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# Smart Home Automation with Geofencing

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**Abstract:**
This work presents the design and model implementation of home automation system based on Internet of Things (IoT) technology. It seeks simplified designs for developing a robust home automation system to deal with the problems of complexity, multiple incompatible standards and the resulting expenses in the existing systems. The embedded system includes some sensors and actuators for interaction in the home. Flexibility in the remote access, operation and management is achieved through mobile GUI applications. Web Application Messaging Protocol (WAMP) is deployed to ensure that applications and systems seamlessly communicate with a relatively high level of security using robust web service security protocol. This system offers a cost-effective and efficient solution, because the costs of a dedicated public IP address and a high-end computer are excluded, which are present mostly in other solutions.

**Keywords:** Remote Access, GUI, WAMP, Cost Effective, Seamless.

## I. INTRODUCTION

The development of technology and the use of smart devices in daily life increases the quality of life. This increased benefits such as comfort, centralized control of appliances, cost reduction, energysaving, security and safety which are reason for the growth of automation technology in our life. As a result, the intelligence of such devices is developing massively while offering higher affordability and simplicity through their connectivity. The inter-connectivity of every device is now possible through the Internet; social networks and machine-to-machine communications. The concept of "Internet of Things", tied closely with the popularization of home automation, is an emerging technology which has received a lot of attention from researchers following the vision of a global infrastructure of networked physical objects. While this vision is capturing, no general agreement exists about its realization. IoT involves integrating objects with the internet. These devices are intelligently interconnected which results inmaking new forms of communication between objects and people, and between objects themselves. It is seen that with increased device processing power and storage capabilities, their size pretends to be smaller making them suitable to be equipped with various type of sensors and actuators. The greater power and capabilities of such type of embedded devices further enable them to be lined up with the desired network protocols for endless communication. Home automation started ages ago with labor-saving machines. But early smart homes faced poor performance, high-cost ownership, complicated set-up and operation, poor maintenance and management, and in many cases, they needed the home to be rewired. While home automation is fast evolving, there have been different procedures based on the wireless and Internet technologies which relates to the concept of “Internet of Things”. This work highlights the problems of complexity, multiple incompatible standards and their expenses in those recent systems by providing a simplified design and developing a distributed home automation system. The system’s independent computing units work together in order to achieve the desired automation functionalities by exchanging only abrupt messages as opposed to human to human communication, to synchronize their current states in addition to the input and output data of the individual applications and systems.

## II. RELATEDWORKS

Several works have been done with various approaches made towards realizing home automation. Bluetooth based works were explored for the home automation using Bluetooth enabled devices to provide the control without internet connectivity. Here, the appliances which are wired to the embedded controller are accessed and controlled by devices with Bluetooth connectivity. However, Bluetooth has a maximum range of operation of approximately 100 m and this limitation made the systems incapable of working with long distance mobility and by this restricting the system control to within the neighborhood. Also, Global System for Mobile (GSM) based solutions for the communication and control of home appliances were implemented where a mobile phone (or GSM modem) is linked to the home controller and receives various AT commands for the control. These systems sufferednil graphical user interface (GUI) for flexible operation. Thus, the users have to remember different codes for various operations. Also, messages could be delayed due to mobile network failure; hence, the solution is not perfect for real-time monitoring as well as long distance data logging. With the popularity of Internet gateways at homes such as broadband and mobile hotspots, remote access to control home appliances are becoming practical. Wi-Fi based home automation solutions utilizing localized systems that manages the connected appliances were presented. Such arrangements usually pose a resource junction as they require complicated network traffic routing for remote operations. Similar architectures were offered where local web servers are deployed at home with applications made to manage the devices over the

Internet. The drawbacks of these setups are that, deployment of a high-end computer will not only raise the cost of installation but also the energy consumption and space by its size. The developed interface applications running on the home servers are not easily upgradable and the data communication protocols employed are not robust and scalable to enhance the future demands. While there are no dedicated severs at the client premises, the allotment of a public IP address makes the system expensive and makes difficulty to the limited addressing resources. Moreover, the deployment of Representational State Transfer (REST) based Web service, as an interoperable application layer does not offer a full-duplex communication for real-time operations. To improve the previous designs, a Cloud-Enhanced Home Controller (CEHC) architecture scheme is proposed. Although, the work attempted to provide a flexible ecosystem of Rich Internet Application(RIA) in the growing automation technology, it overlooked the associated press security issues. Also, an implementation of a cloud based solution is presented leveraging on the Google Cloud Messaging (GCM) service for communication between the distributed cloud platforms. GCM is a free service which allows messages transfer in server-client based applications, and uses Extensible Messaging and Presence Protocol (XMPP). Although, the Push technology defeats the polling and long polling techniques, it is a heavyweight protocol streaming Extensible Mark-up Language (XML) and its big specification sees no complete implementation. In addition, unless a particular contract with Google is considered with some charges applied, there is no limitation from using the system's data for other purpose than storage without users' permission. Our work utilizes ultra-modern Internet technologies realizing a distributed home automation system with the processes as services. We deployed robust and scalable protocols to ensure endless communications between the individual applications and systems. The principal and protocol (WAMP) implements Web socket full-duplex and persistent connection and JSON data serialization. Moreover, flexibility is induced in the automation operations and management through HTML5 web based services and applications development for intuitive GUI mobile and web applications. Generally, this architecture delivers a simplified paradigm for a flexible home automation realization and it eliminates the costs of a dedicated public IP address as well as of a high-end computer, thereby providing a cost effective solution to home automation.

## III. SYSTEMARCHITECTURE

Fig. 1 shows the distributed home automation system which includes mainly two components, the hardware interface and the software control components.

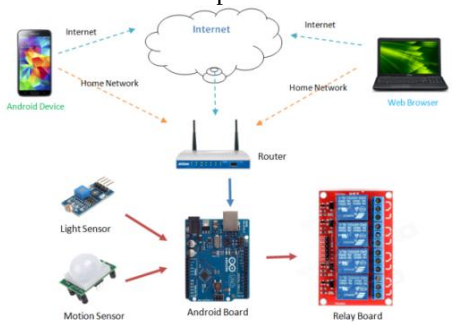


**Figure.1. Overall system layout**

### 3.1. Hardware interface component

The hardware forms the client premises equipment (CPE) which provides the appropriate interfaces to sensors and actuators in the home. The Arduino board is a hardware interface allowing you to control and monitor hardware devices with your computer and smartphone. These are basically plug-in module which allows you to switch devices on and off using a remote control.
Hardware Features:

- 8 Digital Output Control
- 4 Analog Input Sensor
- Control via TCP/IP or Internet
- Control with Browser or Android App

The home appliances are controlled by the power actuators which are majorly relays; electromechanical elements that switch high-voltage, current or power devices with small electrical signals (pre-amplified through transistors) usually from digital controller circuits. An 8 channel relay module is interfaced via a shift register to allow the control with fewer pins from the controller. While light emitting diodes (LEDs) serve as the indicators for the states of the digital output pins and for configuration.

### 3.2. Software control component

The software components consistof web servers, client applications and embedded software. The web servers are the core for managing, controlling, authenticating and monitoring the distributed system processes. The client applications provide graphical user interfaces (GUIs) for client's operations and functions. The Structural design involving in the use of design patterns and frameworks is included in the software system development. The frontend applications which is web and mobile applications which provide graphical interfaces for the user control and monitoring of equipment and sensors. The web application developed is open-source using the HTML5 technology – HTML, PHP, JavaScript, CSS and MySQL. This application is launched through the web browsers of smart gadgets like personal computers, tablets, PDAs, smart phones etc. The mobile application is a simlplest version of the web application using the cross platform development framework, PHP Cordova (or Phonegap). So that in have features like flexibility, intuitiveness, memory efficiency and uncluttered operation were considered for greater user experience. The embedded software program is written in C/C++.

### 3.3. Communication interface

The websocket is the most suitable for real-time bi-directional, full-duplex, persistent connection from a web browser to a server. Web application communication protocol (WAMP) is an open standard Websocket protocol which provides application routing which works with different languages. The WAMP allows a distributed system with loosely coupled applications components communicate in real-time. This is built over Websocket communication protocol and JSON data serialization.

### 3.4. Web service security

The system employed standard web service security techniques in the applications as well as in the communications between them. Which include authentication system built into the web and mobile applications they are ,an unauthorized user cannot enter into the mobile and web applications.

## IV. IMPLEMENTATION

The hardware components are modules by the virtue of the integrated design and development adopted for the work. The standard data bus and jumper wires are used in routing all the network paths for the embedded hardware. At each stage of construction, the modules were tested and each was confirmed to work as required independently. In software development, some frameworks were used in this work for increasing efficiency. These include Laravel PHP framework27, Rachet PHP Websocket framework28, Phonegap mobile apps framework, and Twitter Bootstrap CSS framework. The design pattern is Object-Oriented pattern while the higher level design architecture is the Model-View-Controller (MVC) pattern. The software applications were developed to be reliable and user-friendly.

## V. RESULTS

The scalable and robust architecture involves a Websocket that saves a great deal of bandwidth with terse messages exchanged and exhibits a very low latency needed for a real-time home automation operations saving money, time and space. The system performance is guaranteed although, the actual link characteristics depend on the available Internet connection strength, even at relatively poor connection situations, In the event of total Internet interruption or offline use, the embedded mini web and Websocket servers running on the CPE suffice for continual operations. This system makes user to control the home appliances anywhere, anytime. The user can make sure whether the appliances are working or not.If the user is out of home, the application notifies about the appliances which are switched on. The use of this system makes people easier to control the home appliances smartly.

## VI. CONCLUSION

In this work, the up-to-date web technologies were utilized to render the whole home automation system a distributed type with the processes as services. The cloud portion of the distributed system involves the web applications integrated with data management and repositories as well as communication interfaces. We induced great flexibility in the automation operations through HTML5 based web applications and services development for intuitive GUI mobile and web applications. Similarly, modular design concept was adopted in the embedded hardware development for better functionality and greater reliability. A robust data communication protocol to ensure seamless communication between the individual applications and systems was deployed. Relatively, a high level of security by the virtue of the robust web service security protocol deployed was realized. Overall, the system provides a cost effective solution to home automation as the costs of a dedicated public IP address and a high-end computer, as present mostly in other solutions, are removed.

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