Raspberry Pi Projects – Study of Best Fit Wireless Prototypes

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Abstract — Wireless technology has evolved as a practical approach to many ground-breaking technologies over more than a decade of intense research and development. In a complex environment, they handle end devices, capture and interpret data, provide local command and control, and exchange stored and aggregated information. Thanks to its smooth ability to wireless connectivity across the Internet, Raspberry Pi is quite useful for various projects. The Raspberry Pi 3 has Wi-Fi and Bluetooth built-in, and Bluetooth is a prevalent protocol for wireless networking. Using Wi-Fi and Bluetooth, Raspberry devices can pull various tasks that can come in handy in unlikely difficult situations. The 2019 Coronavirus pandemic has taught the world that we need to use wireless technologies in carrying out various tasks. There is no question that this global pandemic is reshaping our everyday lives and how commercial operations are carried out. With the focus on social distancing as an efficient way of curbing the accelerated spread of contamination, many people, organizations, and businesses have had to rely on wireless infrastructure to ensure the quality of service to keep their activities from being shut down. As a result, in this paper, we'll walk through a few standard wireless technologies, and robotics assistance prototyping approaches Raspberry Pi, with the common goal of contactless, cost-effective, and scalable in mind.

Keywords: Coronavirus, Robotics, Wireless Technology, Pandemic, Raspberry Pi

I. INTRODUCTION

There have been significant and profound improvements in our everyday lives and how we perform business operations since the COVID-19 epidemic became a pandemic. If there is one thing that this pandemic has made all realize, technologies that focus on minimum to no contact are the future of the world. With over a decade of intensive research and development, wireless sensor network technology has emerged as a viable solution to many innovative applications [1] [2]. The wireless infrastructure allows two or more people to connect over distances without using wires or cables of any kind [3]. Wireless Network can help its user to interact with its environment and react to real-world events. There are several widely viable wireless technologies on the market at present. In this paper, a comparative analysis of existing standard wireless technology and its construction and use would concentrate on Raspberry Pi solutions. This paper will discuss two wireless prototypes that can be implied to an individual or a sector. One of the great things about Raspberry Pi is that there is no single way to use it. Technologies like a robotic arm, operable from a smartphone or a computer, distance measurement of a high-rise building, or automated assistance to older people who lack help at home or night are some of how wireless technologies paired with Raspberry Pi is being used to solve. Raspberry Pi makes such devices easy to produce and also cuts down on the cost and size of the devices [4].

This research aims to define and present the build and working of Raspberry Pi projects and the abilities of its usage as wireless technology. The remainder of this article is structured as follows. The necessary information about Raspberry Pi is presented in Section 2. Voice Controlled Robotic Assistant for Senior Citizens a prototype project in Raspberry Pi, and Ultrasonic Distance Sensor in a prototype project in Raspberry Pi, in Section 3. Finally, concluding remarks are given in Section 4.

II. RASPBERRY PI

The Raspberry Pi is a lightweight, powerful, inexpensive, hackable, and educational computer board launched in 2012 [5] [6]. (Fig. 1). This multi-performance, affordable credit card-sized machine is the ideal medium for interfacing with multiple gadgets for $25-35 [6]. A processor and graphics chip, a program memory (RAM), and various interfaces and connectors for external devices are included on the Raspberry Pi board [7] (Fig. 1). Some of these devices are necessary, others are optional, but all Raspberry Pi models have the same BCM2835 CPU, which is inexpensive, efficient, and does not consume a lot of energy. The Raspberry Pi also utilizes an operating system like any other computer.

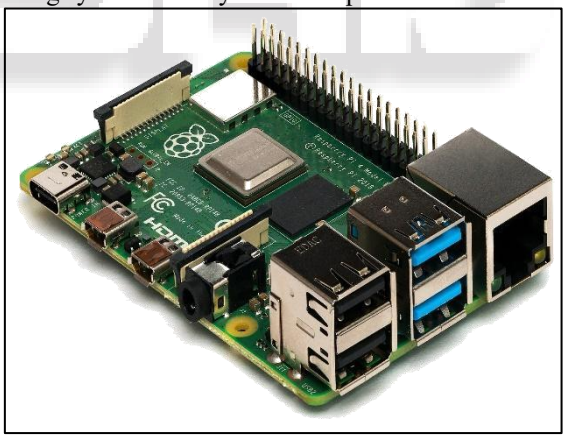

Fig. 1: Raspberry Pi 4 Model B

The fact that it has a large spectrum of applications is one of Raspberry Pi's best things. The sensor node's physical size and cost influence the ease and cost of implementation dramatically and directly. The ease of network distribution is influenced by physical scale so that smaller nodes can be put in more places and used in more situations. The processing of data from as many locations as possible is one of a network's key priorities. Table I provides a comparison of the scale, weight, and cost of the standard Raspberry Pi and wireless sensor node versions.

Name	Size (mm)	Weight (g)	Cost per node (US$)
Raspberry Pi	85.6 * 53.98 * 17	45	25-35
MicaZ	58 * 32 * 7	18	99
TelosB	65 * 31 * 6	23	99
Iris	58 * 32 * 7	18	115
Cricket	58 * 32 * 7	18	225
Lotus	76 * 34 * 7	18	300

Table 1: The Comparison of Size, Weight, And Cost

The values are given in Table 1 illustrate that Raspberry Pi's superiority over other systems lies in its lowest price per device.

III. PROTOTYPES

In this section, we study three different Raspberry Pi prototype projects that use wireless technologies in some way or another [14]. We take a look at the build of the prototypes and understand the working of the prototype.

A. Voice Controlled Robotic Assistant

A robotic arm resembles a human arm, and a robotic arm can perform various intrinsic tasks. The most significant advantage that robotic assistance provides is working in a hazardous area, or it can be used when an actual human is unavailable at the desired location. A voice-controlled robotic arm is simple and helps the user control the robot with a high level of abstraction from the robot, making it seamless to operate at times. Senior citizens and physically challenged people will need assistants most of the time, even for small tasks like getting water, food, and clothes. To assist senior citizens and the physically challenged, a robotic assistant car controlled with a voice command using Raspberry pi can come in handy [8]. A robotic arm using a Bluetooth connection between a phone and raspberry pi can be controlled through a voice command feature. Using a Bluetooth app installed on the phone, we can connect to the python code running in raspberry pi interfaced to the robot arm [9]. By sending signals from the phone to raspberry pi, we will move the robot arm. Table 2 lists down the build of the prototype voice-controlled robotic arm.

Components Name	Quantity	Description
Raspberry Pi 4 with 32GB Micro SD Card	1	1GB or 2GB RAM
DC-130 Motor	4	DC Gear Motor
5V Output Power Bank	1	Two USB Outputs: 5V, 2.1A / 1A
Breadboard	1	Small Size
Breadboard Power Supply Board	1	5V Output
Microphone	1	—
Speaker	1	—
Plastic Car Tire Wheel	4	—
Universal Wheel	2	—
6DOF Robot Arm with Servo Motor	1	Pre-assembled 6DOF robot arm considered for this project
Android Smartphone	1	—

Table 2: Build Of Voice Controlled Robotic Arm

IV. SYSTEM INTERFACE

The robot car with the robot arm is connected to Raspberry Pi 4. The Raspberry pi has inbuilt Bluetooth. By writing a Bluetooth server program at raspberry pi, we will always listen for incoming connections. Using a smartphone will send our voice command [8] [9]. Figure 2 depicts the system diagram of the robotic arm.

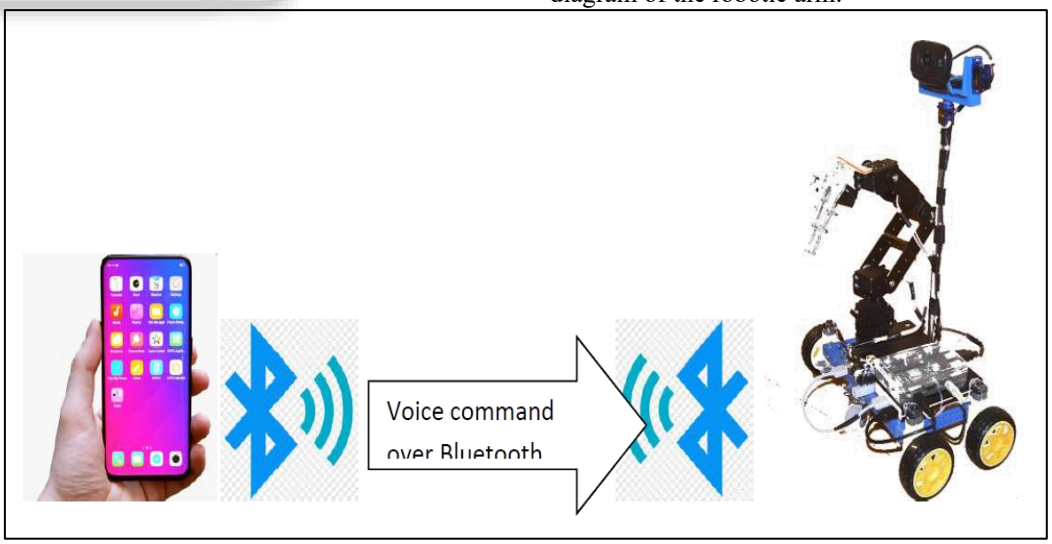

Fig. 2: System Interface Diagram

A. Software

The design implements two software modules. The first module is server-side python code to receive data from the phone. The second module is a client-side application installed on the phone to send voice commands to the robot arm. Server-side python code combines Bluetooth socket program and driver code to drive servo motor and DC-130 motors. Server code waits for incoming connections. Once the connection is established its waits for the control voice commands and sends signals to each motor according to the voice command received. When connected to raspberry pi,

the Bluetooth application can send an order to the robotic arm. The robotic arm acts following the voice command it receives via the application.

B. Ultrasonic Distance

Civil engineers and architects need to provide distinct methods that do not require human intervention to quantify distances between the walls of the room and the building's height. They may use sensors to calculate distance instead of using concrete equipment like measuring tapes. The ultrasonic distance sensor that uses ultrasonic sound (high-frequency radio waves) to measure distance is one solution. The proposed prototype describes a distance measurement system that uses an ultrasonic distance sensor and a Raspberry pi 4B microcontroller-based system. This Raspberry pi microcontroller is readily available at a low cost—table 3 lists down the build of a prototype Ultrasonic Distance Sensor.

Components Name	Quantity	Description
Raspberry Pi 4 with 32GB micro SD card	1	1GB or 2GB RAM
Ultrasonic distance sensors	1	HC-SR04 is an ultrasonic sensor
5V out Power bank	1	Two USB Out: 5V, 2.1Amp, 1Amp
Breadboard	1	Small size
Resistors	2	1k/2k
Jumper wires	4	Male to female jumper wires

Table 3: Build of Ultrasonic Distance Sensor prototype

C. Hardware Build

HC-SR04 is an ultrasonic distance sensor used to measure the distance from the target object. This tests the distance between the object and itself. The gap is calculated using non-contact technology. There is no physical interaction between the sensor and the target. Using ultrasonic sound waves, the distance between oneself and an object is determined. It is used to estimate lengths between 2cm and 400cm with a precision of 3mm.

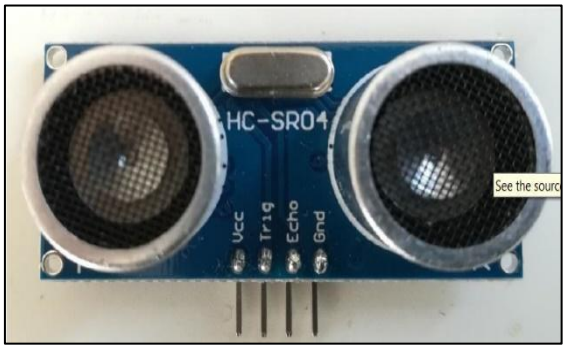

Fig. 3: Ultrasonic Distance Sensor

There are a transmitter and a receiver for the HC-SR04 ultrasonic distance sensor. The transmitter transmits an ultrasonic signal, and the receiver receives an ultrasonic signal. The ultrasonic distance sound property is that if an object or barrier is in front of the sensor and the signal is transmitted out of the transmitter, it will go and hit the item in its direction and reflect it to the sensor receiver as echo signals [10].

D. Working

The transmitter in the Ultrasonic Sensor emits an ultrasound of 40 kHz. To send out a pulse for a minimum time of 10µS, the TRIG Pin of the Ultrasonic Sensor must be HIGH, so 10µS is the length of the ultrasonic sound wave. If the signal reaches the transmitter, it propagates through the air, and the signal strikes the obstacle and bounces back if there is any obstruction in its way. The Ultrasonic Detector then absorbs this bounced signal. You can measure the object's distance since the speed of sound is already understood based on the time taken by the signal to transmit, reach the barrier, and receive back to the receiver [10].

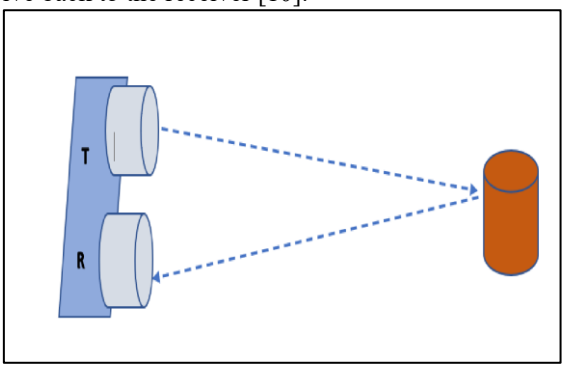

Fig. 4: Transmitter and Receiver in an Ultrasonic Sensor.

V. Conclusion

The above-performed prototypes have shown that Raspberry Pi is an ultra-cheap and available computer board besides its power consumption issue. It allows the ideal platform for interfacing with several different devices. It uses a wide variety of applications, with support for a vast number of input and output peripherals and network connectivity[11][16]. It can connect remotely by combining it with wireless technologies. It paves the way for working on models that could prove to be helpful in many future applications.

References

[1] S. a. X. L. Ferdoush, "Wireless sensor network system design using Raspberry Pi and Arduino for environmental monitoring applications," Procedia Computer Science , vol. 34, pp. 103-110, 2014.

[2] I. B. F. G. R. C. N. M. M. &. P. P. Khan, "Wireless sensor network virtualization: A survey," IEEE Communications Surveys & Tutorials, vol. 18, no. 1, pp. 553-576, 2015.

[3] Prakash Kanade, Divya Kumar, Ghatwal Shama, Sunay Kanade, Shetty Chirag, "Raspberry Pi based Automated Garden Sprinkler System with Integrated Weather, Humidity, and Soil Moisture Monitoring," International Research Journal of Engineering and Technology (IRJET), vol. 12, no. 12, Pages. 728-736, 2025, doi: 10.5281/ZENODO.21940827.

[4] J. A. E. H. C. a. R. L. B. Gutierrez, "Low-rate wireless personal area networks: enabling wireless sensors with IEEE 802.15. 4," IEEE Standards Association, 2004.

[5] Prakash Kanade, Prajna Alva, "RASPBERRY PI PROJECT – ULTRASONIC DISTANCE SENSOR IN

CIVIL ENGINEERING," International Journal in IT & Engineering (IJITE), vol. 8, no. 10, Pages. 1-6, 2020.
[6] S. J. a. S. J. C. Johnston, "The raspberry Pi: A technology disrupter, and the enabler of dreams," 2017.
[7] V. a. M. M. Vujović, "Raspberry Pi as a Wireless Sensor node: Performances and constraints," 37th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO). IEEE, pp. 1013-1018, 2014.
[8] M. a. S. W. Richardson, Getting started with raspberry PI, 2012, O'Reilly Media, Inc.
[9] V. a. M. M. Vujović, "Raspberry Pi as a Sensor Web node for home automation," Computers & Electrical Engineering , vol. 44, pp. 153-171, 2015.
[10] Sunay Kanade, Prakash Kanade, "Raspberry Pi Project – Voice Controlled Robotic Assistant for Senior Citizens," International Research Journal of Engineering and Technology (IRJET), vol. 07, no. 10, Pages. 1044-1049, 2020.
[11] Prakash Kanade, Sunay Kanade, "Medical Assistant Robot ARM for COVID-19 Patients Treatment – A Raspberry Pi Project," International Research Journal of Engineering and Technology (IRJET), vol. 7, no. 10, Pages. 105-111, 2020.
[12] David Baker, (15 August 2013). How ZigBee Compares in Wireless Home Automation, [ONLINE] Available: http://www.control4.com/blog/2013/08/how-zigbee-compares-inwireless-home-automation
[13] Haghighi, M., & Cliff, D. (2013, May). Sensomax: An agent-based middleware for decentralized dynamic data-gathering in wireless sensor networks. In Collaboration Technologies and Systems (CTS), 2013 International Conference on (pp. 107-114). IEEE.
[14] John Donovan, (24 May 2012) Security Issue with Wi-Fi, Bluetooth, and ZigBee [ONLINE] Available: http://www.digikey.com/enUS/articles/techzone/2012/may/security-issues-with-wifi-bluetooth-andzigbee.
[15] A. Alarcón-Paredes, V. Francisco-García, I. P. Guzmán-Guzmán, J. Cantillo-Negrete, R. E. Cuevas-Valencia, and G. A. Alonso-Silverio, “An IoT-based non-invasive glucose level monitoring system using Raspberry Pi,” Applied Sciences, vol. 9, no. 15, Jul. 2019, doi: 10.3390/app9153046.
[16] J. Arshad, “Intelligent greenhouse monitoring and control scheme: An arrangement of Sensors, Raspberry Pi based embedded system and IoT platform,” Indian Journal of Science and Technology, vol. 13, no. 27, pp. 2811–2822, Jul. 2020, doi: 10.17485/IJST/v13i27.311

