Design of Internet of Things (IoT) based Architectural Framework for Hospital Management and Information System (HMIS)

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Abstract: Hospitals are the indispensable part of every mankind’s lives, which provides inimitable medical facilities to people suffering from numerous syndromes. It is a big deal for the hospitals to monitor and maintain the daily activities & records of its patients, doctors, nurses, ward people and other staff personals to make the hospital run smoothly & successfully. Health care is a paramount thoughtful concern the all-time mankind. The consumerization of the health care industry is developing with such rapidity that the entire market is being renovated. Internet of Things (IoT) is one such emerging technology right now, which has the potential to change the way health care is delivered. It aims at providing low-cost reliable automation of the system. The system also provides excellent security of data at every level of user-system interaction and also provides potent & decisive storage and backup facilities. A Hospital Management and Information System (HMIS) is a system or process that provides the information necessary to manage a hospital effectively. A HMIS should be able to influence decision making. A records management system while incorporating aspects of a HMIS should be able to influence decision making in a hospital.

Keyword: Cloud Application; HMIS; HTTP Protocol; Internet of things (IoT); PIC Microcontroller;

1. INTRODUCTION

Internet has emerged into a fundamental sector of our daily life. It has interchanged the living, working, playing and learning styles of people today. Anticipating a world where many objects are used for the purpose of sensing, communicating and sharing information using internet protocol. This is the actual IoT world. Now-a-days for accuracy and ease of use we use automation everywhere. In this paper the automation has been made in the organization named Kovai Medical Centre and Hospital (KMCH) located in Coimbatore, Tamil Nadu to make it a smart hospital using IoT. The main goal of the paper is to frame architecture for HMIS and to develop the system into a robust and stable one. The main objectives of this paper are,

- To reduce Power, Energy and Memory consumption in the web applications.
- To make hospital automated and intelligent and provide comfort to every user.
- To improve primary health needs of the developing nations through Hospital Management and Information System (HMIS).
- To analyse health influencing factors both internal and external to the human body based on the HMIS Model.
- To make the application real time the user can monitor real time data and takes a particular action.

IoT is creating a brilliant, invisible network which is used for sensing, controlling and programming. The products developed based on IoT include embedded technology for exchanging information, with the Internet and it is assessed that about 8 to 50 billion devices are possible to get connected by the year
2020. IoT devices provide better life style, create safer and more matched societies and remodelled health protection. The entire concept of IoT stands on communicating and accessing the information via sensors, gateway and wireless network. Consequently it is bilged to add to an IoT framework that gives riskless health awareness checking.

2. LITERATURE SURVEY

Hospitals are regarded as organizations based on steep technology and information demanding processes. According to Lawrence and Dyer (1982), those organizations are often based on autonomous control mechanisms. A survey under 2752 European hospital managers says that technology has the potential to substantially influence the hospital activities and its services (Anderson, 1993). Healthcare budgets and funding are expected to depend importantly on tacted patient and analysis classifications. The use of IT in analysis and treatment steps will add to the development of clinical, hospital and health care networks [9] [10].

Healthcare management is an emerging technology with raising opportunities in both Direct Care Setting (DCS) and Non-Direct Care Setting (NDCS). As stated by Buchbinder and Thompson, DCS provide direct care to a patient, resident or client who deserves services from the respective organization. NDCS does not provide direct care to persons in need of health services, but instead provides support for individuals through products and services by making them available to DCS [1] [2].

The management of medical information is very essential to develop medical care capability of the hospital, health decision-making level of the management and the operational efficiency of the hospital. Implementation and usage of this information system plays an essential role in developing the degree of patient satisfaction, boosting the efficiency of hospital and quality of healthcare, healthcare protection, and reducing the rate of healthcare [4].

Hospital Management and Information System (HMIS) is increasingly becoming a developing tool in health care arena to enable efficient delivery of high quality health services. These systems contain huge computerized data bases for communication and health and administrative information storage [5] [8]. HMIS has several components and includes broad scope knowledge based systems which provide diagnostic support and intervention for patient care activities. It is believed that the implementation of HMIS is an efficient process conducted towards the IT community. User community in health care arena contains several different user groups (physicians, nurses, administrators, managers, researchers, etc.). Expectations and requirements blooms from what users see and what users hear about the system and interpret the ways in which the system will work for them. Studies states that satisfying user expectation is a unique element to promise the successful HMIS adoption [3] [8].

In health care organizations, there exists of many different user groups such as physicians, nurses, administrators, managers, radiologists, pharmacists, etc., with a variety of backgrounds and conflicting interest. Implementation of a HMIS will happen with an analysis of the feelings and perceptions of individuals who make use of it [6] [7].

3. WORKING METHODOLOGY

Heart of the project is microcontroller which is controlling the entire device. It contains a server which is having a web application working as a cloud application where we can monitor and control the devices connected to it. The sensor will acquire the data from surrounding that is the different types of sensors used in the module will sense and gather the data with current status from the respective module. Data is sent to the controller. Controller sends the data towards web server using HTTP protocol. Data is then stored into Cloud database. Data is displayed on the web page with current status of devices. Updating of the status makes the updated value to be sent to the database and the database gets updated. Updated values are then sent to the controller to control using HTTP protocol. Controller receives commands and performs the action of controlling devices.

![Figure 2 Block Diagram of HMIS](image)

3.1 Patient administration

Patient Administration System (PAS) records the
patient demographics such as Name, Residential Address, Date Of Birth (DOB), Mobile no., Mail Id, Blood group, Marital status, Husband/Father's Name, Occupation and Mediclaim if any and details all patient contact with the hospital, both outpatient and inpatient.

3.2 Doctor's Details and Information
The module comprises of details of every doctor working in the respective organization such as Name, Residential Address, Date Of Birth (DOB), Mobile no., Mail Id, Blood group, Marital status, Designation, working experience, Department, salary details.

3.3 Nursing Management
The module comprises of details of every nurse working in the respective organization such as Name, Residential Address, Date Of Birth (DOB), Mobile no., Mail Id, Blood group, Marital status, Designation, working experience, Department, salary details.

3.4 Ward Administration
The module lists the database of the Paediatrics, Maternity, Geriatrics and Psychiatric wards.

3.5 Laboratory Management
The module lists the details of Specimen Collection, Specimen Acceptance, Specimen Centrifuge, Specimen Transfer, Section Acceptance, Machine Loading, Specimen Cold Storage, Issue Entry, Outcome, Verification, Skip mechanism, Cold Storage Process, Track Sample, View Reports, and Batch Printing.

3.6 Department's Details and Information
The module layouts the details of Cancer centre, critical care medicine, fertility and reproductive medicine, health check program, Internal medicine, radiology and Imaging sciences, heart institute, liver institute, Nephrology/Urology, Neurosciences, Nuclear medicine & PET CT, obstetrics and Gynaecology, orthopaedics and joint replacement, paediatrics and speciality departments.

3.7 Blood bank Management
The module lists the features of Donor Registration, Blood Login, Blood Donor, Medical Equipments, Blood Recipient, Blood assemblage, Stock details, Blood issued.
3.8 Housekeeping Management
The module comprises of details of every housekeeping men & women working in the respective organization such as Name, Residential Address, Mobile no., Blood group, Marital status, working experience, Department, salary details.

3.9 Pharmacy Management
The module lists the database of Drug definition based on Generic name, Brand name, form Name and Drug strength, Multi Units of Measurement and multiple currency, Control of stock, Dosage calculation, Contra indications, Enquiry generation, Purchase plan generation, Goods receipt (GRN) and Drug Expiry control.

3.10 Billing Details and Information
The module provides the database of OP Cash and credit billing, IP cash and credit Billing, Performance interpretation, Employee self-service, Employee scheduling, Analytics and informed decision making.

3.11 General stores Administration
The module gives the details of Stock management, Stock control and receipt of stocks, Quotations and Purchase Requisitions, Purchase order generation and processing, LPO, Purchase order, Goods Receipt Note and Expiry of Stock, verification of invoice and management, Supplier management and supplier payment bucket facility is available.

3.12 Human resource Management
The module lists the database of Managing payroll, Recruitment and on boarding, Keeping attendance records and tracking absenteeism, Performance interpretation, Employee self-service, Employee scheduling, Analytics and informed decision making.
TABLE 1 MODULE OF HMIS

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4. SYSTEM IMPLEMENTATION

The system is implemented using hardware components and software tools. Sensors are used to sense the physical quantities such as temperature, pressure, light, humidity and sound. Microcontroller is used to send the sensed values to the web server. The cloud application is used for data storage and updation and controlling of devices is done via the std protocol.

4.1 Hardware specification

The hardware components used in this paper are PIC18F46K22 Microcontroller, Pressure sensor, Temperature sensor, Pulse oximeter sensor, SPO2 sensor and ECG sensor.

4.1.1 Microcontroller

The PIC18F46K22 is a PIC microcontroller from the company of Microchip. It consists of 64Kbytes Flash memory and 1024 bytes EEPROM. It is a Low-control microcontroller because of competent XLP contraptions joined and provide high performance so it is the best suited one for embedded applications. It is a 40pin plastic DIL package. The significance of this microcontroller is high performance RISC CPU, Compliant oscillator structure, and intense low power management with XLP.

4.1.2 Pressure sensor

LPS25H is the ultra compact pressure sensor used in the project. It is used to measure the external pressure of the patient, operating over a temperature of -30 to +105 degree Celsius. The main features of this sensor are high resolution, low power consumption, high overpressure capability, high shock survivability and small and thin package. It has a supply voltage of 1.7 to 3.6 V.

4.1.3 Temperature sensor

The ADT7320 is a high efficiency digital temperature sensor used to measure and control the temperature of the medical equipment. It operates at a supply voltage and supply current of 2.7 to 5.5 V and 210µA respectively. It is a 16 lead RoHS package. The key features of this sensor are ease of use, no calibration or correction is required by the user.

4.1.4 Pulse oximeter sensor

Pulse oximetry is a simple technique to monitor the amount of haemoglobin that is oxygen saturated. Oximeter is used to measure the total number of hearts beat per unit time which is usually conveyed in bits per minute (bpm). Using TCRT1000 reflective IR
optical sensor is used to streamline the method since both emitter and detector are arranged side by side. This technique is used to measure the heart rate and changes in blood volume that is synchronous to heart beat.

4.1.5 SPO2 Sensor

To monitor the Heart Rate Meter, we use Nellcor Oximax SPO2 sensor are used. The Heart Beat signal is obtained by LED (Light Emitting Diode) and LDR (Light Dependant Resistor) combination. Blood flow though hands invade the light that is reaching the LDR and this signal is converted into digital signal by Analog to digital Converter (ADC) which is then read by the microcontroller.

4.1.6 ECG Sensor

To monitor appearance, duration, segments, intervals and amplitude of waves, heart cycles rhythm and plot of ECG signals, ADS1292R ECG sensor is used. Two thumbs hold on the board and you start getting output in analog form as well as pulse output form. ECG signal is isolated from the sensor to get pure ECG signal by using optocoupler.

Figure 18 SPO2 Sensor

4.2 Software Specification

The software tools used in this paper are Cloud application, HTTP protocol and LAMP (Linux Operating System + Apache HTTP Server + MySQL Relational Database Management System [RDBMS] + PHP language).

4.2.1 PHP Programming

The Programming language used in this project is PHP. It is the most widely used programming language in multi-tasking embedded applications because of its high timing accuracy and code size accuracy.

4.2.2 Cloud storage

Cloud application is an application program that normally functions in the cloud. The cloud storage is useful for the user to monitor and manage devices and access data via Internet from far distance through a web browser. The admin and the trusted users have a login id and password to update the current data.

4.2.3 HTTP Protocol

The protocol used to exchange and transfer sensed data is called the Hyper Text Transfer Protocol (HTTP). The groundwork of communicating data for the World Wide Web (WWW) is through HTTP. A methodized and analytical text using logical links in between the text nodes is called as Hypertext.

5. CONCLUSION

The paper on Hospital Management and Information System (HMIS) is for computerizing the working in KMCH hospital. The software takes care of all the requirements of this multi-speciality hospital and is capable to provide easy and effective storage of information related to all the departments and modules of the hospital. All the physical objects will work seamlessly with machine-to machine and human-to-machine interfaces. It is evident that IoT will facilitate new business models and new healthcare delivery models in the future for both developing and developed nations, irrespective of the challenges faced at the current time.
REFERENCES


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