Home Automation using Wi-Fi and Sensor Networks

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***Abstract*— This is a research on the techniques, algorithms and devices that can be used for achieving home automation. We discuss the various existing technologies that are available for home automation. We have tried to achieve the automation with the least possible user interference by predicting what the user would want in a given physical environment. Control of blinds and light is achieved by employing light sensors clubbed with an algorithm that determines what kind of lighting the user would want in that environment. Also we have employed sensors to determine the density of presence in the room which can be linked to control the ventilation system at the site. All of this has been achieved using a single control and decision making device. All of the appliances linked to the smart home automation system can also be controlled by a handheld device like a smartphone connected to the core controller via a wireless link. This is made possible by connecting the controller to the local network. A web based Graphical User Interface will be available that gives exclusive control to the user over all the appliances.**

Keywords— Home Automation; People counting; Fan control; Curtain Automation

I. INTRODUCTION

Internet of Things (IoT) is one of the fastest growing sectors in the technological field. Having said that more than 21 billion devices will be connected to Internet by the end of year 2020[1]. Wi-Fi is one of the most widely used protocols for wireless communications. It is being used in most of the handheld devices available in the consumer landscape today. We plan to use this leverage to control home appliances. There are many definitions of home automation available in literature. Home automation may be defined as the use of consumer devices like personal computers or smartphones to handle the various aspects of the appliances at home remotely. Such an environment would be called a 'Smart Home'.

A. Existing Technologies[2]

1) INSTEON

Insteon was introduced in 2005. The devices supporting Insteon can communicate over power lines as well as over wireless protocols. Insteon is also X10 compatible, which means that users can add wireless capability to an existing X10 network; doing so can be an effective and cost-efficient way to make a full-blown transition to wireless. Insteon technology even supports home automation novices so that non-technical individuals can set up and add devices to the network.

2) Z-WAVE

One of the most popular of the wireless home automation protocols, Z-Wave runs on the 908.42MHz frequency band. Because this is a much lower band than the one used by most household wireless products (2.4 GHz), it is not affected by their interference and "traffic jams." A significant advantage of Z-Wave is its interoperability. All Z-Wave devices talk to all other Z-Wave devices, regardless of type, version or brand. Further, the interoperability is backwards- and forward-compatible in the Z-Wave ecosystem.

3) ZIGBEE

There are myriad similarities between Z-Wave and ZigBee. Like Z-Wave, ZigBee is exclusively a wireless home automation protocol. While it claims many home automation enthusiasts, its full acceptance is limited by the lack of interoperability between ZigBee devices, which often have difficulty communicating with those from different manufacturers. As a result, ZigBee is not necessarily an ideal choice for anyone just starting down the home automation road–unless, of course, they use devices from just one manufacturer. Plus, there are different versions of ZigBee which do not necessarily talk seamlessly with each other.

4) WI-FI

Boasting a high bandwidth, Wi-Fi is already pretty much everywhere, so many manufacturers are enthusiastically making smart home devices to work with it. A multitude of homes in the U.S. already have wireless routers (which work on the Wi-Fi protocol), so obviously they've already got a central hub in place to which Wi-Fi compatible devices can be connected.

5) THREAD

Thread is a new wireless protocol for smart household devices. The Thread Group was formed in July 2014 by seven founding members, including Google's Nest Labs and Samsung Electronics. More than 250 devices can be connected on a Thread network and because the majority of devices meant to be connected to the network are battery-operated, it is very frugal on power.

B. Proposed System

We propose a system interfaced with a low cost Microcontroller to bring down the cost. The system consists of light sensors to control the indoor lighting and also to control the window blinds, resulting in energy savings. The system also employs sensors and a counting algorithm to count the number of individuals currently present in the room. This module also ensures that all appliances are switched off in a scenario where there is no one in the room. The ceiling fan in the room is regulated by a temperature sensor. All of this results in user comfort and also energy saving. Along with the automatic control, the user gets exclusive control over all the appliances via a smartphone or a personal computer connected to the Wi-Fi network. We propose a HTTP based web page hosted over the local network which is the user interface to get control over all appliances present at the implementation site.

C. Elements of the System

The system consists of an Intel 8051 based microcontroller (µc) to interface all of the devices and sensors. In order to control the window blinds, we use a stepper motor controlled via a motor controller, interfaced to the µc since it allows us to move the curtain more precisely. The indoor illumination is controlled by using light sensors. Also to control the speed of the ceiling fan, we have used temperature sensors that sense the temperature of the room and give an analog signal to the ADC interfaced to the µc. The µc then gives an appropriate signal to the power devices to vary the speed of the ceiling fan. In addition to this, if the user needs to control the system manually, the system can be controlled using any smartphone or computer which is connected on the same LAN network as the automation system.

II. SYSTEM APPROACH

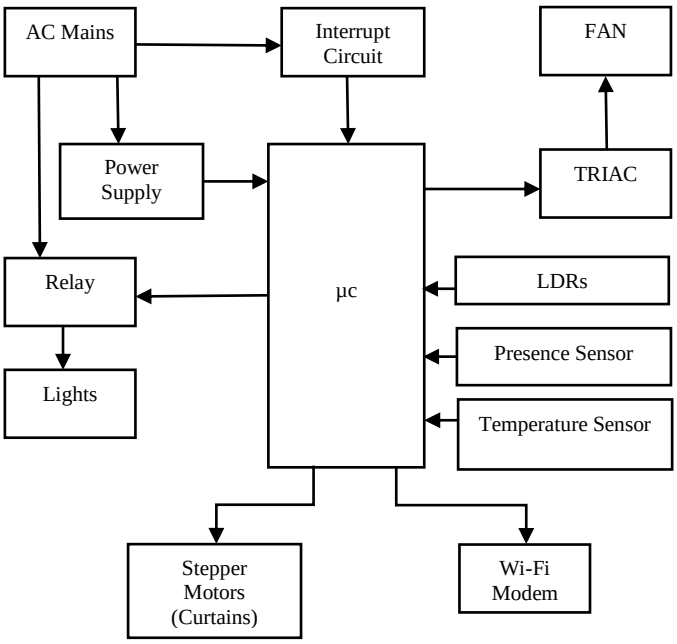

Fig.1: Block Diagram of Home Automation System

Fig.1 Shows the Block diagram of the Home Automation System. The interrupt circuit is used for Zero crossing detection of the AC waveform coming from the mains. This Zero Crossing is detected by the µc and the output is given to the TRIAC with some delay. The point at which the pulse is given from the TRIAC, form the µc, the TRIAC stays ON for rest of the cycle. Hence, lesser the delay, more the power delivered to the ceiling fan and the fan moves faster, likewise, more the delay, lesser will be the power delivered to the fan and hence, the fan moves slower. The fan speed is directly proportional to the ambient temperature of the room. So, if the temperature rises, the fan speed also increases and vice versa.

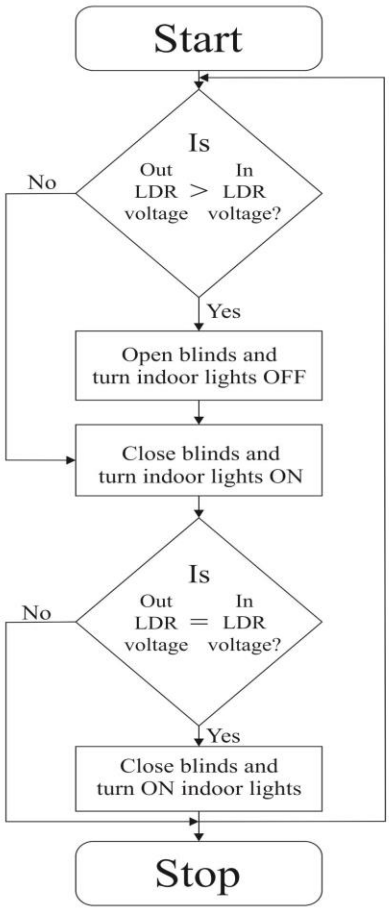

Fig.2: Flow chart for Curtain and Lights control

Lights and curtains' operation is similar to fan control, except that the lights and curtains work on the readings received from LDRs. There are 2 LDRs placed, one is inside the room and another is outside. Depending on the reading of these two sensors, either curtains are opened or lights are turned ON. If there isn't enough ambient light inside the room and there is light outside the room, curtains are raised so that the room gets lit up by the day light. If there isn't light outside the room either, then the light bulbs/tube lights are turned ON. The *Fig.2* shows the flow chart of the algorithm used for controlling the curtains.

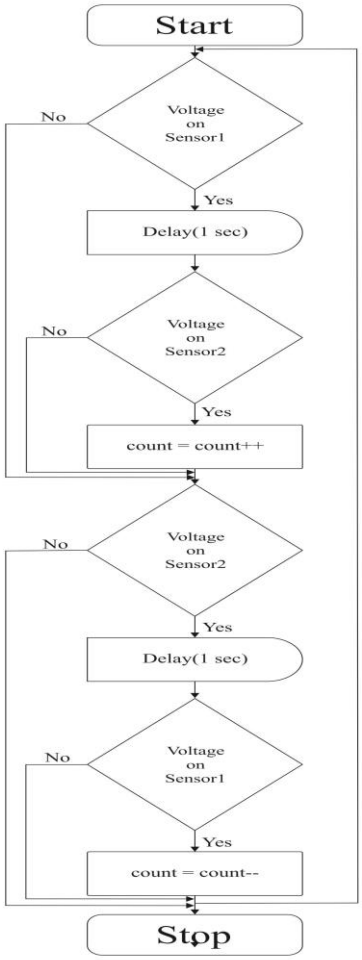

Fig.3: Flow chart for people counting

Now if these mechanisms keep working throughout the day, then there is no use of automation. Hence there is a presence sensor employed to do this job. The presence sensor counts the number of people coming in and going out of the room. Hence, when there is no one inside the room, the light sensing and temperature sensing stops. The *Fig.3* shows the algorithm used for counting people inside the room. This technology to count people can be employed in public spaces as well where counting the number of visitors is required for statistical analysis.

The system specified here can work in automatic as well as in exclusive control mode. This can be done through any of the devices connected on same network as the Wi-Fi modem of the system. This control is made possible with the help of a web based GUI accessible through any modern hand held device with Wi-Fi facility.

III. FUTURE SCOPE

The scope of this research is much more than what has been already done. In the future, more software integration can be done in order to improve the usability and the mass adaption of home automation. One of them could be the integration with Google services like Google Now to determine the actions needed based on online updates about the users status like location obtained from data that is fetched from time to time from these services. Moreover, even more appliances can be connected to the home automation system so as to put up the entire physical environment of the home on to the internet. This can be a major source of raw data that can be processed to perform statistical study of usage of various appliances.

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