International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
(Volume 31, Issue: Special), June 2019
An Indexed and Referred Journal with Impact Factor: 2.75
ISSN (Online): 2347-601X
www.ijemhs.com

IoT Driven Smart Storage Solutions for Managing Volatile Resources in Hospitals

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***Abstract*— Monitoring of volatile compounds such as drugs and medicines is crucial in the medical field. The wastage or theft of these volatile drugs and medicines make up a majority of the expenses for hospitals. Thus, careful monitoring of these resources is the top priority for hospitals. The ultimate objective of this paper is to propose a viable solution for monitoring and tracking the use of resources. Our approach guarantees a simple yet efficient and secure way to track the resources.**

Keywords— Inventory Management, Internet of Things (IoT), Cloud Service, Multiplexer

I. INTRODUCTION

Some drugs and medicines are volatile and thus they should be stored in a well-protected environment with utmost care. "IoT driven Smart Storage Solutions for Managing Volatile Resources in Hospitals" is a system that validates the staff member that is making the request. It also takes input from the sensors and then transfers it over the internet for storage and visualization. With the information collected from sensors, consumption of the resources by each user can be tracked and a record can be maintained. This ensures that theft is prevented and the resources are not wasted. The microcontroller of choice is the ESP-32 or its variants as per requirements.

Each medical professional and staff member will be assigned a unique ID which they will use to request the drugs and medicines that they require. The "IoT driven Smart Storage Solutions for Managing Volatile Resources in Hospitals"system will validate the request and then log this event on the online data storage system. After the required quantity of drugs is extracted from the container the consequent data will also be uploaded to the online storage system. The remaining quantity of drugs in each container can be visualized on the internet. If the quantity of a certain drug falls below the permissible threshold value, a warning can be flashed and a request is made for the procurement of that particular drug.

Developing a system managing these complex and volatile medical resources could solve many issues in hospital management. The appropriate technology has to be selected for the proper adoption of such systems in the hospital. The paper gives an approach to managing such volatile hospital resources.

II. LITERATURE REVIEW

The solution for the proper management of medicines at the hospital is provided in [1], where the system can be used for tracking both regular and emergency medicines. The solution is achieved by using various technologies such as RFID, MySQL, VB.net, and HTTP.

A model [2] is presented that provides a solution to the problem of theft in a pharmacy, through continuous monitoring is developed for achieving objectives of managing pharmacy resources. The technologies such as TCP, HTTP, RFID are used, all of which are monitored by Raspberry Pi. In addition to this, the model will be in accordance with the laws and regulations of the government.

In [3] it can be seen that automatic medicine dispensing machine takes input from various sensors such as pulse rate, temperature, humidity and analyze the values to estimate the medical condition of the patient without the administration of the doctor.

The design of medicine management and dispensing system and their issues are discussed by [4] and different insights about the hardware of the control system and its analysis are provided which will be useful for developing systems for such medicine management areas.

The solution for distributing medicines by using Intelligent Auto guided vehicles and robot dispensing mechanisms is proposed for better management of the medicine inventory management purposes which shows another good approach to managing medicine resources [5].

Problem Statement and Motivation: To counter a rising expense for the hospitals due to the wastage or theft of volatile drugs and medicines. Often it is observed that the staff members don't follow proper procedures for the utilization of medical resources which leads to wastage. It is also observed that the staff members occasionally steal resources and sell them in contraband markets. Thus, monitoring of those resources becomes a priority for hospitals.

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III. METHODOLOGY

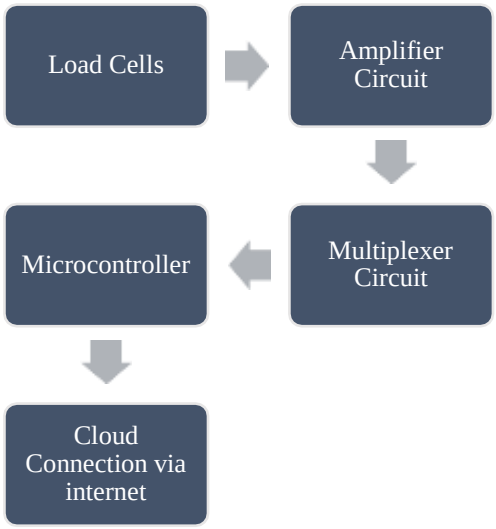

Figure 1: Figure explaining methodology

As observed in Figure 1, initially the weight of volatile resources is measured using load cell. Load cell converts force into an electrical signal that is amplified by the amplifier circuitry. Load cells are perfect for the measurement of volatile substances in containers, but any other mechanical actuator can be used in place of load cells depending upon the application requirements.

Load cells produce minute variations in signals which may not be distinguished by the microcontroller. The amplifier increases the strength of input provided by a load cell. Amplifiers are then connected to a multiplexer, which receives multiple input signals and can forward the desired signal to the output.

The output of the multiplexer is fed to the microcontroller. This output is then recorded into the online database using a cloud connection. Thus, by analyzing the recorded data, the consumption of resources can be tracked. Then the further process is accomplished by the elements in IoT architecture.

The IoT architecture is a basic functional block that is responsible for connecting the microcontroller to the internet and transferring data to the online database system. Depending upon the cloud service or cloud platform used additional elements such as PHP scripts and SQL queries may be required.

Through this system, a leak can also be detected as the online storage system will show the current quantity and the previous record of quantities in each container.

IV. IOT ARCHITECTURE

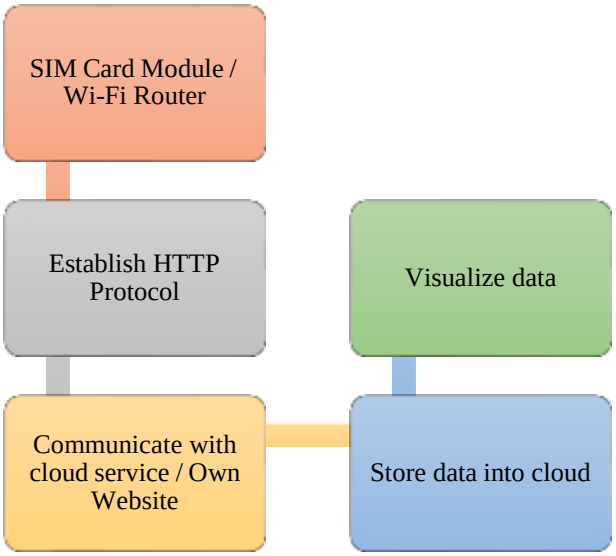

Figure 2: Figure explaining IoT Architecture

The entire setup requires an internet connection to operate, this can be accomplished by using a SIM card module or by using Wi-Fi.

The HTTP protocol is preferred in the transmission of data over the network for storage and monitoring purposes. The HTTP protocol is used if a custom website is developed. MQTT protocol is used by pre-built cloud services like AWS Cloud.

In the case of developing a custom website, seen in Figure 2, various other elements such as PHP script, SQL database need to be set up. A custom website may include charges for domain name and hosting.

In the case of a pre-existing cloud platform, such as AWS, Arduino Cloud, Things-Speak, etc. no additional PHP scripting and Database SQL queries are required as they are handled by the cloud in the backend. Users can be charged according to different plans of subscription.

When using pre-built network architecture, no additional setup is necessary. SQL database can be used to store the sensor data obtained from the microcontroller over the internet. The PHP script can be used to write the data from a microcontroller to the SQL Database and fetch data from the SQL Database and visualize it using charts and bar graphs on the constructed custom website.

V. VOLATILE RESOURCES

The following volatile resources are most commonly stored in hospitals. Being volatile substances, some substances pose a risk of fire, and so their proper management and monitoring are necessary. This responsibility lies with the staff members. The list of the volatile resources along with their usage is shared in the in table 1.

TABLE 1: LIST AND USAGE OF VOLATILE RESOURCES IN THE HOSPITALS

Volatile compounds	Uses
Chloroform, trichloromethane	Anesthetic
Diethyl ether (DME), Methyl Ether	Anesthetic
HFC134a	Refrigerant
Nitrous oxide	Analgesic
Tetrachloroethane	Cleaning solvent
Amyl nitrite	Cyanide antidote
Isopropyl nitrite	Poppers
Oxygen	ICU

VI. BENEFITS

- As most of the processing part is handled by our system, the human intervention required is minimum.
- Provides consistency and accountability with real-time tracking of drugs and other medical substances.
- The process of maintaining records is streamlined to achieve proper monitoring of medical resources.
- The probability of errors is minimal as the system is automated.

VII. CONCLUSION AND FUTURE SCOPE

Our approach of "IoT driven Smart Storage Solutions for Managing Volatile Resources in Hospitals" provides monitoring of volatile resources and maintains a record to ease the intricate task of monitoring in hospitals. The availability of this record will make it easier for hospitals to track resource consumption. Monitoring and controlling the inventory will be possible after implementing the designed framework.

Future work includes integrating blockchain technology to better track drug transactions made in the hospital and increases accountability can be made into this design. Easier report generation and replenishment mechanisms can be developed for further reduction improvement through automation and thus further reducing human intervention.

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