LOW-COST HOME AUTOMATION SYSTEM USING RASPBERRY PI PICO MICROCONTROLLER

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Abstract - *Automating our electronic devices in homes can save electricity and make our lives much easier. Smart homes are becoming very popular now a days due to the major development in the Internet of Things industry and the availability of high computing chips for cheaper prices. In India, smart homes or smart devices in general are not that popular as many people can't afford them.*

In this research work, a low-cost home automation system is built using a Raspberry Pi Pico micro controller and Bluetooth technology. This build costs significantly lower than any other device of the same working. The Raspberry Pi Pico costs around 350 INR which makes it very affordable. In this research work, the above said build is used to automate tube lights and fans which are the most common household electronics that are found in Indian homes.

This can further be used with any electronic device which we use in our every daily life like washing machine, water pumping motor, geyser etc.

Key Words: **Internet of Things, Raspberry Pi PICO, Bluetooth, PIR motion detecting sensor, home automation, HC-05 module.**

1. INTRODUCTION

Home automation and smart homes are becoming very popular in today's world. Home automation technology helps us to control our entire home i.e., the electronic devices in our homes such as fans, lights, television etc. to our doors and it can serve us as a security system for our homes. There are numerous ways to implement home automation, from Wi-Fi to Bluetooth and other ways such as Z wave, ZigBee etc. There are many advantages by using a home automation system.

[1] First of all, with a home automation system we can remotely control various devices in our homes and, we can perform various tasks such as controlling our doors, watering our plants, baby watching and other such tasks from anywhere in the world through this technology.

Generally, we use integrated circuits to make home automation systems for our requirements. They tend to cost very high and changing their working to our needs can't be done easily due to their unchangeable built. [3] There are some research works where people have built their own customizable home automation systems using a smart phone, a computer or even single board computers like the raspberry pi computers. But even these systems are generally expensive. Also, coming to the raspberry pi computers, they need to boot the raspberry pi OS first and then only can they run our required programs. Overcoming this, there are some research works, where a microcontroller like the Arduino Uno Rev3 board was used to build a home automation system.

This makes the build very cheaper compared to the raspberry pi single board computers and other previously known builds. Extending to this build in this research we are using a raspberry pi Pico microcontroller which costs less than half of an Arduino microcontroller and the Pico can be programmed using either C/C++ or even Micro Python which makes it very versatile when compared to an Arduino board. As the Pico does not have any Bluetooth capability, in this research we have used a HC-05 Bluetooth module to act as a bridge between the Pico and the controlling device smart phone or a computer.

2. LITERATURE SURVEY

Home automation is currently the most required and requested technology now a days. People are looking for various ways to automate their living in cheapest way possible. There are various variety of a automation systems in the market but only few can be popular among the people and users.

The Raspberry Pi 3b+ single board computer is used to create a home automation system. In this research paper the author explains us how to interface the raspberry pi computer to a relay switch along with an electric connected to the relay switch. For quite a long time, the web has been generally utilized for the cycles like surfing on the pages, looking through data, downloading visiting, and establishment.

By the fast improvements of new advancements, checking, controlling administrations have been begun to be served alongside the web as an instrument furnishing communication with apparatus and gadgets. The framework can be utilized in a few spots like banks, labs, hospitals, and another complex computerized framework, which decreases the perils of unapproved sections. The principal reason to foster this framework is to save time and labour along with security and comfort [1].

It is an open-source microcontroller that is utilized to control transfer and ultrasound distance sensors kind of Arduino is utilized in this plan. Arduino libraries and capacities are utilized in the program. On the off chance that a low water level is recognized by the sensor then a sign will be sent from the microcontroller to pi. [3] Pi will replay a similar sign to Arduino and the solenoid valve will be turned on through hand-off clarifies the correspondence hardware among Arduino and ZigBee module additionally clarifies the association between the Arduino and a sensor just as Arduino and transfer.

3. HARDWARE DESCRIPTION

In this research work, we have used a Raspberry Pi Pico microcontroller along with a HC-05 Bluetooth module to control all the electronic devices connected to the system. The Pico microcontroller does not have the Bluetooth capability by default, so we are using the HC-05 module to contact the devices through Bluetooth.

A. Raspberry Pi Pico

The Raspberry Pi Pico microcontroller is one of the cheapest microcontrollers in the market. It can run both Micro-python and c language programs on it. Micro-Python is a programming language derived from the computer language python. Micro python is generally used to work with low level devices like the Pico. It contains all the important features of the python language without having all the inbuilt libraries that python has. The Pico has the RP2040 chip which has the following features:

- 2MB flash
- Micro USB B port
- 26 GPIO pins
- 3 pin serial wire debugs
- 264KB SRAM

The Raspberry Pi Pico is the first microcontroller from Raspberry Pi foundation. It comes with the RP2040 chip which was designed by the Raspberry Pi foundation.

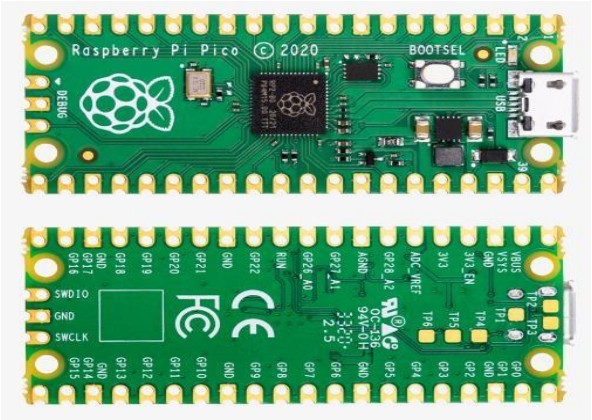

Fig 1. Raspberry Pi Pico REV3.

B. HC-05 Bluetooth Module

In this research work, the HC-05 chip is used to provide the Raspberry Pi Pico with Bluetooth capability. The HC-05 module operates at 5V and uses 30mA current. The range is around 100 meters. It uses the USART protocol for communication and follows the IEEE 802.15.1 standard protocol for Bluetooth communication. It can operate in both Master, Slave modes. The supported baud rates for the HC-05 module are: 9600, 19200, 38400, 57600, 115200, 230400, and 460800.

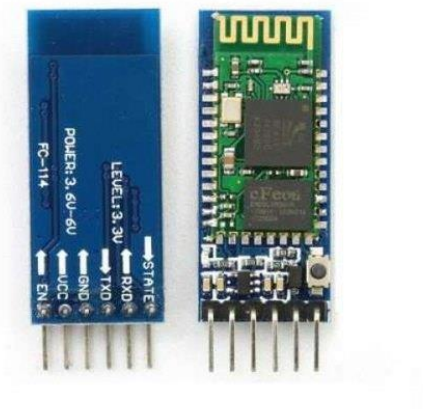

Fig 2. HC-05 Bluetooth Module.

The HC-05 has 2 operating modes, they are Data mode and AT command mode. In the data mode it can send and receive information from another device with Bluetooth. In the later mode, the device's default settings can be altered manually.

C. 5V Low level Relay Module

A 5v relay module is used a bridge between the 5V DC current to 240V AC current to switch the electronic devices ON/OFF. The relay module has 6 inputs IN1 through IN6 with a low-level light coupling. The relay comes with octal-coupler isolation and supports all SCM control.

The relay switch in general is an electrical switch which can trigger power supply in circuits just like normal physical switches. A suitable voltage pull 5V DC in this case is required to alter the relay state between ON/OFF. There are various types of relays ranging from different input voltage like 5V, 12V, 24V etc. When this threshold of voltage is reached the relay coil present inside the relay module gets energized and thus, closing the circuit.

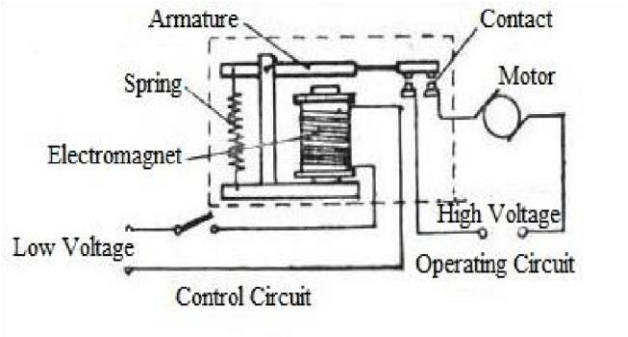

Fig 3. Working of a Relay module.

Later, the relay module alters the circuit state between ON/OFF states accordingly. Thus, the target electronic device is controlled using the Pico microcontroller wirelessly.

D. Passive Infrared Rays Sensor

(HC- SR501)

The passive infrared sensor can be used to detect human presence by sensing the infrared rays emitted from people. In this research work of building a home automation system, we are using the HC-SR501 module to automate the tube lights, which are one of the most common devices in every Indian household. The PIR sensor can be used for many varied applications such as automating lights and other electronic devices and it can be used as a security device to detect intruders.

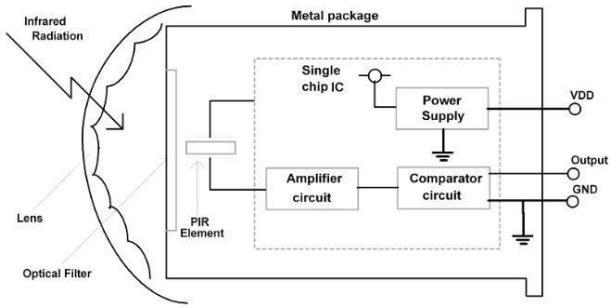

Fig 4. HC-SR501 PIR Module.

4. WORKING PRINCIPLE

In this research work, we are using the Raspberry Pi Pico microcontroller for building a home automation system along with the HC-05 Bluetooth module. Firstly, when a signal is sent to the HC-05 module from a smart phone or a computer through Bluetooth, the HC-05 takes wireless input and triggers the Pico microcontroller. Then, the Pico runs the Micro-Python code and sends a signal to the particular relay which is connected to the target electronic device.

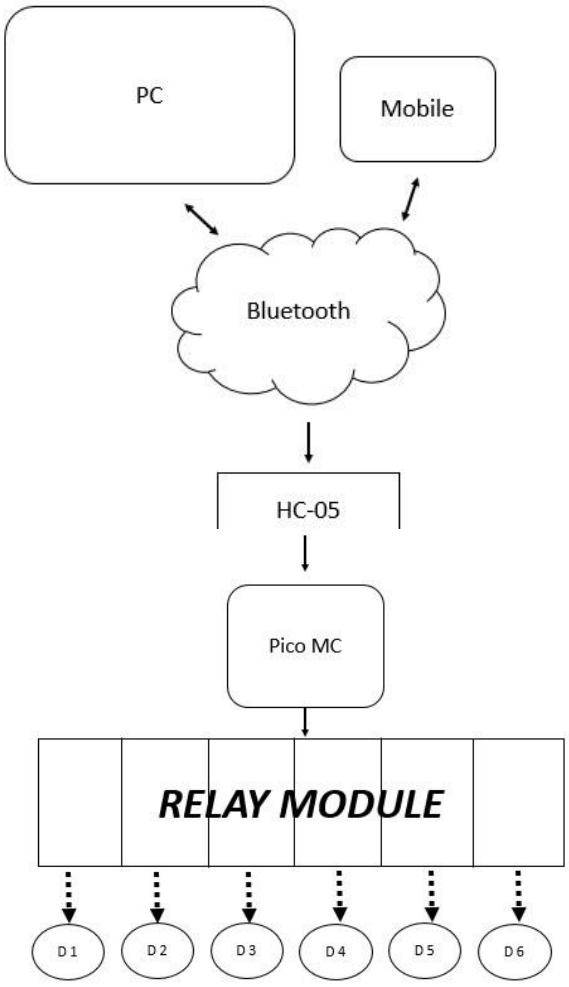

Fig 5. Proposed Home Automation System

Similarly, a PIR sensor can be used along with the Pico microcontroller to build a smart security system that can detect human presence and can trigger an alarm.

In this way, the Pico microcontroller can be used to build a home automation system with the HC-05 module.

5. RESULTS

The entire setup is set and a Bluetooth application to control the devices is made using the kodular.io service. With this, the setup is complete, and the system is tested.

In the Fig.6.1, the entire setup is powered by a 5v DC adaptor and the 240V bulbs are connected to the wall socket. Here, 4 input 5V DC low level relays are used for the connection.

Fig 6.1. Proposed Home Automation System Setup (OFF).

Fig 6.2. Proposed Home Automation System Setup (ON).

The Raspberry Pi Pico microcontroller and the HC-05 Bluetooth module are mounted on a breadboard as a temporary station, this can be further converted into a complete portable device with a mounting and holding case for the entire setup.

```
L1 = Pin(2,Pin.OUT)
L2 = Pin(3,Pin.OUT)
L3 = Pin(4,Pin.OUT)
L4 = Pin(5,Pin.OUT)

while True:

    br = bt.readline()

    if "ON1" in br:
        L1.value(0)
    elif "OFF1" in br:
        L1.value(1)

    elif "ON2" in br:
        L2.value(0)
    elif "OFF2" in br:
        L2.value(1)

    elif "ON3" in br:
        L3.value(0)
    elif "OFF3" in br:
        L3.value(1)

    elif "ON4" in br:
        L4.value(0)
    elif "OFF4" in br:
        L4.value(1)
```

Fig 7. Sample Micro Python Code to control the Pico GPIO pins.

In the Fig 6.2, we can see that the electronic lights connected to the 240V AC current are controlled by the Pico micro controller via the HC-05 using the Bluetooth application on the smart phone. This can expand to any electronic device in our everyday households. The proposed home automation system is complete.

6. CONCLUSIONS

In this research work, we have implemented a home automation system using a Raspberry Pi Pico microcontroller, HC-05 Bluetooth module, 5V Relay Module and a Bluetooth application on a smart phone.

Home automation systems in general are very expensive and are not easily customizable to our needs, here in this research work, we have proposed a home automation system using a Raspberry Pi Pico microcontroller which is very cheap and also, we can program the Pico as required by our needs. It can run both C/C++ and Micro Python making it very accessible to everyone. A HC-05 Bluetooth module is used to extend the capabilities of the Pico and giving it a Bluetooth communication capability via the HC-05 module. In this build, a 5V DC input relay is used to trigger the target electronic devices. The relay is an alternate to the physical switches that we use in our households.

In the figures Fig 6.1 and Fig 6.2 the proposed build is shown. The Pico and HC05 are mounted on a breadboard as a temporary mount, they are powered by a 5V DC power adapter and the electric bulbs are powered by 240V AC current from a wall socket. The 4 channel 5V DC relay module is acting as an electrically controlled switch for the circuit. Finally, the bulbs are controlled by the smart phone through Bluetooth via the HC-05 and Pico microcontroller.

7. REFERENCES

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