Project Proposal Report

-Raspberry Pi Smart Home System (RSHS)-

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Introduction

We offer a proposed system for Smart Home Automation using Raspberry Pi, utilizing IoT alongside, in this report, which is accomplished by integrating cameras and motion sensors into a web application. We are designing this system with a Raspberry Pi module and computer vision methods [1]. The automation system can be used to operate household appliances linked to the internet through a monitor. For sensing and surveillance, Raspberry Pi operates and controls motion sensors and video cameras. For example, it captures the identification of the invader and identifies its existence using a basic Computer Vision Technique (CVT). When motion is detected, the cameras begin recording, and the Raspberry Pi device notifies the owner through SMS and an alarm call.

Automation, in the modern world, plays an important part in all workplaces and residences. Smart automation approaches are currently implemented utilizing a microcontroller or a computer. Multiple programs cannot be executed on a microcontroller at the same time. It is difficult to operate both appliances and surveillance at the same time when using a microcontroller, i.e., it is highly tough to conduct several operations at the same time. We can accomplish this using a computer, but it is highly expensive for this purpose and uses more power. However, the Raspberry Pi, a single-board computer, may be used to solve these issues. Simply said, the Raspberry Pi system works like a computer with a tiny configuration. It has GPIO and USB ports. We can operate the appliances with the sensors and connect the camera for surveillance using these connections. Depending on our needs, the Raspberry Pi may be utilized for a variety of applications.

Home automation provides safety, convenience, control, comfort and energy savings. Here's a deeper look at some of the most significant advantages of home automation, in addition to the kind of devices you should consider to gain these benefits:

- enhanced safety and security
- convenience
- data and control
- comforting routines for residents
- greater peace of mind
- conservation of energy

The rest of the report is structured with the functional description of all the components, elaboration of the system design, algorithm and connectivity of the proposed system, the results from the aforementioned planning and significant discussion of future ideas with a suitable conclusion.

Components

1. Raspberry Pi 4

The Raspberry Pi 4 is a compact, cheap computer that can be hooked into a computer monitor or TV and is about the size of a credit card. It is a competent tiny gadget that enables users of all ages to learn programming in languages like Scratch and Python and to explore computing. Thanks to its ability to decode 4K video, quicker storage via USB 3.0, and faster network connections via real Gigabit Ethernet, the Raspberry Pi 4 is faster and more powerful than its predecessors.

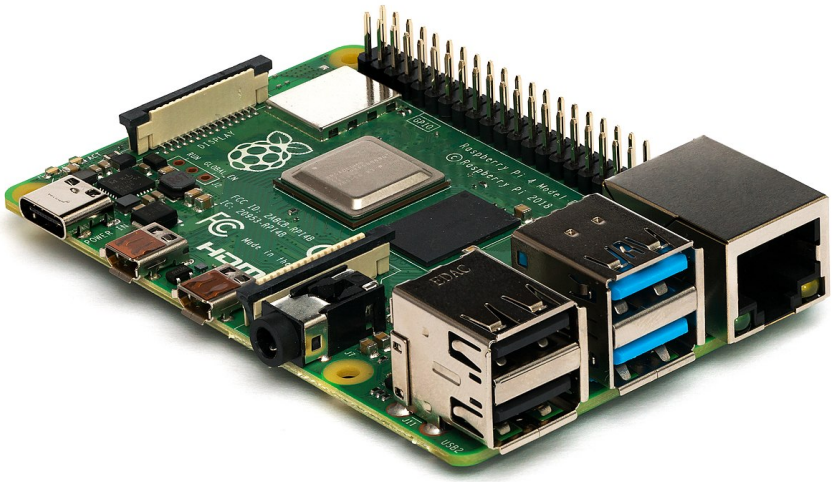


Fig 1: Raspberry Pi 4 [2]

The Raspberry Pi 4 is a flexible tool that may be used for a range of tasks, from educational tools to hobby projects. It is a popular option for everyone due to its inexpensive price and compact dimensions.

2. Raspberry Pi Camera

The Raspberry Pi Camera is a camera module that may be used with Raspberry Pi devices to take pictures and videos. The first 5-megapixel Raspberry Pi camera module was released in 2013, followed by the 8-megapixel Camera Module 2 in 2016 and the most recent 12-megapixel Camera Module 3 in 2023.

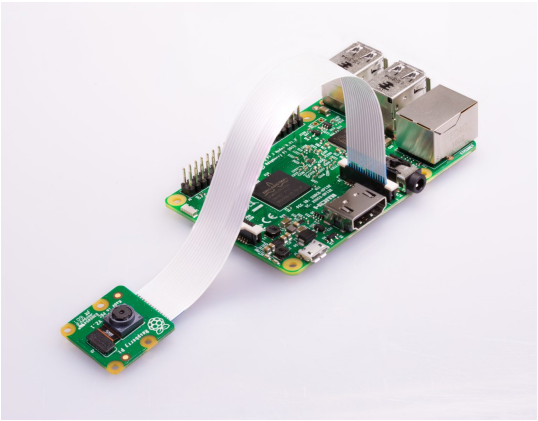


Fig 2: Raspberry Pi Camera [3]

The 'Legacy Camera Enable/disable legacy camera support' option must be chosen in the 'Interface Options' part of the raspi-config command in order to enable the operation of the camera module. While Picamera2 is a libcamera-based successor for Picamera, giving an accessible Python API for the camera module, Picamera is a Python interface to the Raspberry Pi's heritage camera stack.

3. Ultrasonic Sensor

Ultrasonic sensors are widely used to measure distances in Raspberry Pi applications. High-frequency sound waves are emitted by these sensors, and the time it takes for the waves to return after hitting an object is measured. The sensor's distance from the target item can be determined by the Raspberry Pi using this time measurement.

Fig 3: Ultrasonic Sensor [4]

It's crucial to remember that the HC-SR04 ultrasonic sensor normally operates at 5V while the Raspberry Pi runs on a 3.3V logic level when using an ultrasonic sensor with it. As a result, a sensor's Echo pin must be connected to a Raspberry Pi GPIO pin that has been set up as an input. The Vcc pin of the sensor must be linked to the positive rail of

the breadboard, and the GND pin must be connected to the negative rail, as well as ground connections between the sensor and the Pi.

4. Two Channel Relay Module

A Raspberry Pi two-channel relay module is an electronic device that uses the GPIO pins on the computer to operate two powerful devices. There are two relays inside, each rated for a maximum current of 10A at 250VAC or 30VDC. These relays are helpful for home automation projects since they may be used to turn on or off a variety of electrical equipment, including lights, fans, and motors.

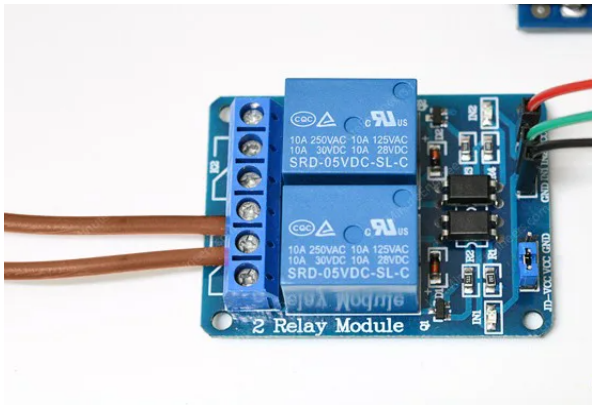


Fig 2: Two Relay Module [5]

To supply current to the electromagnet, relay modules must be connected to a lower power source, like a Raspberry Pi. You can connect a relay module, like the SRD-05VDC-SL-C, directly to the Raspberry Pi's GPIO pins.

5. DC Motor

A DC (Direct Current) motor is a type of electric motor that may be used with a Raspberry Pi to power mechanical components in various projects. GPIO ports on the Raspberry Pi can only supply so much current, thus a motor driver like the L293D H-bridge motor drive is required to supply enough power for the motor.

Fig 3: DC Motor[6]

Additionally, Pulse width modulation (PWM), which is more expensive than a DC motor, is also frequently used to control the motor's speed by regulating the amount of power going to it.

6. Buzzer

A buzzer is a gadget that may make simple noises for many reasons, such as alarms, alerts, and notifications, in the context of the Raspberry Pi. The Raspberry Pi's GPIO pins can connect to passive and active buzzers of two different varieties.

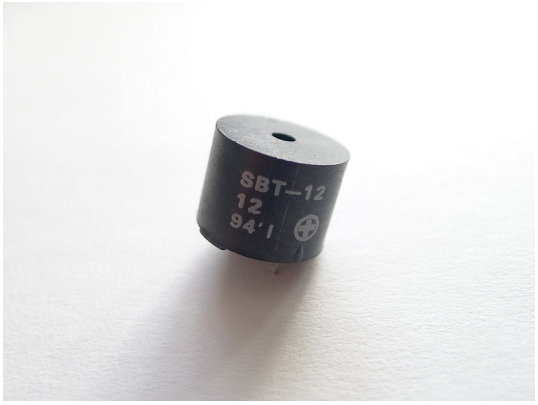


Fig 4: Buzzer [7]

You must import the RPi.GPIO library and establish the specified GPIO pin as an output pin in order to use a buzzer with a Raspberry Pi. The buzzer may then be made to beep by using the GPIO.output() method to set the output to high or low levels for a predetermined amount of time.

7. Motor Driver Module

A motor driver module is an electrical circuit or integrated circuit (IC) that gives a DC motor the necessary power or current for the Raspberry Pi to operate it safely and smoothly. To directly power a DC motor, the Raspberry Pi's GPIO pins' 16mA maximum current per pin is insufficient. To ensure that the motor receives the necessary current, a Motor Driver Module must be used. The Raspberry Pi will be used by the Motor Driver Module to control the motor's direction and speed while the motor is powered by a separate power source.

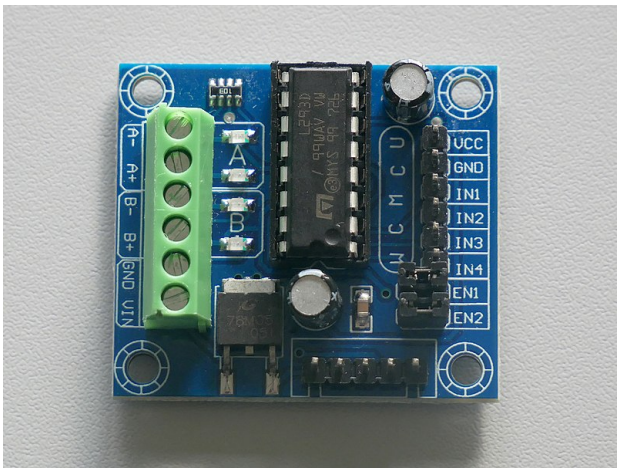


Fig 5: Motor Driver Module [8]

Without a motor driver, connecting a motor directly to a Raspberry Pi risks breaking the device. We'll need a Raspberry Pi, an L293D H-bridge motor driver or an L298N Motor Driver Module, as well as example motor control code, to use a Motor Driver Module with the Raspberry Pi.

8. Jumper Wires

Jumper wires are a typical tool used while working with a Raspberry Pi to create circuits on breadboards. By enabling a more logical and accessible component layout, these wires are intended to make managing the circuitry simpler. It is frequently simpler to connect components since the wires are often cut to precise lengths that fit nicely between two holes on the breadboard.

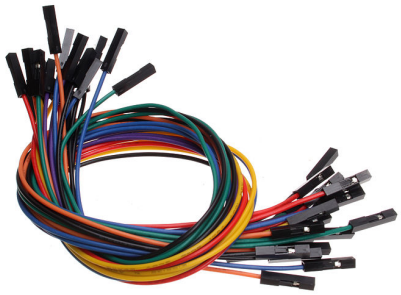


Fig 5: Jumper Wires[9]

Jumper wires are suitable for use with Raspberry Pi because they work at the 3.3V or 5V levels that the board uses. They are commonly available for purchase pre-cut or on spools. Additionally, they may come with connectors already attached, known as jumper wires. When starting with Raspberry Pi, it is recommended to buy a bundle of jumper wires as they make it easier to connect circuits to the GPIO pins.

9. GSM Module

A GSM module is a piece of hardware that enables a Raspberry Pi to connect to the GSM network and use mobile services like SMS messaging and mobile internet. It takes a few steps to connect a GSM module to a Raspberry Pi. The GSM module must first be linked to the Raspberry Pi using either USB or GPIO ports. The Pi must then be set up to detect the module, and the required drivers and software must be installed. When the module is configured correctly, the Raspberry Pi can utilize it to create a mobile internet connection by executing a command like sudo pon a-gsm.

Fig 9: GSM Module[10]

In the absence of Wi-Fi or an Ethernet connection, the Raspberry Pi can use this to access the internet or send SMS messages. Depending on the GSM module being used and the Raspberry Pi's individual configuration, the precise procedures needed to set up a GSM module may change.

10. Serial Module

The Serial module of the Raspberry Pi enables users to interact with other devices via serial communication, a wired method of sending data between two devices.

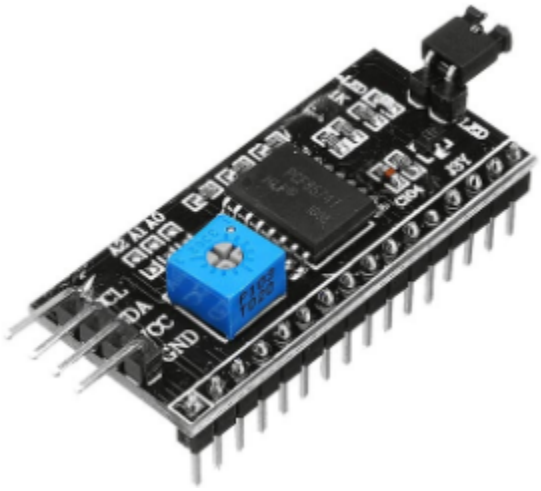
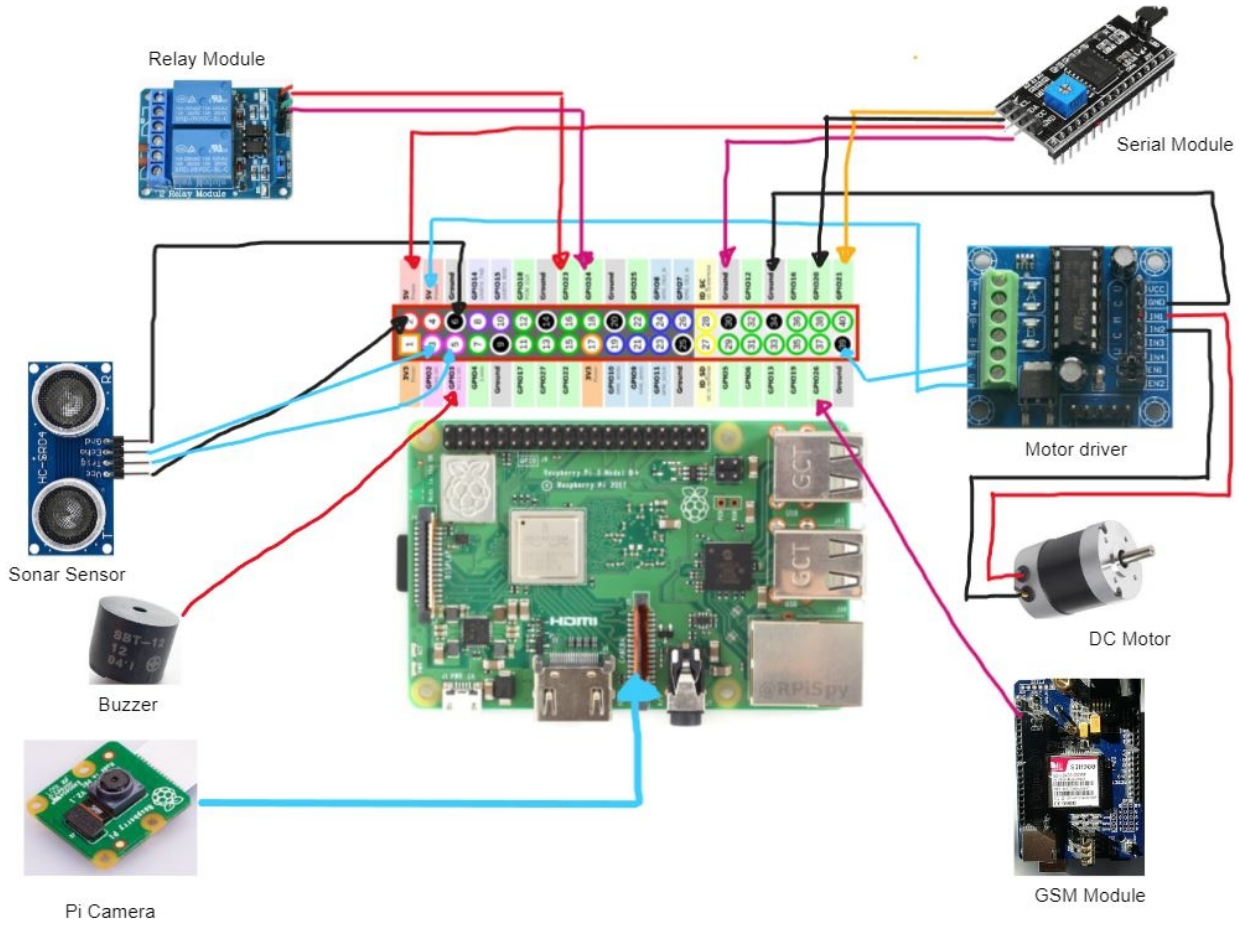


Fig 10: Serial Module[11]

We can connect your Raspberry Pi and an Arduino board using the Serial module in addition to talking with other devices. Depending on your Arduino board, a voltage

level-shifter may be required to establish a serial connection between the Raspberry Pi GPIOs and the Arduino pins using only standard wires.

Connectivity



Firstly, we connected the Raspberry Pi Camera module to the camera slot available in the Raspberry Pi controller board. To connect the ultrasonic sensor, we used GPIO-2 and GPIO-3 pins for the ECHO and TRIG pin connections respectively. The buzzer was connected with the GPIO-3 pin, and it would be enabled HIGH when the ultrasonic sensor detected some unauthorized access to the home security system. Furthermore, the DC motor was connected to the in1 and in2 ports of the motor driver, which controls the speed and direction of rotation of the motor, and also provides sufficient power for the motor to operate.

Results

Component's Name	Quantity	Price(BDT)
Raspberry Pi 4	1	14000
Raspberry Pi Camera	1	4700
Ultrasonic Sensor	2	200
Two Channel Relay	1	200
DC Motor	4	400
Buzzer	4	80
Motor Driver	4	800
Jumper Wires	60	100
GSM Module	1	2000
Serial Module	1	600
Total		23080

Table 1: Components Estimated Costs

The table above shows the estimated cost of the Smart home system will cost around 23000 to 24000 taka. The average cost of home automation is around 96,245 taka [12]. However, it is noted that the cost of a home automation system can vary based on the features and level of integration desired by the homeowner. Our approach for home automation would be significantly less expensive than the average cost of a home automation system which is evident from the cost analysis shown in Table 1. While cost is one important factor, it is also important to consider the features and capabilities of a home automation system.

Apart from the cost our home automation offer the following benefits:

- Use facial recognition features with the help of Pi camera which is a powerful computer vision tool
- Theft detection using ultrasonic sensor
- Alert or notify users using the buzzer
- Notify users via GSM module to our phone as bluetooth or wifi may not always work
- All of our components can be easily assembled
- Automation of doors and fans are easily possible with the use of DC motor

Future Improvements

The cost-effective home automation system using Raspberry Pi is a promising project in the field of home automation technology. The project is aimed at making home automation affordable and accessible to everyone. However, there are a few limitations in this project that need to be addressed in order to make it more efficient and effective. The first limitation of this project is the control range. The Raspberry Pi has limited control range, which means that it cannot control devices that are located far away from the device. This can be overcome by using a wireless communication module like Zigbee or Bluetooth to extend the range of the system [13].

In order to enhance its functionality and usability in the future, we can improve the current compatibility of our system with existing home automation systems. Many homeowners may already have smart home devices running on different platforms, such as Apple HomeKit, Google Home, or Amazon Alexa [14]. Therefore, a future enhancement could be to enable cross-platform compatibility, allowing users to control their Raspberry Pi-based home automation system using their preferred platform. This could be achieved by integrating the Raspberry Pi with other smart home hubs or creating a standalone app that supports multiple platforms.

Furthermore, there are challenges with the integration of different hardware components and software modules. Several software modules are required to make this system work coherently, and some components might not be compatible with each other. This can lead to compatibility issues or system instabilities. To address these challenges, a modular approach can be adopted, where each module is designed to work independently, and components can be swapped out without affecting the overall system [15].

Another area for improvement is the integration of voice control. The current project requires users to interact with the system through a graphical user interface (GUI) or a mobile app. So, integrating voice control would make the system more convenient and user-friendly. The

Raspberry Pi can be programmed to recognize voice commands, enabling users to turn on lights, adjust the temperature or perform other tasks with a simple voice command.

The security measures to protect the system from cyber threats can be improved in the future, if we can expand the scope of our project and focus on implementing robust security mechanisms to safeguard the users' data and privacy. This includes measures such as data encryption, two-factor authentication, and intrusion detection.

Conclusion

In conclusion, the cost-effective home automation system using Raspberry Pi has a lot of potential for the future. With continued development and improvement, this system can revolutionize the way we interact with our homes. However, it is important to address the current limitations of the system in order to make it more accessible and efficient for the mass market. The implementation of the proposed solutions outlined above can help overcome these limitations and facilitate the widespread adoption of home automation technology.

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Contribution

Introduction …….Arman,Azharul

Components……..Fahmid, Rafid

Connectivity…….. Fahmid

Results……..Rafid, Azharul

Future Improvements……Nowshin, Arman

Conclusion……Nowshin

References……..Fahmid, Rafid