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Home Automation System using NodeMCU

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Abstract: This paper proposes a low-cost flexible and reliable home automation system with additional security using Arduino microcontroller with connectivity through local Wi-Fi for accessing and controlling devices by authorized user remotely using Smart phone application. The proposed system is server independent and uses Internet of things to control human desired appliances starting from industrial machine to consumer goods. The user can also use different devices for controlling by the help of application on smart phone. To demonstrate the effectiveness and feasibility of this system, this paper proposes a home automation system using Arduino UNO microcontroller and NODE MCU(EPS8266) as a WIFI module. It helps the user to control various appliances such as light, fan, LCD, door and can take decision based on the data provided by sensors remotely.

I.   INTRODUCTION

Our proposed system is an Arduino based home automation done with Arduino connected to a Wi-Fi and controlled via android app. This system deals with the safety in home and smart home technologies which will be cost efficient. Arduino can sense the surroundings by receiving input signal from a variety of sensors. The Passive Infra-Red (PIR) sensors allow one to sense motion, almost always and are used to detect whether a human has moved in or out of the sensors range. The PIR sensor is a pyroelectric device that detects motion by measuring changes in the infrared level emitted by surrounding objects. This motion can be detected by checking for a high signal on a signal I/O pin. They are small, inexpensive, low-power, easy to use and don't wear out. We are controlling light, fan and lock. The user can give permission to open the door via app otherwise not. And the user can control the light and fan using the same procedure. This is sufficient to carry any household appliance as these devices do not draw much current. The Wi-Fi shield provides internet connectivity for the embedded micro web server which allows internet access and controls from a web application.[1]

II.   OBJECTIVES

The working of proposed system is that the four different appliances such as fan, light, door and lads are operated remotely using Wi-Fi and through an application installed on android. These appliances are connected through Arduino Uno with its digital input/output pins. These devices are connected with Wi-Fi using a communicating module called NodeMCU.[1]

III.   LITERATURE SURVEY

A.   WIFI Based Home Automation System

The home automation system that uses Wi-Fi technology consists of two main components; the first part is the server (web server), which presents system core that manages, controls, and monitors users' home. Users and system administrator can locally (LAN) or remotely (internet) manage and control system code. Second part is hardware interface module, which provides appropriate interface to sensors and actuator of home automation system. Unlike most of available home automation system in the market the proposed system is scalable that one server can manage many hardware interface modules as long as it exists on Wi-Fi network coverage. System supports a wide range of home automation devices like power management components, and security components. The proposed system is better from the scalability and flexibility point of view than the commercially available home automation systems.[2]

B. Cloud based Home Automation System

Home automations provide full control and flexible monitoring of home appliances for increased comfort, efficient energy use, costs saving, improved safety and security, and have driven the development of various smart homes technologies. Implementation of a home automation system utilizing the Internet of Things (IoT) technology tackles the problems of complexity and incompatible standards inherent in the existing home automation solutions using a robust distributed computing approach. The embedded system operates on dual Advanced Virtual RISC (AVR) microcontrollers, ATmega328p and ATmega16L, interfaced to input and output modules-sensors, actuators, Wi-Fi shield, LCD, keypad etc.-for interactions with users, appliances and the environment. The HTML5 based intuitive mobile and web applications, developed for the system, induces unrestricted flexibility in the system operations and management.

The system deploys a novel Web Application Messaging Protocol (WAMP), implemented with WebSocket full-duplex and persistent connection protocol and JSON data serialization, for seamless individual applications and subsystems integration with a relatively high level of security through web service security protocol. This cloud-based home automation solution has lower implementation cost compared to the existent systems because, as it removes the expensive costs of on-premise high-end computers and dedicated public IP addresses.[3]

C. Bluetooth based Home Automation System

Technology is a never-ending process. To be able to design a product using the current technology that will be beneficial to the lives of others is a huge contribution to the community. The design and implementation of a low cost but yet flexible and secure cell phone-based home automation system is based on a standalone Arduino BT board and the home appliances are connected to the input/ output ports of this board via relays. The communication between the cell phone and the Arduino BT board is wireless. This system is designed to be low cost and scalable allowing variety of devices to be controlled with minimum changes to its core. Password protection is being used to only allow authorized users from accessing the appliances at home.[4]

D. GSM based Home Automation System

This research work investigates the potential of 'Full Home Control', which is the aim of the Home Automation Systems in near future. The analysis and implementation of the home automation technology using Global System for Mobile Communication (GSM) modem to control home appliances such as light, conditional system, and security system via Short Message Service (SMS) text messages is presented in this paper.

The proposed work is focused on functionality of the GSM protocol, which allows the user to control the target system away from residential using the frequency bandwidths. The concept of serial communication and AT-commands has been applied towards development of the smart GSM-based home automation system.

Home owners will be able to receive feedback status of any home appliances under control whether switched on or off remotely from their mobile phones. PIC16F887 microcontroller with the integration of GSM provides the smart automated house system with the desired baud rate of 9600 bps. The proposed prototype of GSM based home automation system was implemented and tested with maximum of four loads and shows the accuracy of ≥98%.[5]

E. ZigBee based Home Automation System

In recent years, the home environment has seen a rapid introduction of network enabled digital technology. This technology offers new and exciting opportunities to increase the connectivity of devices within the home for the purpose of home automation. Moreover, with the rapid expansion of the Internet, there is the added potential for the remote control and monitoring of such network enabled devices.

However, the adoption of home automation systems has been slow. There are certain reasons for this slow adoption and evaluates the potential of ZigBee for addressing these problems through the design and implementation of a flexible home automation architecture.

A ZigBee based home automation system and Wi-Fi network are integrated through a common home gateway. The home gateway provides network interoperability, a simple and flexible user interface, and remote access to the system. A dedicated virtual home is implemented to cater for the system's security and safety needs. To demonstrate the feasibility and effectiveness of the proposed system, four devices, a light switch, radiator valve, safety sensor and ZigBee remote control have been developed and evaluated with the home automation system.[6]

IV. EVALUATION EXISTING METHOD

Our proposed system is an Arduino based home automation done with Arduino connected to a Wi-Fi and controlled via android app. This system deals with the safety in home and smart home technologies which will be cost efficient.

In recent years, wireless systems like WLAN have become more and more common in-home networking. Also, in home and building automation systems, the use of wireless technologies gives several advantages that could not be achieved using a wired network only.

1) Reduced installation costs.
2) Easy deployment, installation, and coverage.
3) System scalability and easy extension.
4) Aesthetical benefits.
5) Integration of mobile devices.[2]

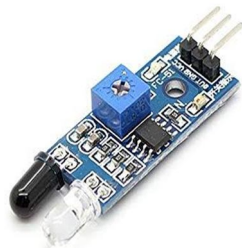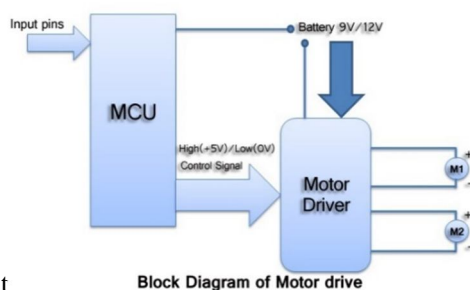The hardware contains various parts such as:

a) Arduino UNO
b) Resistors
c) Wires
d) LED's

e) Relay Module
f) LCD
g) Blub

h) IR Sensor
i) FAN
j) Push Buttons

Block Diagram of Motor drive

k) Motor Driving Circuit

l) DC Adaptor

m) Bread Board

n) NodeMCU

A. *Disadvantages*

1) *WIFI*

a) Notified when Wi-Fi is down.

b) Lower hardware costs.

c) Speed.

d) Security. [7]

2) *Cloud*

a) Effort and Costs.

b) Privacy and Security. [8]

3) *Bluetooth*

a) Limited to Short distance

b) Not suitable as a receiver, on battery-based applications.

c) Data Rate is low

d) Slow

e) Limited communication possible

f) Not a swift way to communicate

g) Not in the trend

h) Not robust at all [9]

4) *GSM*

a) Many of the GSM technologies are patented by Qualcomm and hence licenses need to be obtained from them.

b) In order to increase the coverage repeaters are required to be installed.

c) GSM provides limited data rate capability, for higher data rate GSM advanced version devices are used.

d) GSM uses FTDMA access scheme. Here multiple users share same bandwidth and hence will lead to interference when a greater number of users are using the GSM service. In order to avoid this situation, robust frequency correction algorithms are used in mobile phones and base stations.

e) GSM uses pulse based burst transmission technology and hence it interferes with certain electronics. Due to this fact airplanes, petrol bunks and hospitals prevent use of GSM based mobile or other gadgets.[10]

5) ZigBee
a) It requires knowledge of the system for the owner to operate ZigBee compliant devices.
b) It is not secure like Wi-Fi based secured system.
c) Replacement cost will be high when any problem occurs in ZigBee compliant home appliances.
d) Like other wireless systems, ZigBee based communication is prone to attack from unauthorized people.
e) The coverage is limited and hence cannot be used as outdoor wireless communication system. It can be used in indoor wireless applications.[11]

B. Proposed Method
Home automation systems face four main challenges, these are high cost of ownership, inflexibility, poor manageability, and difficulty achieving security. The main objectives of that research is to design and to implement a cheap and open source home automation system that is capable of controlling and automating most of the house appliance through an easy manageable web interface to run Design and Implementation of a Wi-Fi Based Home Automation System. The proposed system has a great flexibility by using Wi-Fi technology to interconnect its distributed modules to home automation server. That will decrease deployment cost and will increase the ability of upgrading, and system reconfiguration. System will make use of secure wireless LAN connections between distributed hardware modules and server, and secure communication protocols between users and server.

C. Advantages
1) User friendly interface
2) Security and authentication
3) Low cost per node / High node count
4) Large area coverage
5) System Scalability

D. Applications
1) Lighting control
2) HVAC
3) Lawn/Gardening management
4) Smart Home Appliances
5) Improved Home safety and security
6) Home air quality and water quality monitoring
7) Natural Language-based voice assistants
8) Better Infotainment delivery
9) AI-driven digital experiences
10) Smart Switches
11) Smart Locks
12) Smart Energy Meters

V.   SYSTEM ARCHITECTURE
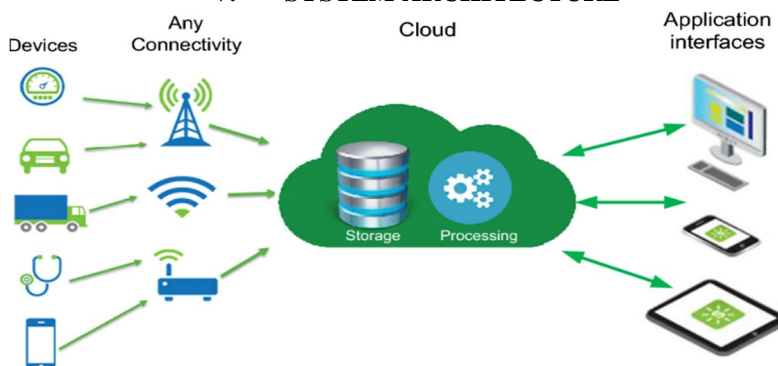
VI. IMPLEMENTATION

Available technology	IEEE Standard	Network Topology	Maximum Power Consumption (in mW)	Data Rate	Maximum Range (in meter)	Cost
Bluetooth	802.15.1	One to Many	100	1 to 3 Mbps	10	medium
Zigbee	802.14.5	Star, Cluster, Mesh	3	20 To 250 Kbps	100	high
NodeMCU	802.11	Star, mesh	100	1 To 11 Mbps	150	Low

From table, it is observed that NodeMCU works on 802.11 b/g/n protocol whereas Zigbee uses 802.14.5 protocol. Zigbee consumes least power as 3mW whereas Wi-Fi and Bluetooth consume nearly 100mW. But if we compare speed of NodeMCU has maximum speed up to 11mbps but Zigbee has only 250kbps. Clearly NodeMCU defeat Zigbee and Bluetooth not only in cost but also in speed. Fig.1 is giving a brief idea about the interconnection of microcontroller, peripheral devices as well as sensors and what is the architecture behind it.[12]

VII. CONCLUSION

Home automation systems face four main challenges, these are high cost of ownership, inflexibility, poor manageability, and difficulty achieving security. The main objectives of that research is to design and to implement a cheap and open source home automation system that is capable of controlling and automating most of the house appliance through an easy manageable web interface to run Design and Implementation of a Wi-Fi Based Home Automation System. The proposed system has a great flexibility by using Wi-Fi technology to interconnect its distributed modules to home automation server. That will decrease deployment cost and will increase the ability of upgrading, and system reconfiguration. System will make use of secure wireless LAN connections between distributed hardware modules and server, and secure communication protocols between users and server. The following list gives an overview of the most important requirements of the proposed system

A. User friendly interface.
B. Security and authentication.
C. Low cost per node / High node count.
D. Large area coverage.
E. System Scalability.

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