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Home Automation and Internet of Things

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Abstract: This paper introduces a system, which uses the idea of Internet of Things for bringing in automation in our homes. Internet of Things or IoT is nothing but an evolved version of Internet, which includes sensors, consumer electronic devices and other embedded systems connected to it besides computers, smart phones and tablets to collect and exchange data with one another. This interaction of data is the key element behind the development of this proposed system. The system consists of different sensor modules, ubiquitous microcontroller board Arduino Mega 2560, various household electrical devices connected to the microcontroller board via the relay and a computer connected to the Internet. The sensor modules are used to find the number of persons, ambient temperature, humidity and light prevailing in a room. These values along with the user made requests are then used to control the various electrical devices connected via the relay, by the microcontroller and also conveyed to the end user on a website.

Keywords: Internet of Things, Home Automation, Arduino microcontroller board, Relay.

I. INTRODUCTION

Modern Humans are said to have originated in Africa about 250,000 years ago [1] and since then, we are trying hard each day to live our lives in a more meaningful and smarter manner. The quick and consistent advancement in technology are helping us to achieve the purpose at a faster pace.Today in the era of intelligent machines, we need our homes to grow smarter so that we could live in our homes, which would utilize energy in a more efficient manner, and also reduce the basic interventions that we face while we are living and working in them.
Automation or automatic control in our homes will bring us closer to the way we want our homes to be. Now, everybody craves to have a smart device at their disposal. And living at a smart home or working at a smart workplace is also no more a fiction, but turning into reality. Today when some parts of the world are lacking electricity or facing shortage of it, energy efficient homes will play a major role in conserving energy and may help get some part of the world electrified.

Authors have explored the history and implementation of Internet of Things by reviewing modern technology and by finding how close, implementation actually is [2]. Authors have described, how different devices can be applied different access policies on it [3]. Authors have explained about how IoT and Cloud computing can work together to address the Big Data problems. They have proposed a prototype model for providing sensing as service on cloud and also illustrated it using few applications like Augmented Reality, Agriculture, Environment monitoring, etc., [4]. Authors [5] reported an effective implementation for Internet of Things used for monitoring regular domestic conditions by means of low cost ubiquitous sensing system.

With all this background, in this paper, authors developed a prototype model of the proposed system using the idea of Internet of Things for bringing in automation in our homes. The proposed system is discussed in Section II and its design and implementation is discussed in Section III. Finally, we concluded this paper in Section IV.

II. SYSTEM

The proposed control system appears as illustrated in fig1. The figure shows us clearly the various components of the system, namely the –

A. Arduino Mega 2560

Arduino Mega 2560 is a microcontroller board based on the microcontroller ATmega2560. It has 54 digital input/output pins, of which 15 can be used as PWM outputs, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

B. DHT 22

DHT 22 is used for sensing the ambient temperature and humidity prevailing in the room.

C. DS18b20

DS18b20 is used for sensing the ambient temperature prevailing in the room. It is used additionally to have a better measurement of the ambient temperature by having measurement done, at two distant locations inside the room. It is done to detect any fire breakout.

D. HC-SR501 PIR motion sensor

HC-SR501 PIR motion sensor is used to detect motion.

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The system has two of them (labelled as 'PIRin' and 'PIRout') to count the numbers of persons present in the room at any time.

E. Light Dependent Resistor (LDR)
A LDR is used to know the ambient light intensity prevailing in the room.

F. Buzzer
A buzzer is used to set off an alarm if fire break out is detected. Normally the system will detect fire in the room when its ambient temperature rises to some critical value.

G. Relay module
A four channel relay module is used to activate and deactivate four loads.

H. Loads
The loads connected to the relay are, a light bulb, a household appliance other than a light bulb (like fan, water heater, refrigerator, water pump, television, etc.), a room heater and a room cooler.

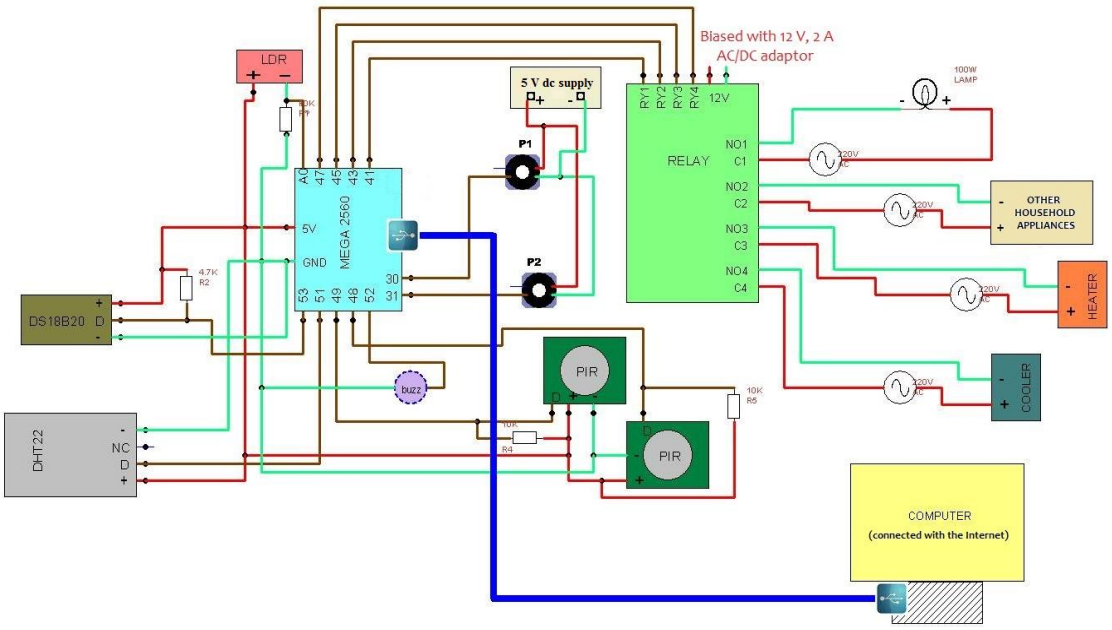

Fig1.Complete schematic diagram of the proposed control system

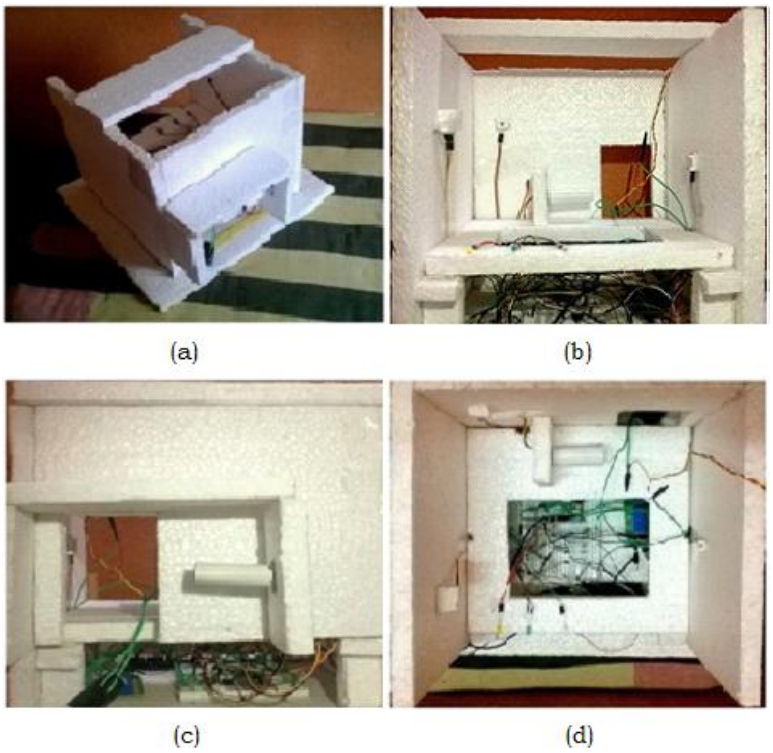

Fig. 2. (a) Aerial view, (b) Rear view, (c) Front view and (d) Top view, of the model of the proposed system

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I. Pushbuttons
Two pushbuttons are included in the system to have a manual control of the two loads, namely the light bulb and the load labelled as 'Other household appliances'. This is provided user to have an offline control of those two loads.

J. Computer
A computer connected with Internet is just connecting the Arduino Mega 2560 to the Internet. This will actually help the user to have a web based control of the two loads, i.e., the light bulb and the other household appliance.

K. MB-102 Breadboard power supply
It is not explicitly shown in fig. 1., but is used for powering some of the sensors with 5V.

L. Other power supplies
220 – 250 V AC are used for the computer and the loads connected to the relay module.

M. AC/DC adaptor
An ac/dc adaptor of output rating 12V, 2A is used for powering the relay module and MB-102 breadboard power supply.

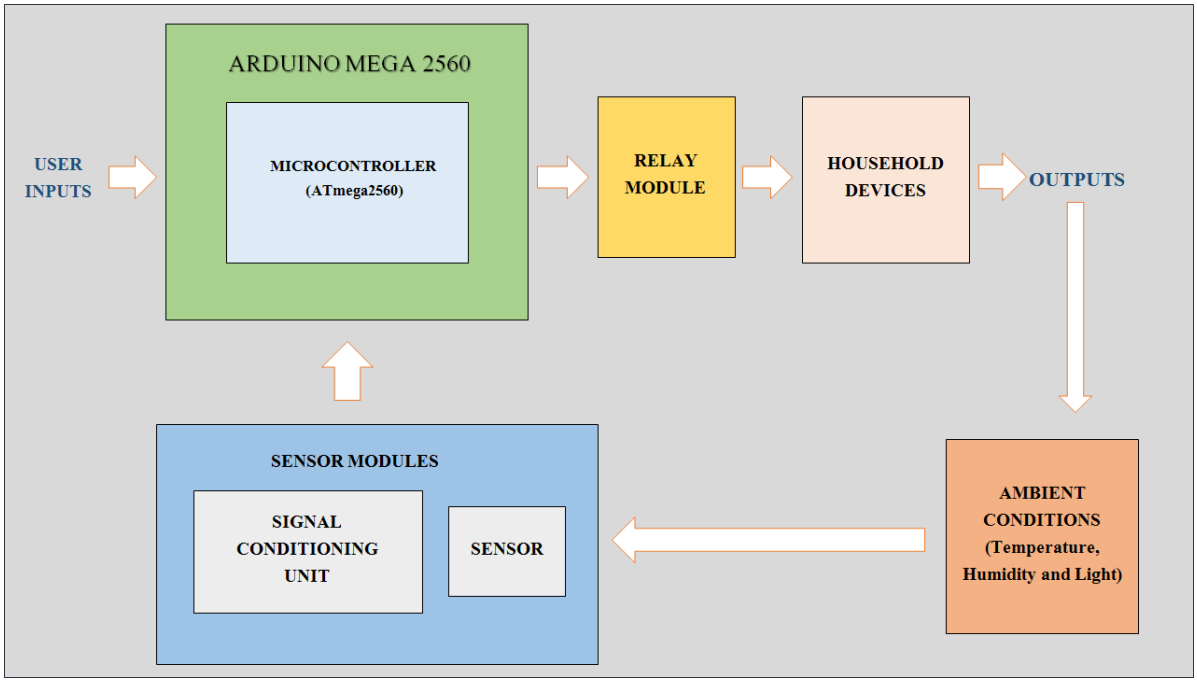

Fig. 3. Overview of the proposed home automation system

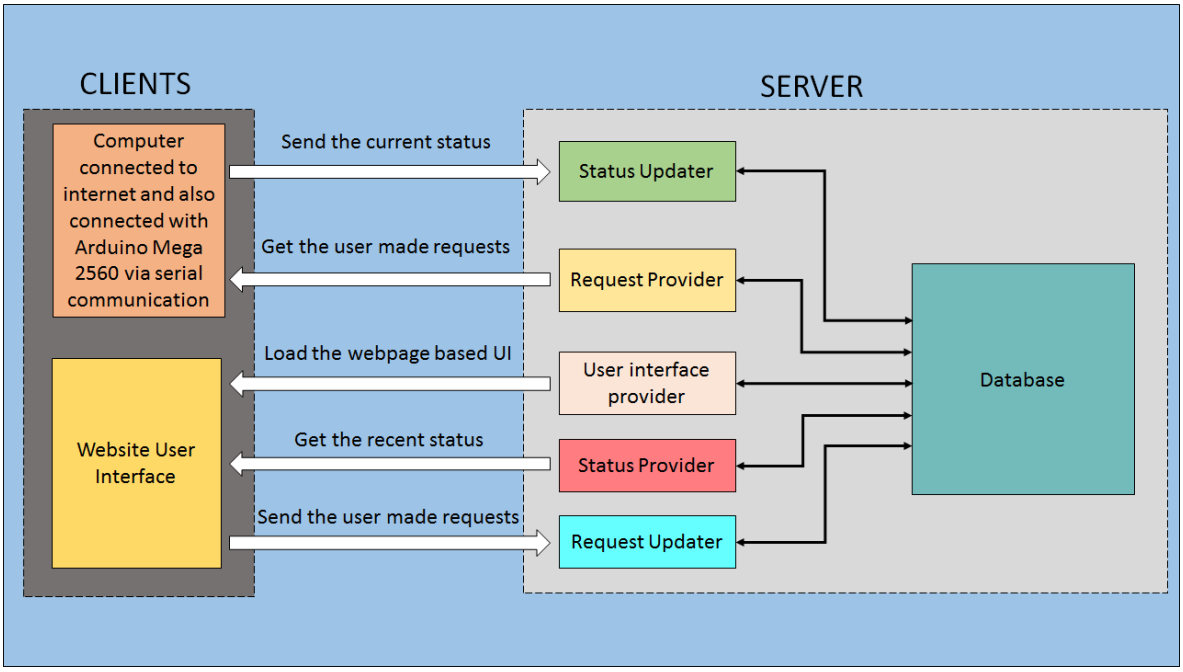

Fig. 4. Overview of the process happening between the clients and the server associated with the system.

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Fig. 5. The remote user interface of our proposed home automation system

III.SYSTEM DESIGN AND IMPLEMENTATION

The present home automation system is designed with an aim to connect every household electrical device like the refrigerator, the air conditioner, the television, the fluorescent lamp, the water pump, the water heater, and any other appliances that you may name now, to our well-established global connectivity, the Internet. This connection of the household devices to the Internet will revolutionize the way we interact with them, and will definitely bring us closer to them, while being thousands of miles away from them. They can be switched on/off by just a click on a webpage speciallydesigned to interact with those devices, by being anywhere in the world with a computeror asmart phone connected with the Internet. Moreover, there was one another problem that was addressed and solved while designing this system and that is the basic interventions that we face every day while working on some job more superior than mere switching on/off some device that is needed. Like while working, we need to turn on the lamps of our study every time, when we enter the room. Again we need to turn off the lamps, when there is sufficient light in the room or when we are leaving the study. These and the numerous other interventions sometimes increase to such extent that it becomes a real time consumer of ours. Sometimes we avoid these interventions by allowing our devices to run unnecessarily, which ultimately leads to loss of energy and increase in entropy in the planet. Here comes the automation at our rescue. So let us understand how this system can be designed to overcome the above two problems, and then we will look how to extend to some other devices, which are not covered by the present system, but may be realized very easily.

In fig. 2, the working model of the proposed system is displayed. Two HC-SR501 Pyroelectric infrared (PIR) motion sensors are included in the system to count the number of persons present in the room at any time. This is done by placing one of them just outside and the other one just inside the entrance of the room. Now, when a person enters the room, the outside PIR motion sensor detects motion at first, and then the inside PIR motion sensor and the opposite thing happens when a person leaves the room. Keeping this fact in mind, we incremented the counter counting the number of persons present in the room, by one, each time the outside PIR motion sensor detects motion at first than the inside one and decrement by one if the opposite thing happened. This headcount is necessary because if in any room there are no persons present, then there is no need to turn on the devices (like lamps or fan)unnecessarily, hence these sensors are useful and so they are included in the system.

DHT 22 and DS18b20 sensor modules are collectively used to measure the ambient temperature prevailing in the room. DHT 22, additionally measures the ambient humidity prevailing in the room. They are placed on the opposite facing walls inside the room to correctly measure the physical parameters. Then with the help of the microcontroller and these sensor modules, proper decision making is done to control the temperature and the humidity of the room to the levels desired by the user. Moreover, when the temperature rises above some predefined abnormal level, set initially by the user, fire alarm is set off by the microcontroller to alert everybody in the home. For this the buzzer is used, which is already included in the system, as indicated in fig. 1 as ‘buzz’.

LDR or Light dependent resistor is used to detect whether the room has sufficient amount of light or not. If enough light is found to exist in the room, the microcontroller will just switch off the lamps in the room to save electricity and in this way the system will conserve energy.

To turn on/off a device via the microcontroller, the user may use, the pushbutton associated with the device, available locally inside the room, or the web switch designed specially on a webpage in the ‘Control’ section as illustrated in fig. 5. The website is the place where users will be able to see all the present temperature, humidity, number of persons, and safety parameters like the fire

status of the room on a webpage, besides controlling the devices present in it from anywhere in the world.

To facilitate remote control over any household device, we need to connect the microcontroller board Arduino Mega 2560 to the Internet. In order to connect the board to Internet, we have used a computer. The computer is connected to the microcontroller board via serial communication. It communicates with the server, on behalf of the microcontroller and sends the data received from it to the server. The website then downloads this data from the server and displays on the webpage. The user made requests are then sent to the server which is then downloaded by the microcontroller via the computer and necessary actions are undertaken by the microcontroller to meet the desired user made requests. In this way the remote control is established between the system and the end user with the help of Internet. The overview of this process is clearly illustrated in fig. 4.

Extension of the system to control various other household devices can be achieved by adding just a relay needed to turn it on/off and a pushbutton (for a manual, offline or direct control), besides making some minor modifications in the algorithm, driving the system. Even the system can be reorganized, to accommodate some subsystems, based on home security, firefighting, lawn and street lighting and garden watering, etc. to increase its scope.

IV. CONCLUSION

Through this paper we proposed a home automation system with an added feature of remote control over the household devices with the help of Internet. We have tested our system, and it is fully functional and feasible, yet it requires certain improvements like, to make the system more compact we may use the various Ethernet and Wi-Fi shields compatible with the microcontroller board Arduino Mega 2560 or even use microcontroller boards integrated with Wi-Fi or Ethernet adaptors like the Arduino Yun to eliminate the usage of computer in the system or any additional shields. The system is limited only with the quality of sensors interfaced with it. Good quality ubiquitous sensors interfaced with the system will uplift its accuracy, but may escalate the overall installation cost of the system on the other hand. So a trade-off is needed to be considered while installing the system. Once installed, it would involve very low maintenance cost and easy modifications, whenever needed.

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