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Raspberry Pi Based Interactive Home Automation System through Internet of Things

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Abstract- 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. Home automation refers to control of home appliances using information technology. There are lots of devices on the market that allow you to monitor your home from a central interface. Thus the already existing methods for the automation of home are Bluetooth, Zigbee, GSM based technology. But with the help of rapid expansion of the Internet, there is the potential to control and automate the home appliance using it. It is achieved by interfacing the internet with embedded systems. This paper deals with the idea of implementing the Raspberry pi based interactive home automation system through internet of things and to measure temperature, humidity, soil moisture and status of rain in an agricultural environment. . Through this project we able to secure our home, reduce the wastage of water, etc.
Index Terms-Raspberry Pi, Home automation, Agricultural environment, MSP430, web server, security purpose.

I. INTRODUCTION

Home automation refers to the application of computer and information technology for control of home appliances and domestic features. Its application varies from simple remote control of lighting to complex computer/micro-controller based networks involving varying degrees of intelligence and automation. Home automation results in convenience, energy efficiency, and safety benefits leading to improved quality of life.

The popularity of network enabled home automation has been increasing greatly in recent years due to simplicity and much higher affordability. Moreover, with the rapid expansion of the Internet, there is the potential for the remote control and monitoring of such network enabled appliances. However, the new and exciting opportunities to increase the connectivity of devices within the home for the purpose of home automation through internet are yet to be explored. Several definitions are available in the literature for home Automation.

Bromley et at (2003) describes home automation as the "introduction of technology within the home to enhance the quality of life of its occupants, through the provision of different services such as telehealth, multimedia entertainment and energy conservation". There has been significant research into the field of home automation with many other communication protocols like Bluetooth, hand gestures, DTMF etc. The XlO industry standard, developed in 1975 for communication between electronic devices, is the oldest standard identified from the author's review, providing limited control over household devices through the home's power lines. Sriskanthan et at (2002) introduced a Bluetooth based home automation system, consisting of a primary controller and a number of Bluetooth sub-controllers. AI-Ali et at (2004) developed a Java based home automation system. The use of Java technology, which incorporates built-in network security features, produces a secure solution. However, the system requires an intrusive and expensive wired installation and the use of a high end Pc. Baudel et at (1993) proposed a novel control network, using hand gestures. The controller uses a glove to relay hand gestures to the system. Ardam et at (1998) introduced a phone based remote controller for home and office automation. The system differs in that all communications occur over a fixed telephone line and not over the Internet. The system can be accessed using any telephone that supports dual tone multiple frequency (DTMF).

The research available into home automation in public domain lies predominantly in the academic arena, with little industrial research being available in open literature. The adoption of home automation technologies into commercial systems has been limited, and where available consumer uptake has been slow. The aforementioned systems offer little in the way of interoperability. Attempts have been made to provide network interoperability and remote access to home automation systems through the development of home gateways. Kushirio et at (1998) proposed a home energy management focused home gateway, which connects the home network with the Internet. The system was installed in twenty houses in the Tokyo area. Saito et at (2000) defined a home gateway as the point of ingress between a personal area network and a public access network. Yoon et at (2008) implements a home gateway that accepts mobile phone signals and activates or deactivates an LED representing a home device. Ok et at (2006) proposed a home gateway based on the OSGI (Open Service Gateway Initiative), which allows service providers to access home automation systems for administration and maintenance services. These systems have made a

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significant contribution to the development of a home gateway. However, the existing network infrastructure within the home environment has not been taken into consideration when selecting the networks for integration with the respective home gateways.

This paper proposes a Raspberry Pi based home automation system through e-mails and to measure temperature, humidity, soil moisture and status of rain in an agricultural environment. The system is intended to provide portable, scalable and affordable solution to achieve optimized usage of water supply. Not only this, it is also used for security purpose and automation.

II. PROPOSED SYSTEM

The proposed system for security purpose and to monitor the flow of water basically consists of raspberry pi module, sensor and MSP430 microcontroller. The figure1 shows the configuration for the home automation system for the security purpose.

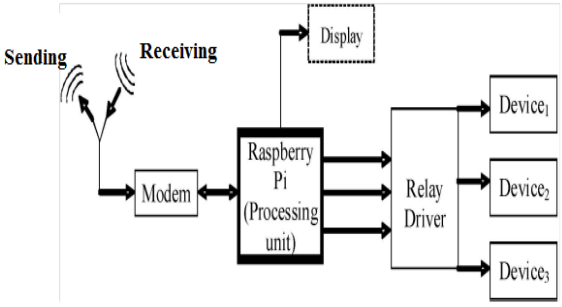


Fig1. Block Diagram for the configuration of home automation system

Raspberry Pi has been chosen as the processing unit for the system because of its user friendly features and economical benefits. Further, python coded algorithm has been fed into the raspberry Pi and is connected to the internet through Modulator Demodulator (MODEM) interface to access and send e-mails to the consumer. The Devices to be controlled have been interfaced with raspberry Pi using relay driver circuit due to different power ratings of devices and raspberry Pi. A display (optional) may also be connected to view the instantaneous status and processing of raspberry Pi.

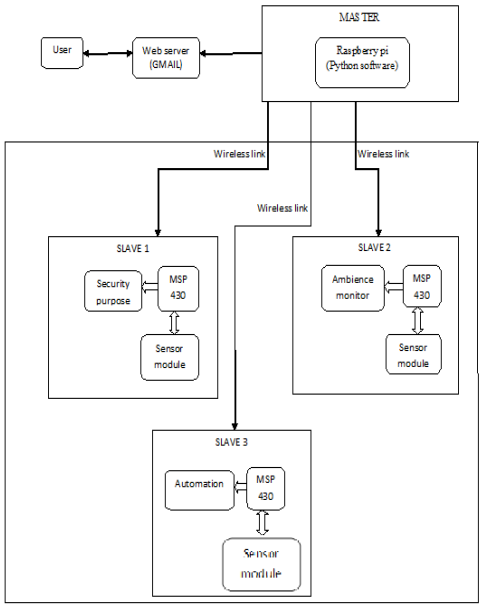


Fig2. Block Diagram of the proposed system for security purpose and to control the flow of water

The figure2 shows the architecture of the proposed system for security purpose and to control the flow of water. The slave1 block is used for the security purpose like turning on/off of light. The slave2 block is used to monitor the changes in atmosphere by measuring the temperature, humidity, soil moisture and status of rain in an agricultural environment. The slave3 is to provide the automation to the system. These entire three slave block collects and monitor the data with the help of wireless sensor networks which is interfaced to the main raspberry pi which is being used as a “hub” for the home automation system, connecting to other open-source hardware parts like MSP430 and sensors.

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Several different methods are now being used like drip irrigation, sprinkler irrigation, etc. that provide controlled water supply, but some software support is also needed for decision making like where and how much watering is desired. Such intelligent irrigation is an essential part of smart agriculture. A different framework to develop intelligent and autonomous systems being offered specifically for agriculture domain. It collects on field data like atmosphere temperature and soil moisture with the help of Wireless Sensor Networks (WSN). The collected data stored in the centralized data server. On the basis of these data, an expert system generates a decision about the need of water irrigation in the field. Optimized usage of water reduces the wastage of water and also increases the production.

Thus the results for user were generated by a series of E-mails sent to the G-mail account of raspberry pi. 'ON1' was sent to raspberry pi account from the consumer account. The algorithm, read the subject 'ONI' and turned ON the device 1 represented by LEDI and instantly replied to sender by an email - 'Turning ON switch l' under the subject- 'Home automation activated'. The code also includes exception handling in case of invalid e-mail from the consumer.

Similarly the same switch can be turned OFF by sending an e-mail with subject 'OFFI' to the raspberry Pi account. Further, this work consists of two more switches which can be controlled by sending e-mails under the subject- 'ON2' & 'ON3' to turn ON the switch2 & Switch3 and correspondingly - 'OFF2' & 'OFF3'' to turn them OFF. So, the home automation can be implemented successfully with efficiency and reliability.

III. HARDWARE

The major components used in the proposed have been discussed briefly:

A. Raspberry Pi

The Raspberry Pi is a wonderful platform that can be used to build your own home automation system. Clearly, the Raspberry Pi board is perfect when being used as a "hub" for your home automation system, connecting to other open-source hardware parts like Arduino boards and sensors.

Raspberry pi is a credit card sized single board computer which is capable of doing the entire job that an average desktop computer does Like spread sheets, word processing, Internet, Programming, Games etc. It consist of 512mb RAM, ARM v6 Processor,2 USB and an ethernet port, HDMI & RCA ports for display,3.5mm Audio jack,SD card slot (bootable), General purpose I/O pins, runs on 5v. The Raspberry Pi model is shown in fig.3.

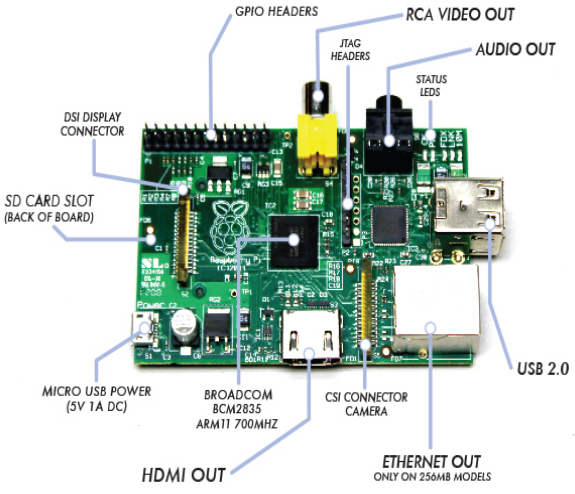


Figure3. Raspberry Pi module

Raspberry pi runs on Linux kernel based operating systems. It boots and runs from the SD card. It does not have any internal memory other than the ROM. It has an SD card slot which is capable of reading up to 32 GB. The GPIO pins of the raspberry pi are programmed using Python programming language. The Electro-valve is connected to GPIO pins with the help of transistor and relay so that we can switch on switch off it whenever needed.

B. GPIO

One powerful feature of the Raspberry Pi is the row of GPIO (general purpose input/output) pins along the edge of the board,

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next to the yellow video out socket.

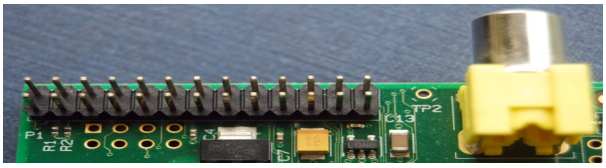


Figure4. GPIO pins

These pins are a physical interface between the Pi and outside world. At the simplest levels, they are the switches that can turn on or off (input) or that the Pi can turn on or off(output). Out of the 26 pins, 3 pins have been used to control three devices in this project which have been represented by 3 LEDs for testing the switching signal. For practical purposes a relay driver circuit and relays can be interfaced with Raspberry Pi and appliances, respectively, for their controlling.

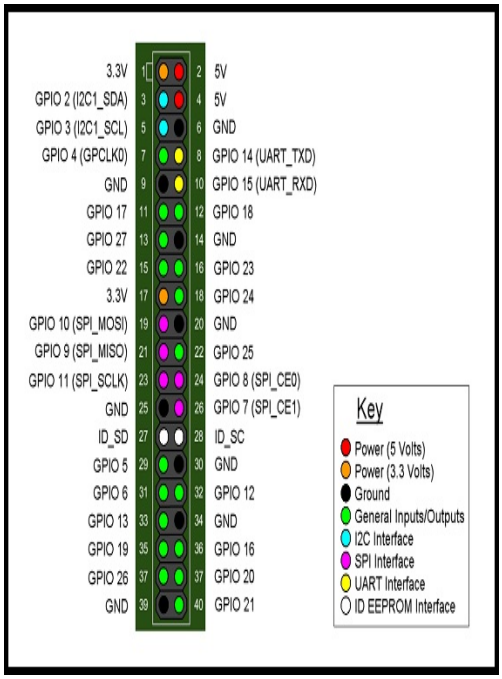


Figure5. Pin layout of raspberry Pi GPIO used in system

The program can be written on the pins to interact in amazing ways with the real world. Inputs don't have to come from a physical switch; it could be input from a sensor or a signal from another computer or device, for example. The output can also do anything, from turning on an LED to sending a signal or data to another device. If the Raspberry Pi is on a network, you can control devices that are attached to it from anywhere and those devices can send data back. Connectivity and control of physical devices over the internet is a powerful and exciting thing, and the Raspberry Pi is ideal for this.

C. Relay Circuit

A relay is an electrically operated switch. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. In our system the output from rapi is directly given to relay circuit. According to the output of Raspberry Pi, corresponding relay will turn on and makes its device working. We are using a NPN transistor in relay and it works based on concept of emf. The relay can be selected according to our application purpose.

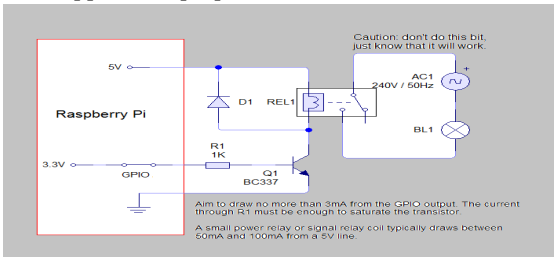


Fig6. Relay connected with raspberry-pi

The home automation system ends up with the working of relay circuit. In this home automation system we can add devices

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very easily into system. Also it can be configured with more security and functional services. the Raspberry Pi minicomputer can be make use more better to incorporate variety of applications to our home automation system. Since our system makes running in low power compared to other system, it is having a tremendous application view.

D. MSP430

The **MSP430** isa mixed-signal microcontroller family from Texas Instruments. Built around a 16-bit CPU, the MSP430 is designed for low cost and, specifically, low power consumption embedded applications. The MSP430 can be used for low powered embedded devices. The electric current drawn in idle mode can be less than 1 µA. The top CPU speed is 25 MHz. It can be throttled back for lower power consumption. The MSP430 also uses six different low-power modes, which can disable unneeded clocks and CPU. Additionally, the MSP430 is capable of wake-up times below 1 microsecond, allowing the microcontroller to stay in sleep mode longer, minimizing its average current consumption.

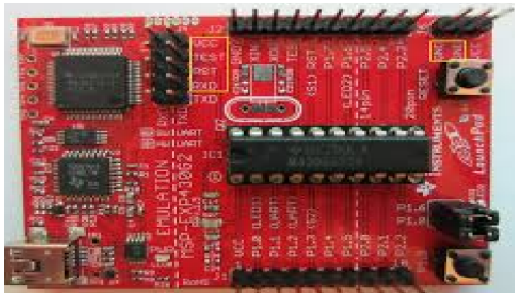


Fig7. MSP430 microcontroller used in Raspberry Pi

There are, however, limitations that preclude its use in more complex embedded systems. The MSP430 does not have an external memory bus, so it is limited to on-chip memory (up to 512 KB flash memory and 66 KB RAM) which may be too small for applications that require large buffers or data tables. Also, although it has a DMA controller, it is very difficult to use it to move data off the chip due to a lack of a DMA output strobe.

IV. RESULTS AND DISCUSSION

From here, I have now discussed the all points related to this Home automation system. This research and implementation of idea is based on the new device which provides flexibility and high economy for home automation solutions in our daily life. Because nowadays the users are scared about the technology, they don't want to be controlled by a computer. The users don't want "something more", but they prefer "something known" with some "intelligence". The best approach and best solution is the automation of home through the internet of things.

In this paper, Raspberry Pi was used for the automation of home through the Gmail for the security purpose. And the irrigation of water is also done with the help of ambience monitor for the agricultural environment.

V. CONCLUSION

In this highly developing era, where directly or indirectly, everything is dependent on computation and information technology, Raspberry Pi proves to be a smart, economic and efficient platform for implementing the home automation. This paper provides a basic application of home automation using Raspberry Pi which can be easily implemented and used efficiently. The code provided is generic and flexible in a user friendly manner and can be extended for any future applications like power control, surveillance, etc, easily. Moreover, this technique is better than other home automation methods is several ways. For example, in home automation through DTMF, the call tariff is a huge disadvantage, which is not the case in proposed method. Also, in Web server based home automation, the design of web server and the space required is eliminated by this method, because it simply uses the already existing web server provided by G-mail.

VI. ACKNOWLEDGMENT

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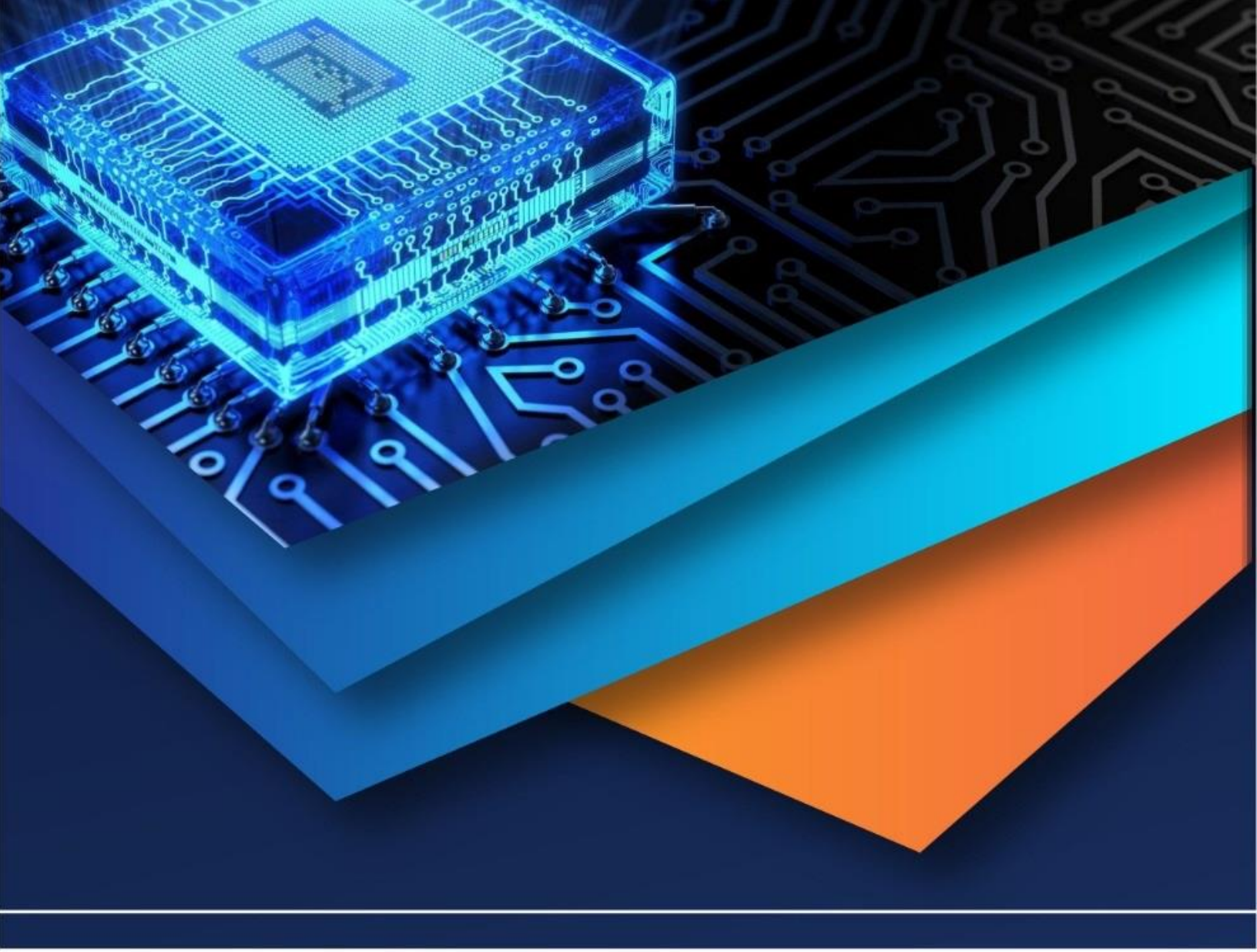
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