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Cloud Based Management Framework to Monitor Heart Diseases Using Internet of Things (IoT)

Swaleha Zubair[1*] and Mohd Saqib[2]

[1,2]Department of Computer Science, Faculty of Science, Aligarh Muslim University, Aligarh (India)
Email: [1]swalehazubair@yahoo.com and [2]saqib9828@gmail.com

ABSTRACT

The Internet of Things (IoT) comprises enmeshing of communication via embedded devices using webworknetworking devices. Cardiois considered to bethe most prevalent ailment affecting people across the globe. We still fail to control it due to negligence and lack of adequate knowledge. A heart patient needs a regular check-up and monitoring butto visit a hospital on a daily basis is not possible and this can be sometimes costly too. The present study proposedasystemthat describes an idea about a cloud-based monitoring system using IoT.The implied system not only help the physician to have knowledge about various heart-relatedparameters of the concerned patient, however, family members, as well as another relative, can also receive regular feedback regarding the health status of the patient. The unit involves a microprocessor IoT based monitoring devicethatcommunicates with cloud on regular basis and eventually, the data can be stored used byinformationsystemproposed.

KEYWORDS: Information Technology, IoT, Cloud Computing.

[*]Corresponding author

Dr. SwalehaZubair

Assistant Professor,

Department of Computer Science, Faculty of Science,

Aligarh Muslim University, Aligarh (India)

Email: swalehazubair@yahoo.com.

INTRODUCTION

Cardio Vascular Diseases (CVD) areconsidered as the main cause of death across the globe. A general estimate suggests around 600,000 deaths per year have a direct correlation with CVD in the United State[1]. Another alarming statistics report around 715,000 heart attack incidences in the USA per yearCVD led to around 26% adult death in 2001-2003[2]. Not confined to developed countriesonly, an alarming of heart-related diseases has been observed in Indian population as well. The recurrence of heart-related diseases is a very common feature. Around, 30% of the patients are readmitted at least once within 90 days with readmission rates ranging from 25% to 54% within 3 to 6 months[3](Figure 1).

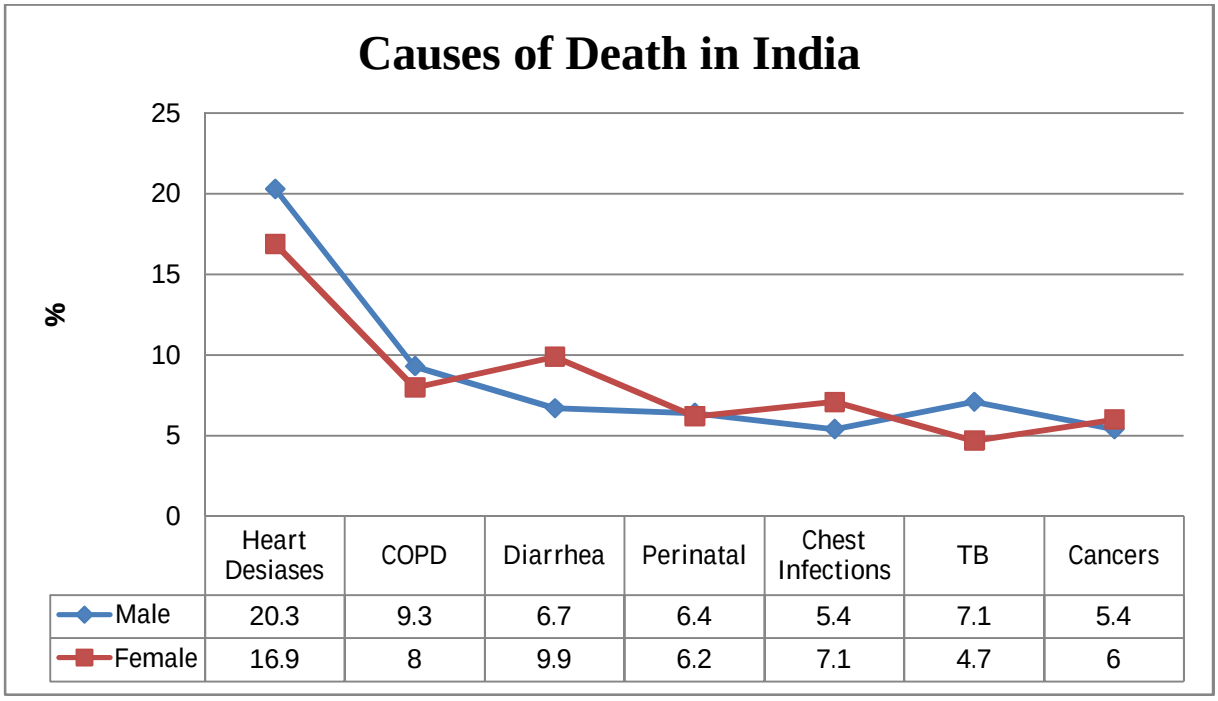


Figure 1: Causes of Death in India. SRC: Registrar General of India (2009).

The Internet of Things (IoT) comprises enmeshing of communication via embedded devices using webwork networking devices.IoT solutions offer a novel efficient tool to monitorpatients 'health. The related device not only improves the diagnostic and process but also decrease the cost of running healthcare facilities by drastically reducing workflow and admin time. The newly emerging technologies such as cloud computing, and wearable devices of Internet of Things (IoT) may find a great deal of scope in providing an attractive monitor module[4].The systemmonitoringfacilitates the vital functioning of the cardiovascular system. The global market forwearable technology raised to 210 million unit shipments and$30 billion in revenue by 2018 from 96 million unitshipments and $8.5 billion in revenues as compared to fiscal year [5,6]. The involved advances in sensor and connectivity technologynot only increase the scope of data compilation, however, it also helps in monitoring the health condition of the patient[7].In fact, CVD patient requirescontinuous monitoring to

get the detail about parameters such as mainly temperature, heartbeat, blood pressure and other related heart specifications. The average heartbeat per minute for a 25-year healthy person between 140-170 bpm while for a 60-year old it isaround between 115-140 bpmon the other hand body temperature of a healthy individual is37degree Celsius or 98.6 Fahrenheit[8]. For a cardiovascularpatient, such parameters may alter during various phases of the disease. The continuous monitoring is feasible only of such parameters in hospitalized patients.

In the proposed system, we employed a low-cost sensor to collect and analyze the generated data. Next, we employed Wi-Fi Arduino to send data on the cloud using with Arduino and eventually retrieval of data by webpages or android app.

Health monitoring employing wearable devices has a tremendous scope. Many systems, ideas, and concepts have been employed to divers tied diseases. IoT and cloud computing can be explored for remote health monitoring systems. An android application can be used to integrate clinical data on one hand and electro-cardiogram on the other. The data can be classified into low, medium and high categories. The cloud hasamended output in a more presentable form making it comprehensive medical related issues. A prototype comprising of a monitoring system which collects the patient's data from IoT devices rather collecting directly from patients[8]. We employed [9], Arduinoandraspberry pi 3 for data generation followed by the same on the cloud using HTML and Wi-Fi. Instead of storing sensor data on cloud collected from patients it can be directly forwarded to the doctors or concerned persons via SMS or Email system[8,6]. The system is designed as a smart monitoring device that may facilitateboth data mining and machine learning to predictcardiovascular diseases [17]. we used available data and made a smart machine based prediction whichmayhelp doctors for quick diagnosis followed by the appropriate treatment the concerned patient[11].

The uniqueness of the Purposed System:

A lot of research papers and proposed works have been published so far like[6,12,13,14]. These studies are either Android or web-based. Many are related to storing data on the cloud and some directly communicated to the doctors or concern person via SMS or Email like[8] and[6].

All the above are focusing only on technologies used in the development phase but the purposed study is not only about the development of Heart Diseases Monitoring System (HDMS) but also describing various tools, concepts, and theories use to make an effective information system. Various modules are described, the relation between them through ER-Diagram and shows the flow of data via Data Flow Diagram (DFD).

PROPOSED OPERATIVE MODEL

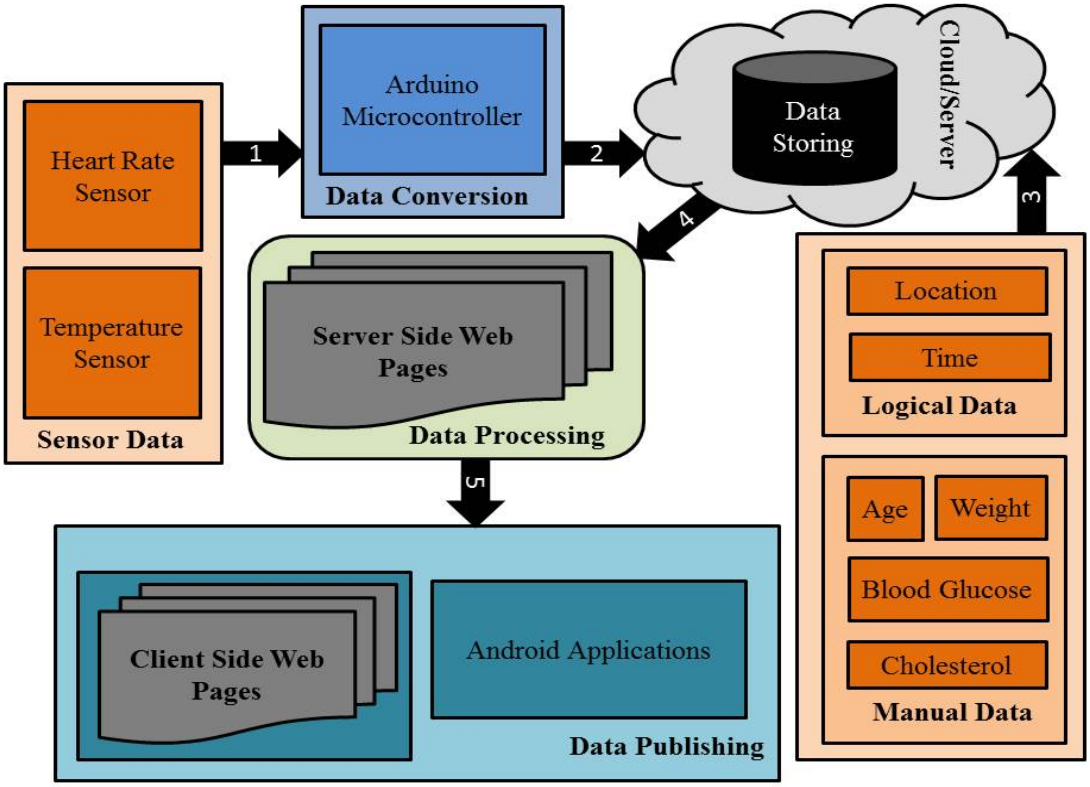


Figure 2: Operative Model of Heart Diseases Monitoring System (HDMS)

1. Data Sensor -Varioushealthcaresensors are available in the market to monitor related parameters such as forpulseheartbeat,bodytemperatureetc. Theproposed system relies on *Fingertip Measuring Heart Rate Sensor* (Figure 3) to determinetheheartbeat and *Thermistor Temperature Sensor*(Figure 3) for sensing body temperature [7].

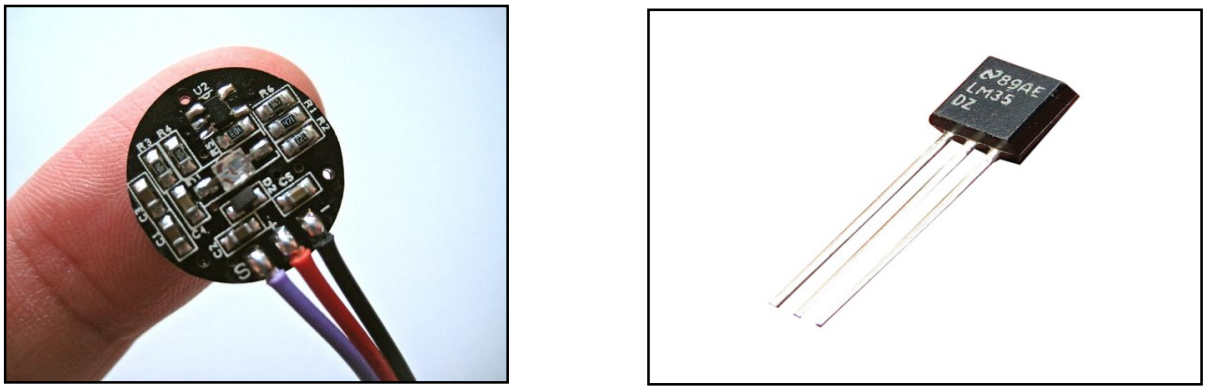


Figure 3:Fingertip Measuring Heart Rate Sensor (SRC: pulsesensor.com), Thermistor Temperature Sensor (SRC: makerlab-electronics.com) (L to R)

2. Data Acquisition- The Arduino microcontroller (Arduino ATMEGA 2560) (Figure 3) helpsinconvertingthe raw data such as Fingertip Measuring Heart rate sensor and Thermistor Temperature Sensor[78] and also attached to the PatientID(P_ID)to monitor current location, date and

time, etc.. The retrieved data is further forwarded to cloud viaArduinomicrocontroller (named ESP8266).

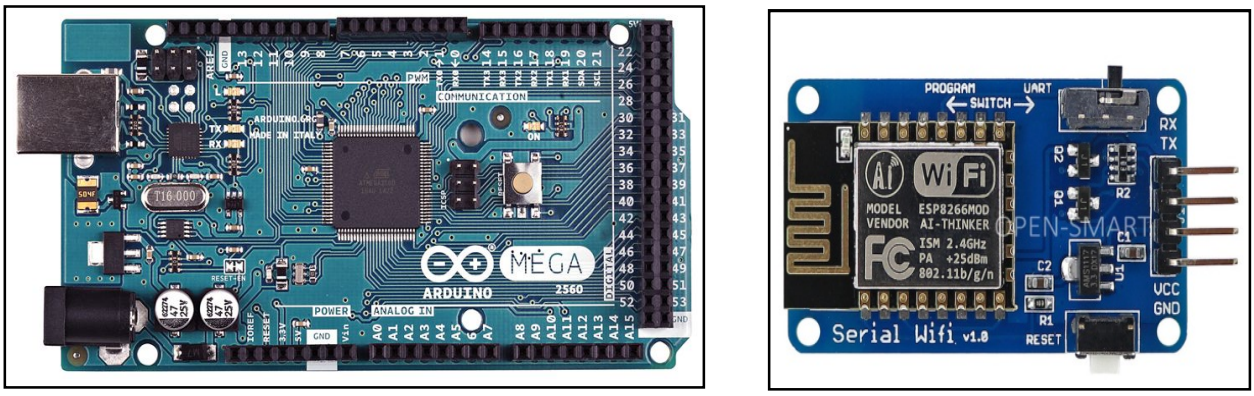


Figure 4Arduino ATMEGA 2560 (SRC: https://www.physical-computing.jp/product/463), ESP8266 (SRC: http://www.rcbasseterre.fr/carte-arduino-wifi/) (L to R)

3. Data Storing- ESP8266 (Figure 4) offers a self-standing Wi-Fi networking with TCP/IP protocol stack which provides a Wi-Ficonnection to any microcontroller. ESP8266, when connected on board, has provision for storage and processing of related data and can be easily connected to a specific sense device aswell. The ESP8266as the wireless module has a compact size and high performance[8].

External Data like weight, location, age, and time that do not need specific sensing devices, however, can still be combined with patient sensors data and insertedsubsequently on the cloud. Weight and Age can be fed at the time of registration. Location of the patient can be tracked by Global Positioning System (GPS). The parameters like Blood Glucose and Cholesterol cannot be sensed without a drop of blood. But these are necessary data for prediction. So the proposed system has a solution for this problem. Nowadays, many Home Kits are available to measure these two parameters. So, patient or any caretaker of the patient can easily measure and using Attendant Login can update on the cloud.

4. Data Processing- The huge data stored in the cloud will generate raw big data. Using specific mining techniques, we can predict other related information. Nevertheless, the main aim of the proposed system is to process individual patient data.Relying on theprimary key and the foreign key concept of Database Management System (DBMS) we may retrieve detailsof various parameters using date and time column value. Therequired value system can be processed on the basis of pre-defined logic and programs that can be forwarded to any android app or web pages for publication.

5. Data Publication- The processed data system acquired using the android app or web pagescan be publishedusingtheprocessed data system. Hypertext Markup Language is the standard markup for making website pages and web applications. With Cascading Style Sheets (CSS) and JavaScript, one can frame a group of three of foundation advancements for the World Wide Web programs get

HTML records from a web server or nearby capacity and forward those to media site pages. HTML depicts the structure of a site page semantically (As shown in Figure 5).

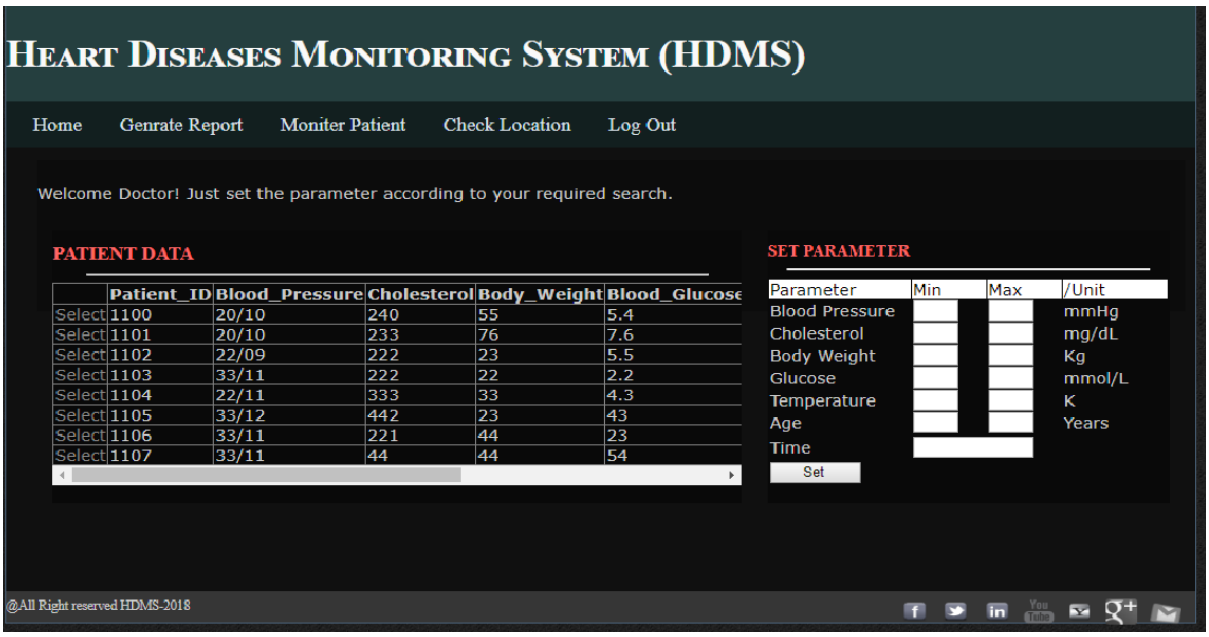


Figure 5: Doctor Panel after login

Software description of the proposed operative model

This represents the detailed software description of the prototype system using different models for representing interaction among entities, the schema description, the control and workflow of the involved factors, etc.

1- Data Flow Diagram- Data Flow Diagram (DFD) is a pictorial representation of data flow in any information system[15]. In (Figure 6), there is DFD of HDMS which shows the flow of patient data which is the most important entity of the proposed system.

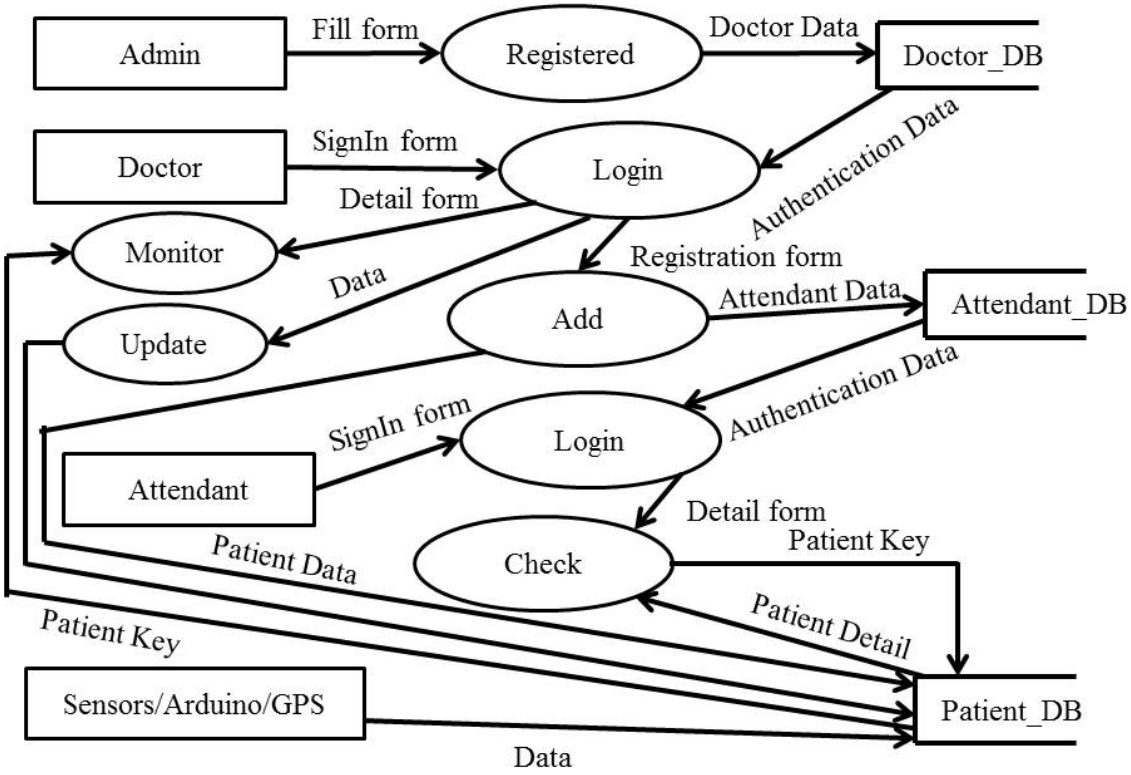


Figure 6: DFD of HDMS

2- Use Case Diagram (UCD) -It represents the functionality(s) of theentities in the system involved for. In the UCD of the proposed system (Figure 7), there are mainly three factors/entities involved- Doctor and Attendant.

In the beginning,the unique ID of the patient and his attendant can be generated to login the system. The tasks can be performed by a doctorusing steps as follows-

- The doctor can add and remove patients ID and their relative,
- He can search and monitor patients by ID, location, situation, health attributes, etc.
- Change own detail which is updatable,
- View and manage relative's database.

The attendant is the second main important person in the system that can monitordetails of the patient health continuously. The tasks can be performed by a relative are following-

- The attendant can view particular patient detail,
- He can view the doctor profile.
- Change own and patient associated editable details.

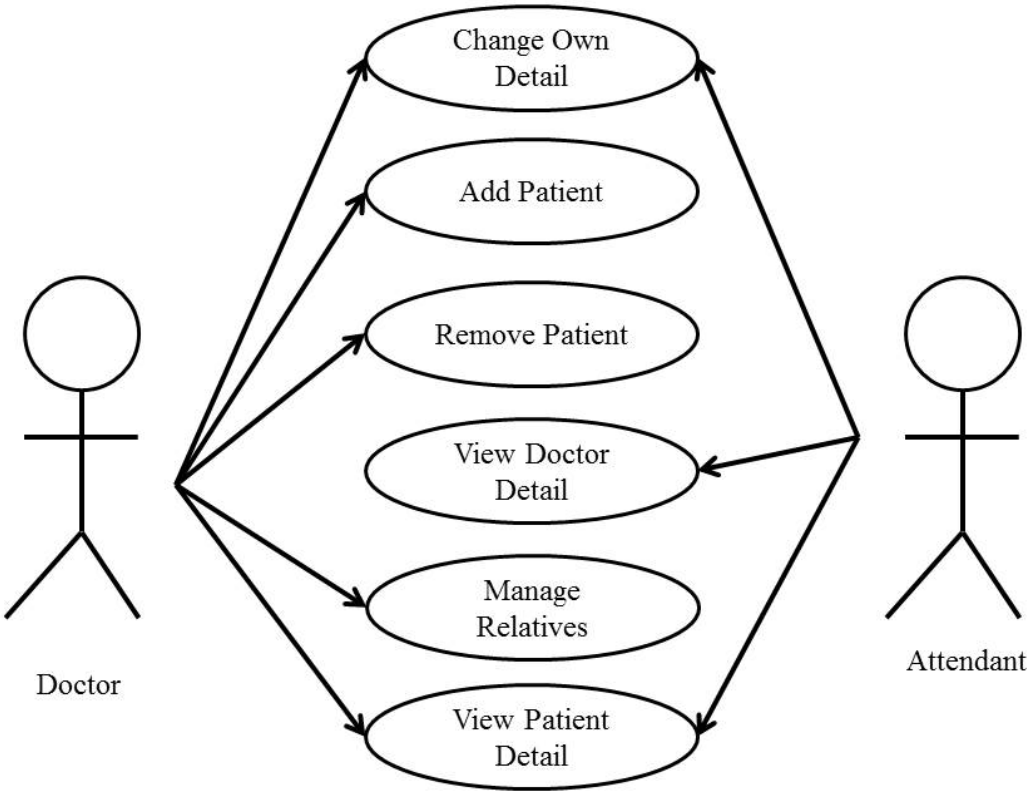


Figure 6: Use-Case Diagram of HDMS

3. ER-Diagram- An entity relationship diagram signify the relationships among entity sets stored in agiven database[16]. An entity basically considered asacomponent of data. In another word, entity relationship diagrams illustrate the logical configuration of databases (Figure 8). The following three main entities are involved in the model:-

A. Admin: The admin looks after patient care of a given hospital. It remains the main figure of the involved system Doctors of the hospital forward all the necessary information along with documents to the admin whocan verify and upload the related meaningful information in a manneron the cloud. The Admin entity has two major features “Admin ID” and “Password” to login in cloud data system and performs all another related task (i.e. figure 8).

B. Doctor: The Doctor registered by admin with a unique D_ID and a self-assigned password which can later be changed by Doctor. Further attributes on the part of Doctorinclude name, specialization, contact details (address, email, phone no.) and other related information (timing and schedule, etc.).

C. Attendant: The Attendant assigned by Doctor to a particular patient assumes a unique A_ID and a self-assigned password which can later be changed.It also includesfeatures like contact detail and associated patient IDetc..

D. Patient: Patients specific database can be generated bythe Doctor but the modification the generated the databasecan be automated employs Arduino. The database involves attributes like temperature, heartbeat, etc. which can be associated with a particular location, date and time of the specific patient.

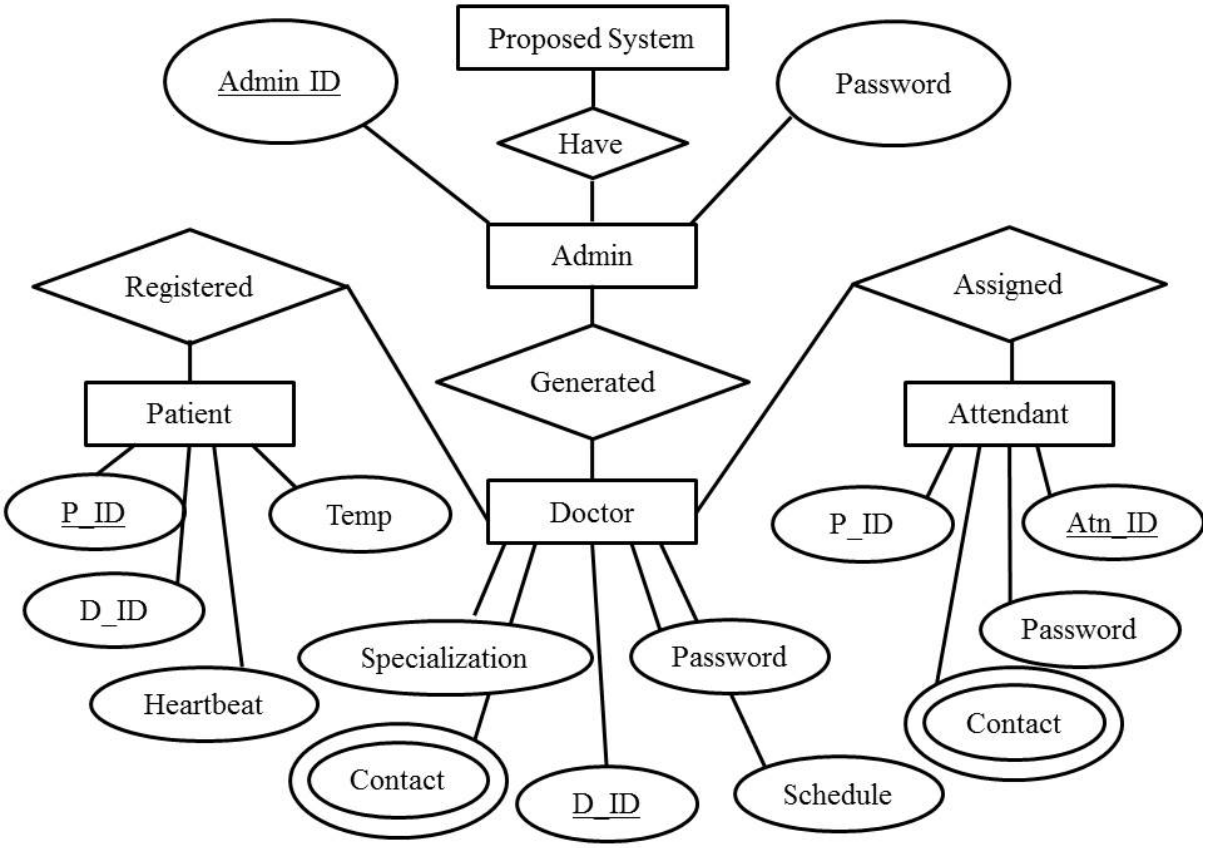


Figure 8: ER-Diagram of HDMS

4- Proposed System Prototype- The application can be deployed in various operating environments that involve smartphones, monitoring desktops of hospitals, etc. Based on the need of the execution platform or operating system the application can be augmented with compatible updates or programming reorganization. However, the software will act as a standardto open doorway to software developers to program applications dedicated to medical utilities and services. Figure8shows a snapshot of the pilot applicationwhile running at the doctor's system.

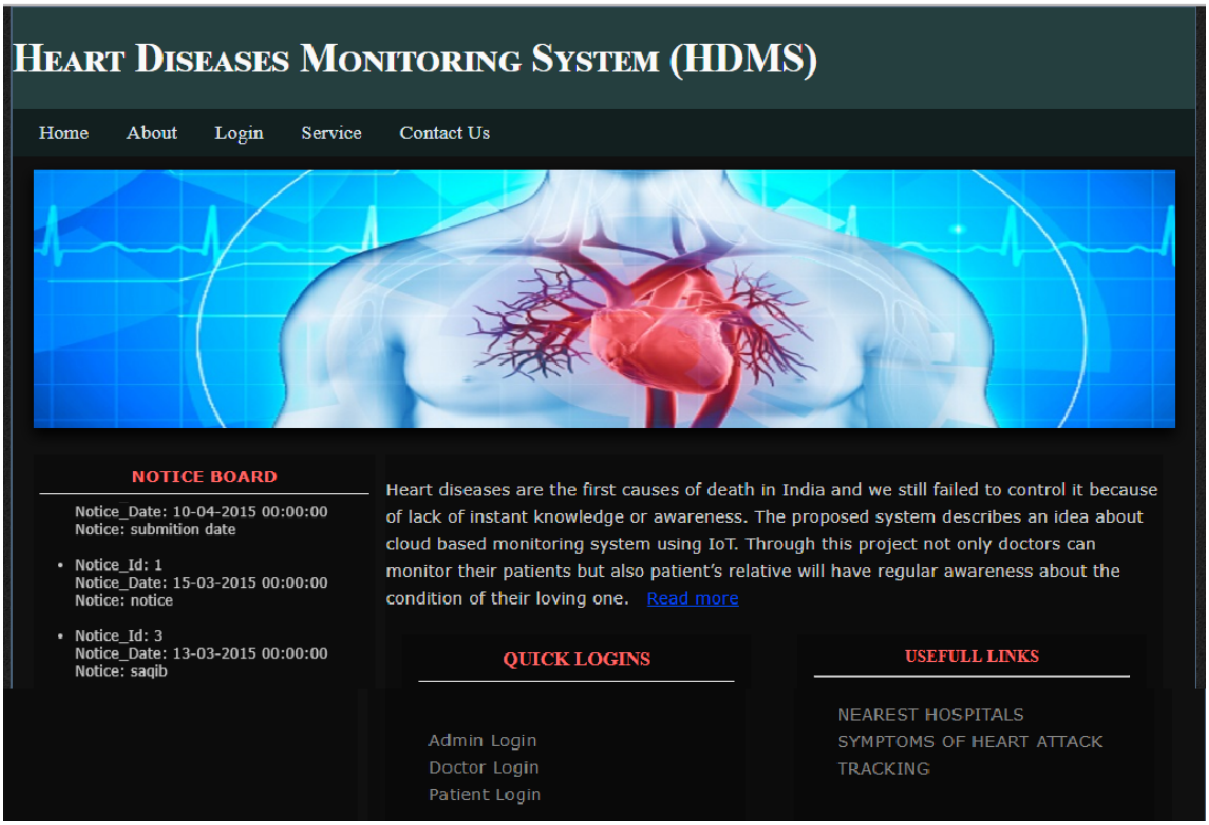


Figure 7: Homepage Snapshot of HDMS

FUTURE SCOPE ANDISSUES

The proposed system focuses on information system which can be exploited in retrieving various data sets cloud base sensing device. The handling of the huge dataset from several patients in a short time span remains a daunting task. The developed system may acquire huge data which can be used subsequent to analyzevarious parameters[17,18]. Using a specific algorithm of machine learning such as clustering, linear regression, K^{th} Means, etc., we can predict information pertaining age, weight and heart diseases Parameter relation of a particular patient. That is why it also opens the door for the researcher to do work in the collaboration of heart diseases and Artificial Intelligence (AI).

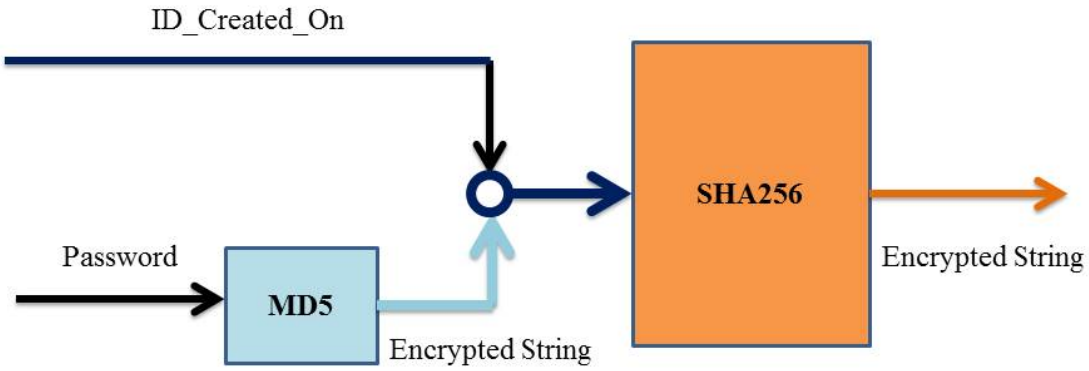
The security of web-based information system still considerstobe an issue in the modern era of Ransomware, CryproJacking, web scraping, and several latest hacking and data-stealing tools[19], the proposed system is also equally vulnerable to such malware. A patient can be a business tycoon, any political icon or celebrity who has huge fan and well-wishers but the enemy as well. Data received by a doctor can be easily interrupted or changed. However, using a secured algorithm and a goodprogramming approach, we can overcome such issues. For example, Encryption[20] is a very good technique to secure the data. In the proposed system "Password" field is sensitive data because

knowing anybody can get whole information about the patient. Encryption proposed system can prevent hacker in the following manner.

```php
<?php
    $id_created_on_date='2015-07-05 00:00:00';
    $myPassword='Saq@12349876';

    $myPassword2=md5($myPassword);
    $combo=$myPassword2.$id_created_on_date;
    $new_encrypted_password=hash('sha256',$combo);
    echo "Doctor's Password=".$myPassword;
    echo "<br>";
    echo "Encrypted Password=".$new_encrypted_password;

    ?>
```



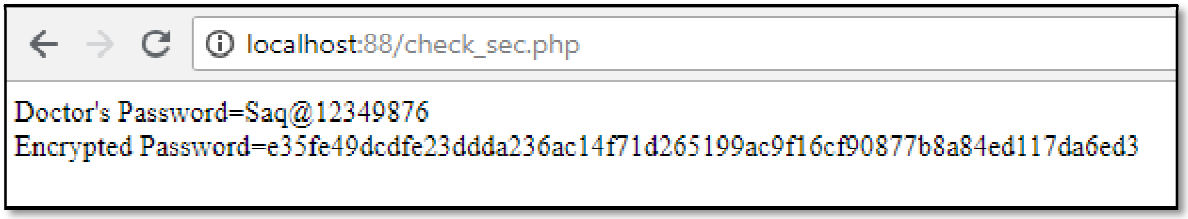


Figure 8: Doctor's Password Encryption Example

In (Figure: 9), two times encryption take place, once when password encrypted by MD5-Encryption and after combining with ID creation date it used SHA256 to encrypt. In this way, a hacker can never get plain text password via digest string. And this string also a combination of created date so hacker needs to know creation date and time to crack the password.

Second, as already mentioned in operative model description HDMS using several clients and server-side script using JavaScript and other languages to refresh and reload the data frequently, so the proposed system needs good and stable net connectivity.

CONCLUSION

The present study involves designing and implementation of a cloud-based smart heart disease management framework for intelligently monitoring the patient's health conditions system bythedisplayof the real-time information about patient remotely using GPS Location.It will also regulate high priced equipment thus making monitoring patient health parameter were efficient.The sensing data will be continuously collected in a database and subsequently to update thepatient to any unseen problemand possible diagnosis. The two modules employed in the proposed system works differently. The doctor can manage the all patient data on one hand while attendant-module can view data of concerned patient after processing. Moreover, the information system is an excellent choice for doctors and patients especially that with cardiac ailments as it is very user-friendly, cost-effective and trustworthy.

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