such as the physicians, nurses, patients and doctors easy access to all data and allows the patient to monitor his own condition using a Mobile application.

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