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A Review of Home Enviornment Monitoring System using IOT

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Abstract: *Today, as an ever-increasing number of families have working individuals, homes are in effect left unmonitored for a few hours every day. There is no arrangement for crisis cautions, robotization systems or observing offices for the home condition conditions. There is colossal potential for mechanical improvement toward this path particularly in view of the progression in the Internet of Things (IoT) [1]. It is conceivable to screen home condition conditions utilizing sensors to distinguish temperature, stickiness, light, stable and gas focuses noticeable all around. It is likewise conceivable to screen altered circumstances, for example, water tanks being full, dustbins being over-burden and fridges left open. The need of great importance is a coordinated answer for have the option to screen nature conditions from a solitary portable application [7]. Some level of mechanization to control the home condition conditions alongside warnings if there should be an occurrence of crisis circumstances, for example, gas spills additionally should be a piece of this single arrangement. This contextual investigation paper is taken to give a solitary coordinated answer for the previously mentioned issue of being not able to keep homes checked for a few hours in the day. The idea is tweaked to screen these conditions and advise the client on his versatile application remotely. Most condition factors can be checked by opening and invigorating the application. Crisis circumstances and altered cautions are scared to the client by sending pop-up messages to his cell phone with the end goal that he can be made mindful of any significant conditions right away. The sensor information is put away on the cloud with the end goal that it tends to be versatile and the information can later be utilized for diagnostic purposes also. The idea worked in this paper is a truly necessary arrangement in this day and age. At the point when most people are out of home during the day time, this arrangement can alarm them if there should be an occurrence of a gas release, over-burden water tanks and can likewise assist them with sparing force by remotely turning on and off the electrical gadget present at home. It is a coordinated and adaptable answer for provide food the fluctuating needs of clients. It helps for observing the whole house on the client's cell phone from any piece of the world.*

Keywords*: Integrated Development Environment, Internet of Things, Java Development Kit, Light Emitting Diode, Model View Controller, Platform as a Service.*

I. Introduction

With the advent of the Internet of Things, there is a rising trend to connect every device, we use in our lives and give us information at our fingertips. We are slowly becoming more aware of the resources available to us and how we can utilize them most efficiently. With the advancement in technology, it is possible to be in control of the environment around us. It is possible to monitor our surroundings to a high degree of accuracy. As more and more families have all-working members, homes are left empty for several hours in the day. It is important that people monitor their houses when they are away for ensuring maximum safety and being in control of the house. There are several aspects of the house that can be monitored, and with this work, the aim is to develop one product that can monitor several of these aspects. The products that exist currently are isolated systems like thermostats to monitor temperature, however the aim is to make a single product that can be used to measure and monitor lighting, humidity, temperature, air quality and sound. The product can also be customized for alerts about things such as the refrigerator being left open or the dustbin being full. The need is for people to be able to keep a complete track of the home environment through a single product that can display the required information on their personal mobile phones.

With the massive increase in the number of nuclear households in urban areas, men and women work for long hours and their homes remain unattended throughout the day. This work helps people to monitor their homes and be alerted in case of any emergency situations such as gas leaks and helps people take appropriate actions to rectify any problematic situation at home. It is also customized to automate electrical 3 devices such as remotely turning off lights to save power when the user is not at home from the user's mobile device. The solution also helps users to activate alerts for situations such as water tanks being full and dustbins being full. Overall this work has immense potential in the direction of home monitoring and automation which is highly required in today's developing world. The technology used is simple and reliable for monitoring home conditions. The importance of this work is evident by the fact that unmonitored homes for long times can lead to hazardous situations that need to be handled in time. This work is designed to ensure safety and optimization of resources being used at home.

II. Literature Survey

There are several products in the market that are available to monitor the home environment components individually. Some of these include EnviroAlert[4], Acurite Environment System[5] and Emerson Protected Home[6]. These systems are designed to monitor one or two home environment factors and provide the readings within the home environment. These systems are loosely integrated and are difficult to deploy with high operational costs and are usually very expensive. Individual monitoring systems are available for temperature monitoring, gas leakage and smoke detection. There are several small products available for these purposes. Air quality monitors with wireless sensors can be deployed in home environments or work environments to monitor the levels of dangerous gases in the environment. Temperature monitoring and light monitoring is used to monitor power consumption. Emergency situations can be alerted by using individual smoke alarms. All such systems are available in the market individually and are effective only when someone is present in the vicinity of the house to monitor the readings and alerts.

Although individual systems are available for monitoring home conditions from within the house, there is a lack of an integrated system that provides all such facilities. Most of the available devices do not provide data remotely. The costs of the systems are high and the user must be present at home to manage the home environment as a whole. Analysing the existing systems, this work is developed to fulfil the requirements for a better, well integrated and remotely accessible system for home environment monitoring. It is designed keeping in mind that there is a need to monitor home environments in an integrated manner and from mobile devices.

Home environment monitoring is increasingly become an important demand as more and more people stay outdoors for long hours and their houses are empty with no one to look after them. These systems are also extremely important when it comes to analysing the consumption of energy in terms of lighting and power that is being consumed in the household. Another common concern is to check for any gas leakage or signs of fire in an empty house. Automated alerts for carrying out daily tasks is another requirement in today's fast paced lives. To deal with such problems, there are two several isolated devices which provide individual problem-based assistance but there is a lack of an integrated single market product which can be used as a multipurpose home environment monitoring system.

This case study work is chosen with the purpose to design an all-inclusive house monitoring system which can be used with ease by the customer. To make this possible, a number of technologies are used together for the system to work overall. As the IoT architecture consists of three parts – the device end, the server end and the client end, modern day technology will be used for all parts. At the device side, the main requirements are to use several sensors which are able to detect air quality, lighting, sound, temperature and humidity. Distance detecting sensors would be required to check if the refrigerator is shut or the dustbin nearly full. The Arduino Mega microcontroller will be used along with a Bluetooth module to handle the data acquired by the sensors and send appropriate information to the cloud [2][[3] . The server side would be deployed on a cloud platform such as Microsoft Azure that provides Platform as a Service (PaaS). A MySQL database will be hosted on the cloud to store data received from the microcontroller appropriately. The cloud services will be used to ensure scalability and efficient utilization of resources. At the client end, an Android based mobile application will be designed to display the statistics to the user as per his requirements. Changes in the home environment will be displayed as the user refreshes his application and the user can set the application according to his needs. All the data acquired at the device side and processed at the server can easily be viewed by the customer using the mobile application. Any alerts will be sent as notifications to the user.

III. Home Environment Monitoring System

The home environment monitoring system is based on the IoT architecture, which has three major components: the device side, the server side and the client side. The integration of the three components creates the entire end-to-end system which will enable the user to monitor his house environment from his mobile device.

The design methodology used for the development of the system is an incremental model.

The work components will be developed individually and later integrated to create one work.

The deliverables from this work can be incrementally released by including the addition of one or more sensors with each release. Different sensors are used to measure the different aspects of the home environment monitoring work and as and when newer technology leads to the creation of sensors for other different purposes, this system can be extended to include such sensors.

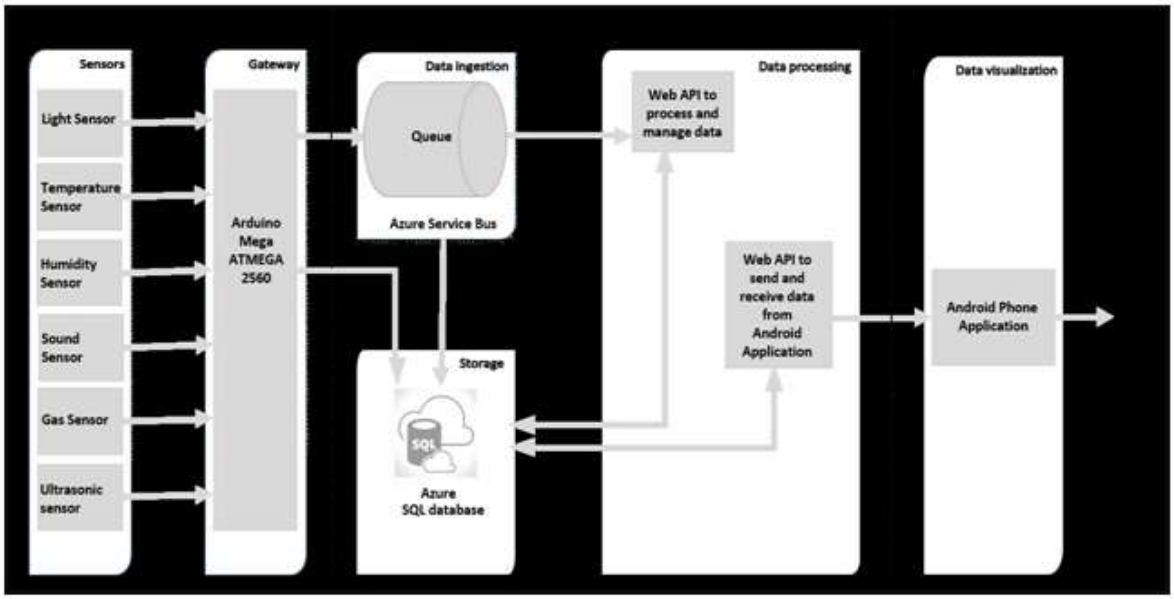

Figure 1 Architectural of Home Environment Monitoring System

As can be seen from the architectural design, the system is the integration of the physical model which includes the sensors and the microcontroller; the cloud platform which hosts the entire server side code and database work; and the user side which consists of the mobile application which acts as the interface for the user to interact with the product.

Device Side Design

The device side is designed in an incremental model. It consists of the Arduino Mega microcontroller and this is used to support the number of sensors that are to be used for the system. Each of the sensors will be connected to the microcontroller using a breadboard and also by connecting directly to the analog and digital pins on the Arduino board. At a production level, higher quality sensors with WiFi adaptability can be used to make the deployment of the work possible in a home environment. This is restricted at the system level due to cost constraints. Each deliverable of the work will have the set-up of a few sensors and the overall end product will have all the sensors including temperature, humidity, lighting, sound, ultra-sonic, IR and gas sensors. The readings received from the sensors will be sent in real-time to the cloud service using a Bluetooth module which will be integrated with the microcontroller.

Server Side Design

The server for this work will be hosted on the cloud using Microsoft Azure as the platform. Microsoft Azure is a new age cloud service very well known for providing Platform as a Service (PaaS). Hosting the backend on cloud ensures scalability and reliability and also opens up a lot of options for analytics of data in the future. The two main modules that will run on the server would be an Azure Service Bus Queue and a MySQL Database with Mobile Services. The Service Bus Queue will be responsible for handling and queueing the incoming data stream in a First in, First out (FIFO) manner. A web API written in C# using the MVC Framework will be used to receive the data from the Queue and store it in the database. The MySQL database with an entity-relationship model will be used to store the incoming data. It will be integrated with the Azure Mobile Services such that each time the user application is used or refreshed, the latest data entry into the database will be loaded on the application. The work will also trigger notifications on the user's mobile device each time an alert or warning needs to be sent using a Web API.

Client Side Design

The user end will be designed using Android Studio and the code will be written in Java. The layout will be designed using XML sheets. The outcome will be an Android application on a mobile device which connects to the cloud storage through a web API. The user interface of the application will be simple and will display all the required information for the user in a single page making it convenient for browsing data. All sensor information will be displayed to the user in a manner that can comprehend. Sensor values which are out of the normal range will be displayed in red to alert the user about the unusual situation. Emergency warnings and alerts will be sent to the user's mobile device using the Microsoft Azure push notification work for Android applications.

The development and the testing of each low level design along with the final integration, all the individual units will result in the creation of the entire end-to-end work which will be thoroughly tested using several test cases in which the sensors will be exposed to different environmental conditions and the resulting alerts and value updates would be visible on the mobile device. The overall product will be methodically developed, tested and modified to ensure precision and accuracy.

IV. Results And Discussion

The results of this system implementation can be divided in three parts. The first part includes the test results of each of the individual sensors. Each of the sensors connected to the Arduino are tested by placing them in varying conditions such as dark and bright environments, humid and dry conditions, varying temperatures and in air with high and low smoke concentrations. Each of the sensors produced appropriate results with the readings showing noticeable change each time the environment conditions were changed. The values are noted down and analysed to understand the ranges for each of the sensor values. The working circuit is shown in the figure below.

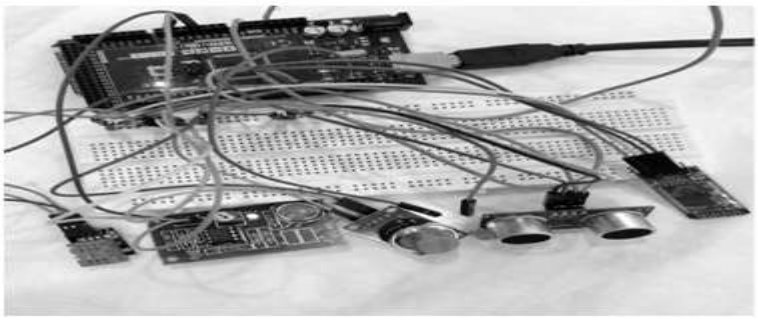

Figure 2 Circuit with all Sensors and Microcontroller 46

The data sent by the controller is received by the database hosted on the cloud and all the data are stored in a MySQL table. The server stores the sensor data and pushes notifications to the client side whenever the range of values falls in a category that needs to be alerted to the user. A screenshot of the database table is shown below.

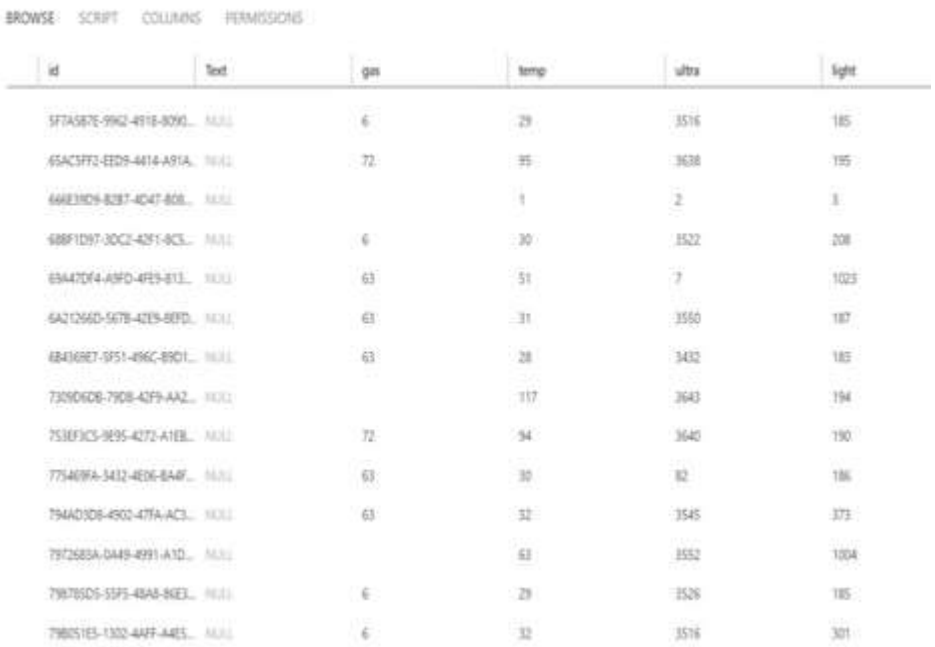

Figure 3 Microsoft Azure Database Table Screenshot

The Android mobile application provides a simple user interface to display the home conditions of the user at his fingertips. It also shows comments as text and the actual sensor values. The user receives push notifications in case of emergency situations such as gas leak and alerts the user when customized requirements are met such as water tank being full and refrigerator being left open. The Application also provides the option to control the home lighting by switching on and off the lights of the home from the mobile application. A screenshot of the mobile application can be seen in the following figure.

Figure 4 Client Side Android Application

The device side Arduino microcontroller is connected to the server side Microsoft Azure cloud MySQL database and data readings from the sensors is continuously stored in the database. Each time the Android application is opened on the mobile device, the latest value of temperature is retrieved from the database and displayed along with the comment about whether the temperature falls in the normal range or is too high or too low. The end-to-end system works starting from the device which consists of the sensors, microcontroller and the connection with the server. The server stores and processes the data received from the microcontroller and sends a push notification to the mobile device whenever the processed data indicates that a particular variable value is out of the normal range. In case the there is an emergency like a fire or a gas leak, the user will get a push notification on his mobile device from wherever he is available. Apart from receiving alerts, the user can choose to monitor all environment variables on his mobile device at any given time by opening the application. When the application is newly opened or refreshed, the latest values are 48 fetched from the MySQL database hosted on Azure cloud platform and made available to the user.

The successful completion of an end-to-end data transfer from the device side to the client application is an indicator that the entire work can be successfully developed and used as a home environment monitoring and alerting system. It is an integrated system which monitors multiple environment variables and makes the data available to the user on his mobile device remotely. The user can use this information to monitor his resource and power consumption and take corrective action to improve the efficiency of the same. He can also be alerted in case of emergency situations such as a fire or a gas leak.

From the results of the tests, it can be seen that the work is designed in a way to produce results in an effective and timely manner so that it can be viewed by the user on his mobile application at any time and from any location if he is connected to the internet. It is also clear that this work gives the user the option to activate alerts for several customized conditions. In case of such alerts and also in case of emergency situations, push notifications are sent to the user's mobile device. This system is a proof that an entire home monitoring integrated system can be developed to provide a complete picture of home conditions to users even when they are away from home at work or when they leave their house unattended for several days. Instead of the existing solutions that require individual solutions for each environment variable separately this solution is integrated and provides a single package with all the sensors and the microcontroller. The scalability and reliability of the data storage can be guaranteed by using a cloud hosted database which can later also be used to perform useless analytics on the data and make the user aware of useful patterns related to resource consumption. According to changing lifestyles, more sensors can be added to this system as per the needs of the users. This system provides a single, integrated, remotely accessible solution that can monitor the home environment of all its users.

V. Conclusion

It can be concluded from the successful implementation and testing of this case study work that a single integrated solution for home monitoring and alerts can be developed and deployed in homes for safety and awareness. It can be used to keep a check on home resource consumption and can be customized for automation. People can monitor several aspects of the home and opt for customized alerts based on their needs. They can keep track of the status of the electric devices at home and switch them on and off at their convenience after getting alerts from the application. This can be done by the users at a low cost as compared to buying individual devices for each environment variable. Some devices such as light bulbs can be turned on and off through the application itself, even when the user is not physically present at home. Apart from this, the user gets immediate notifications if his water tanks are full or refrigerator is left open for a long time. The user is immediately updated in case there is a gas leak or if the smoke levels in the air are higher than the normal expected limit. This product provides a complete integrated solution to monitor home environment conditions sitting far away from home. It is highly required in today's urban society in which all adult members of the house are usually away from home for several hours during the day and the home in left unattended for several hours. This system acts as the user's home safety check mechanism and provides the user with instant real-time updates each time he wishes to monitor his home conditions.

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