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Smart Community using IoT Systems

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Abstract

This study presents the design of smart community environment using a feasible IoT solution. The smart community environment can be split into two phases. The first phase would be monitoring and the next phase would be controlling. In the monitoring phase, the basic environmental parameters like ambience, carbon monoxide level, gas leak level and pressure level are measured and analyzed using NODEMCU8266-12E module. In the controlling phase, a small variety of home appliances are controlled with the help of relay module. To manage the flow of data in ease, XAMPP server is used to maintain the database of each and every sensor node values. The PHP My Admin tool is used here to customize the database structure and to keep track of sensor values. All the authorized users would be able to view the status of surroundings in a particular area. The controlling and monitoring can be operated using an Android App that connects to the XAMPP database. In this study, the controlling of home appliances is also done via speech recognition. Here, Ionic framework is used to develop mobile application software which is hybrid in nature.

Keywords: XAMPP Server, PHP My Admin, NODEMCU8266-12E, DBMS, Visual Studio code

1. Introduction

A precise growth achieved by cities is associated to their abilities to find the issues related to modern urbanization and respective social, economic and environmental issues in a holistic manner. In India, 32% of current population can be accommodated in the cities which in turn contribute 31.4% of Gross Domestic Product (GDP) according to census 2011[1-6]. Many innovated organizations adopt some guidelines and measures that help them to make data driven decisions, maintaining a consistent perception of neighborhood activities and stay

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associated with all of their internal elements. Impressive smart communities do so by applying a pivotal approach that links people with the information and technology to integrate the nature of life, innovation, and better choices. To get the most out of the technology endowment section, by manipulating a combination of Internet of Things (IoT) devices, comprehensive apps, and neighborhood retaliation to gain previously unimagined perceptions [7-9].

An optimized smart community aims to achieve six main goals: sustainability, safety, healthy living, prosperous living, and well-run infrastructure. .

Smart community is an urban region that is highly advanced with strong infrastructure and all possible technologies to ease day to day activities. A smart community should ideally offer seamless mobility, round the clock accessibility to all services, and easy analysis of environmental surroundings. Smart community refers to a precisely planned neighborhood that depends on IT as a facilitator to solve many of its dilemmas from the help of sensors to smart grids and data analytics that concede community framework and utilities to meet problems and civilian demands effortlessly and certainly. Internet of Things (IoT) is an emerging technology that is making the world much smarter. In IoT enabled smart community environment various things such as lighting, home appliances, computers, security camera etc.., all are connected to the internet and allowing user to monitor and control things regardless of time and location constraints. The proposed system presented in this study is used for monitoring and controlling smart community environment. Though this may sound futuristic, it is now likely to become a reality as the ‘smart community’ movement unfolds in India.

2. Literature Review

As per the survey there doesn’t exist that much systems that could do the monitoring and controlling in the smart community [10]. Since, IoT is an emerging technology in India, practically there are very less systems which is used for the user convenience. As India is adopting many smart cities and smart community research’s, this work could be one of the milestones for future works. Srinidhi in 2017 proposed a home automation and control based on IoT using Raspberry pi [11]. Since, Raspberry Pi module is costly, this is a disadvantage for this research. Syed in 2017 proposed a Raspberry Pi Based Home Automation Using Wi-Fi, IoT & Android for Live Monitoring [12]. Since, nothing can be done until the Raspberry Pi has updated itself, which takes at least two hours. Ravi Kishore Kodali in 2016 proposed a IoT based smart security and home automation systems using TI Wi-Fi CC3200 Launchpad [13]. Since, this system [14,15] is completely dependent on the user’s directions and the judging

capability of the situation whether it is the authorized user or an intruder, this makes this research very tough. Hence proposed to make smart community with high level of authentication.

3. System Configuration

A. Sensors and Devices

A sensor is a mechanism, module, or subsystem whose objective is to identify action or changes in its environment and dispatch the information to other electronics, intermittently. The list of used sensors and devices are listed in Table.1. DHT11 sensor is used to monitor and control temperature and humidity in the home automation systems and also it regulates climate conditions to ensure the comfort and safety of occupants in a room. Carbon monoxide detection systems are used to monitor air quality and prevent carbon monoxide poisoning in homes. LDR is used to control brightness based on ambient light levels, and security systems detect changes in light levels. BMP180 sensor helps to predict weather changes when combined with other sensors. MQ2 detects the presence of smoke and initiates fire safety measures in smoke detectors and fire alarm systems. It's an important part of building safety systems. In order to reduce electrical noise and maintain safety, optocoupler is used to isolate or interface between two separate electrical circuits. Especially 4 channel relay module utilized for remotely operate high-power electrical appliances, lights, and motors. Bulb Holder utilized in lighting fixtures to attach and retain light bulbs.

Table 1. Sensors and Devices

SENSORS	
Temperature & Humidity	DHT11
Carbon monoxide	MQ7
Light Intensity	LDR Module
Air Pressure	BMP180
Smoke	MQ2
DEVICES	
OptoCoupler 4Channel relay module	
Bulb Holder	

B. Hardware Components

The hardware components of the IoT system play a crucial role in collecting and transmitting data. One such component is the NODEMCU8266-12E, a popular IoT development board. This board integrates Wi-Fi connectivity, making it ideal for connecting sensors to the network. It also supports various programming languages, allowing for flexibility in development which is referred in Figure.1. In that all type of sensors and server with mobile app and web pages were interlinked with NODEMCU which commonly used for IOT applications.

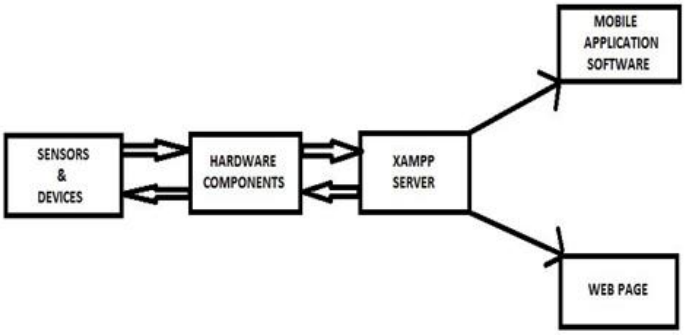

Figure 1. Block diagram of Hardware Parts

The term 'NODEMCU' indicates the firmware shown in Figure.2. The Lua language is been included in the firmware. The ESP8266 is a System on Chip (SoC) Wi-Fi integrated with a Tensilica Xtensa LX106 core, which is widely used in all kinds of IoT applications. This NodeMCU also supports MQTT (*Message Queuing Telemetry Transport)*. ESP8266 offers a complete and self-contained Wi-Fi networking solution

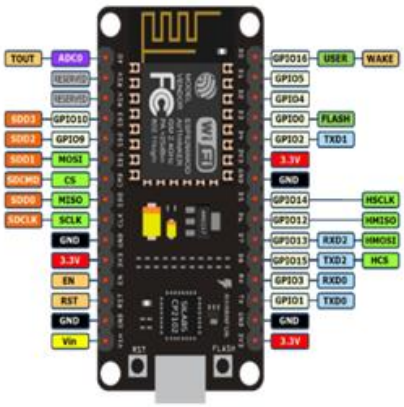

Figure 2. NodeMCU

It has an integrated Cache, which is used to increase the performance of the system. It also serves as a Wi-Fi network adapter. Any controller can be turned into a Wi-Fi adapter using

the connectivity features like SPI, I2C, and UART interface. The main aim of this NodeMCU is to reduce the power consumption with the help of many proprietary techniques. It has three types of power saving modes: sleep mode, active mode and deep sleep mode. In order to satisfy the power demand of mobile and wearable electronics, ESP8266 can be programmed to reduce the output power to fit various application profiles, by trading off range for power consumption.

C. XAMPP Server

XAMPP is a free of cost and open source cross-platform web server explication sheaf kit developed by Apache Friends which is shown in Figure.3. XAMPP symbolize for Cross-Platform (X), Apache (A), Maria DB (M), PHP (P) and Perl (P). This becomes extremely handy for the builders to devise a local web server for testing and implementation purposes. XAMPP is called as a cross platform software; this indicates that XAMPP is very well compatible.

Linux, Mac and Windows. It comes with the other supporting modules like phpMyAdmin, Wordpress etc.., the main motto of XAMPP designers is to allow the website designers to monitor and check the results without any access to the internet.

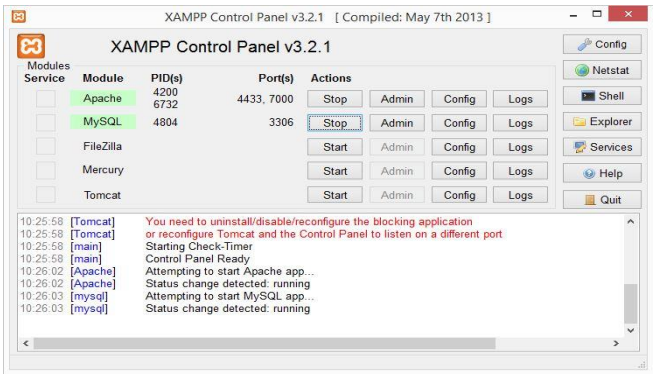

Figure 3. XAMPP Control Panel

Mobile application software is a kind of an application software which is designed to run on a mobile devices, androids, tablets or tablet computer etc.., Applications are generally small, individual units which is having a limited function. A more sophisticated approach has been developed to provide the consumer a better user experience. In this research an application which will be used to control the home appliances, to know the status of home appliances and monitor the environmental parameter is developed.

4. Operation of the Hardware and the Database

In this study, the complete flow of data starting from the hardware to the end user is implemented with the help of a XAMPP server. The sensor values are updated periodically for every six seconds to the database. Each and every sensor values are posted along with the current date and current time.

Here, phpMyAdmin tool is used to customise the database and also to formulate the structure of database. This is mainly used for web hosting applications. Some of its features are Data Base Management System (DBMS), Web Interface and cross platform supporting. To make sure the database columns are taking the correct values, here the Postman tool is used to cross check. The postman tool is used to send and receive a request, so as to make sure the data is flowing properly. Here, for the convenience the database is split into two tables. First table 'dash' contains temperature, humidity, air pressure and pollution level. Whereas, the second table 'dash2' contains light intensity and gas leak level.

5. Operation of Mobile Application Software

To build a hybrid mobile application using Ionic, several software's have to be installed. And They Are, Gitbash (Optional), Nodejs, Java Development Kit (Jdk), Visual Studio Code and Android Studio.

Git bash emulates the bash environment on Windows. It lets you use all git features in command line plus most of the standard UNIX commands. Node JS, or Node, is an open source and cross-platform runtime environment for executing JavaScript code outside of a browser. Quite often it is used in Node to build back-end services also called API‟s or Application Programming Interfaces. The Java Development Kit, commonly called as software development environment provides the developer environment for the Java application development. The Visual studio code, is the newest member of vs code family and brings with it a rich editing experience to developers on both Windows, Linux and OS X. now beyond the traditional editor feature set it also integrates capabilities like intelligence code navigation task automation. The Android Studio, is the Google‟s official IDE for Android development. In that a combined robust code editor with an entirely new system based in Gradle is built. The Android studio, is used to build android based mobile application for mobile devices. The Ionic framework, is used to build hybrid mobile apps in order to build the app in android OS Android studio is used. The Cordova, packs the Ionic application and converts it into native

application using Android studio for android OS based APK files to run that app in the mobile devices.

6. Results

Under the database name of phase_2, there are two tables. First table ‘dash’ contains temperature, humidity, air pressure and pollution level which is shown in Figure.4. Whereas, the second table ‘dash2’ contains light intensity and gas leak level. This has been done for our own convenience while building the prototype model. And also, a valid reason would be, since NODEMCU826612-E Module consists of only 1 analogue pin it is very difficult to read more than one sensor value through that same pin. So, The NODEMCU was coded to read both the sensor value at a same time. Since the readings from both the LDR sensing element and the MQ2 sensor, were collected in analogue form,a separate table under the same database was created. However, this will not affect the monitoring of data in the mobile application software.

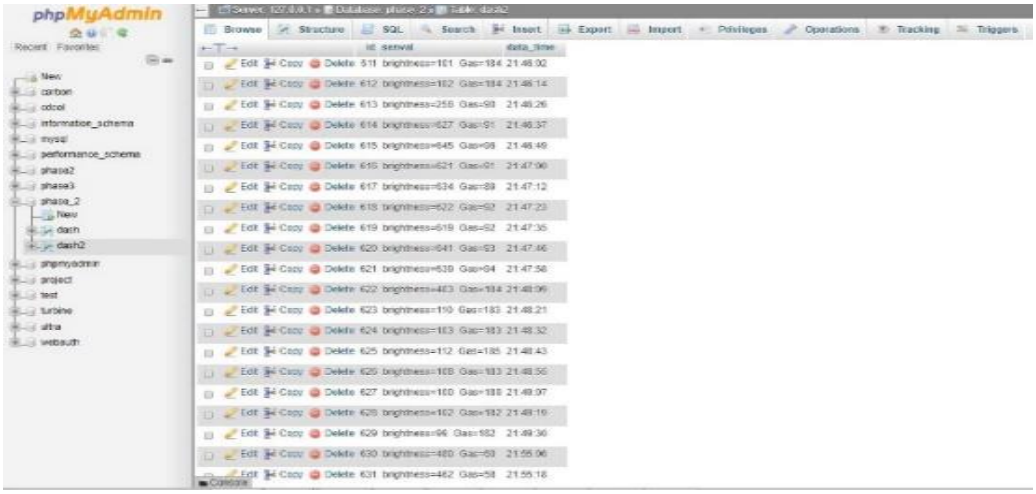

Figure 4. Database server

The prototype model of smart community is designed similar to a house environment referred in Figure.5. in this research the prototype was designed to have a hallway, main bedroom, bedroom 2 and finally the kitchen. According to the usage of parameters the sensors are placed in a particular area inside the box. Say example, MQ7 sensor and BMP180 is placed in the hallway. Whereas, DHT11 sensor is placed in the main bedroom and the MQ2 sensor in the kitchen. The controlling of a 40W bulb in the bedroom 2 and the immersion heater rod in the kitchen is shown. With the help of relay module, the bulb is connected via 220v which is same as for the immersion heater rod via 220v. The system also does the controlling of home appliances thereby reducing the human mistakes like forgetting to switch off the light/fan etc.

The implementation of IoT systems in smart communities has yielded significant results. Figure 6-11 refers to a mobile application that uses control dashboards for user convenience. By leveraging the power of connectivity and data analytics, communities have achieved improved energy efficiency, reduced waste, optimized transportation systems, and enhanced public safety. Residents have benefited from personalized services, increased convenience, and improved quality of life. The real-time monitoring capabilities of IoT systems have enabled prompt responses to emergencies and efficient resource allocation. Overall, the integration of IoT systems in Smart Communities has proven to be a transformative force, driving sustainable development and creating connected, intelligent environments.

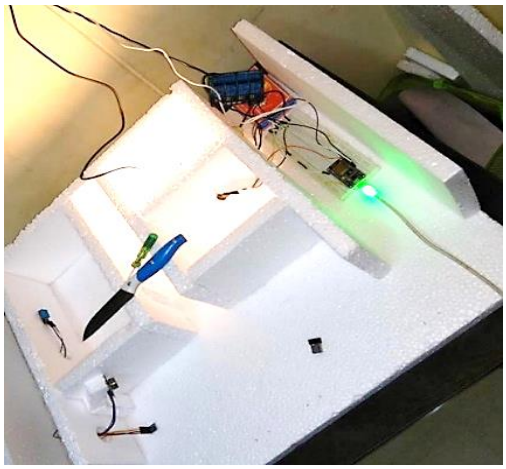

Figure 5. Smart Community Prototype Model

Figure 6. Home page

Figure 7. Dashboard

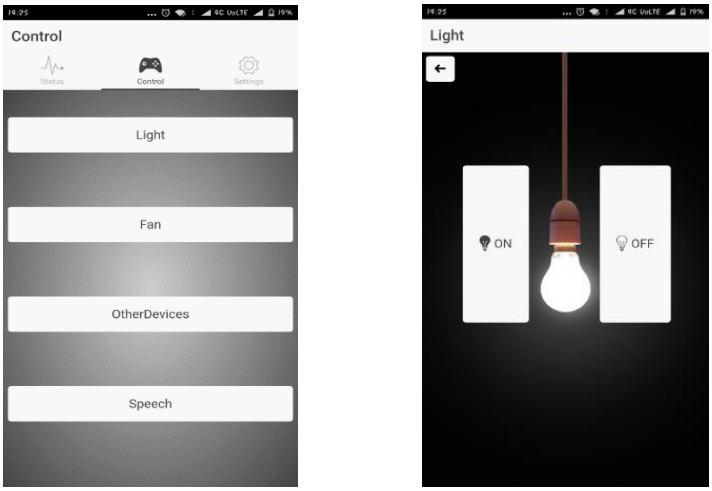

Figure 8. Controlling Dashboards

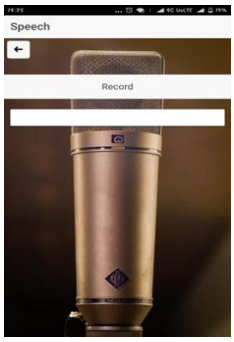

Figure 9. Speech Recognition

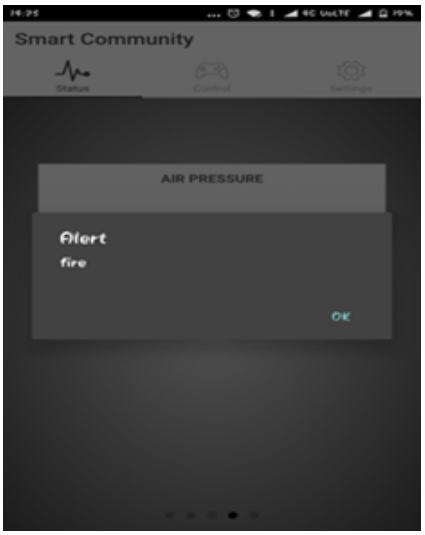

Figure 10. Alert Dashboard

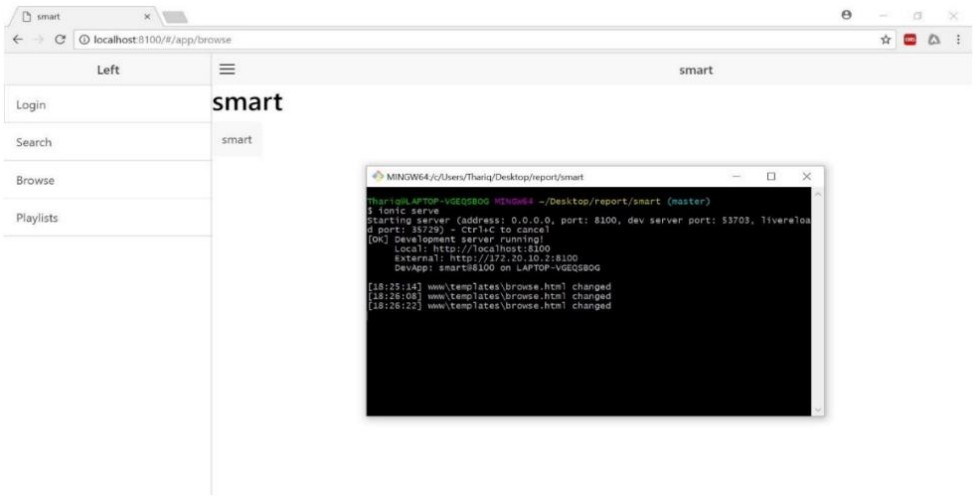

Figure 11. Viewing the Changes in Browser

Features of App

- Auto refreshing for every 7 seconds
- Both monitoring and controlling can be done simultaneously
- Graph and chart indication for better user experience
- Speech recognition for controlling the appliances

7. Conclusion

These kinds of systems are rarely implemented in most of the areas where the environmental parameters have to be measured and analyzed. For example, Delhi city is now

in the need of an immediate requirement for these kinds of systems because as the statistical report says that Delhi is acquiring more pollution than the threshold level that is set. As a result, the majority of diseases are expanding and the environment's resources are seriously deteriorating. The proposed system helps the user by monitoring the environment of a particular area so that he/she is well aware about how the environment is. The system developed is an absolute application for better user experience. The system also did the controlling of home appliances thereby reducing the human mistakes like forgetting to switch off the light/fan. This can also be seen from an alternative perspective, such as consuming less electricity and conserving energy. Even though this sounds "futuristic," everyone will eventually come upon this idea.

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