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***Abstract*— Technology advances at an exponential rate, resulting in a significant improvement in our living standards. It is extremely close to us, which is why we must take advantage of it because these changes imply the ability to continue progressing in any area. This project shows how a Raspberry Pi minicomputer may be used to control a Brushless motor and propeller. Thus, a system has been developed for controlling punctual angular locations, given a specific menu, and for stabilizing said positions even in the presence of external disturbances, by adjusting the rotational speed of a Brushless motor through changes in the percentage of a signal pulse width PWM. The controller and data collecting was programmed using the Thonny development environment, which is based on the Python programming language. The results of the implementation suggest that using a low-cost minicomputer, as a control device is beneficial.**

Keywords—Raspberry PI 4B, DC Motor, L298N, Python, the driver circuit, speed control, direction control.

I. INTRODUCTION

Microcomputers such as the Commodore 64 and the ZX Spectrum grew at educational institutions during the 1980s, allowing teachers to teach programming concepts in Basic and allowing them to be easily replaced due to their low cost. Prohibitively costly PCs and difficult-to-reprogram gaming consoles halted the trend in the 1990s, and it was exacerbated with the introduction of smartphones and tablets, which are entirely closed devices. The figure of (Eben Upton), a former University of Cambridge professor who created and launched the Raspberry project, appeared during this time[1]-[6].

The Raspberry Pi Foundation, better known as (RPi), created a small credit card-sized computer in 2006 to encourage the teaching of computer science in schools all around the world. A project centred on education that has grown to all fields, eventually reaching the daily with the simple creation of an app. This computer has a lot of features at a modest price of around €35. Because there is no power cable, box, or hard drive, an SD memory card is used. However, we may attach other peripherals such as a mouse, keyboard, monitor, and, if we need more storage memory, an external hard drive, to create a computer that is practically identical to the one we have at home, albeit with some limits.

Models A and B of the Raspberry Pi share several characteristics, including the chip, graphics processor, inputs/outputs, and the ability to play video in 1080p resolution. It should be noted that the Model A is not widely available. Model B contains double the memory (512 MB vs. 256 MB in Model A), two USB ports (vs. one in Model A), and a network cable connector. It has a processor that runs at 700 MHz. It can also accelerate 3D graphics using hardware, which means it may be compared to computers that first appeared on the market in 2003, but with a significant difference in size, weight, and energy consumption (which is 80 times lower)[7]-[10].

In this paper, we'll learn about PWM and how to control the speed and direction of a DC motor utilizing a special tool called a motor driver chip. A graphical user interface, speed measurement, error detector, PID controller function, and PWM generation function are all included in the DC motor controller application. The L293D motor driver IC is a low-power current amplifier that converts the Raspberry Pi's low-current control signal into a comparable high-current signal capable of controlling the motor. The L293D amplifies our low current Raspberry Pi control signal into a high current signal to drive the motor, which is why it's called an amplifier.

The next step is to use a Python script and a GPIO header on the Raspberry Pi to operate the DC motor, which will help us visualize how the robot functions. We'll use Python to develop an executable script because we'll be controlling the speed of the DC motor with a Raspberry Pi. The DC motor starts rotating back and forth after we run the Python program with the RUN command. Starting at +12V, the current will flow through the coil, which is the motor coil, and the motor will run merrily without stopping[11]-[16]-.

A DC motor requires a large current surge to move, so the motors must be powered by an external power supply from the Raspberry Pi. A DC motor cannot be connected to the microcontroller because the output current of the microcontroller is very small and it cannot control the motor.

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Almost all types of DC motors have an internal mechanism, electromechanical or electronic, to periodically reverse the direction of current in a part of the motor.

This paper includes a basic overview of the Python Control Programming Language's programming syntax as well as full instructions for connecting DC motors to a Raspberry Pi board. We also learned how to wire our circuit and write a Python program to verify the signal for our small motor.

This work aimed to design and implement a low-cost DC motor control circuit for researcher students.

The rest of the paper is organized as follows: Section 2 presents the relevant related research, Section 3 presents the hardware and software required for this paper, Section 4 discusses the practical hardware and software system results, and finally, Section 5 presents conclusions and suggests further work

II. Related Work

This section examines the system that was created and compares it to some comparable work in the same field (DC motor controller), such as studies that used different methodologies, such as different types of microcontroller types control and monitoring systems. The devices utilized in other proposals in this area are listed in Table I.

TABLE I. List of related works

Name Of Authors	*Type of microcontroller*	*Types controller*
Xu Hu, et al [17]	Arduino Mega	Switches
Huda M. Abdul Abbas, et al [18]	FPGA	Switches
Nurshahirah Shaharudin, et al [19]	Arduino UNO	Mobil application
Ademola Abdulkareem, et al [20]	PIC18F452 Microcontroller	PC
Rajesh Singh, et al [21]	8051 Microcontroller	Simulation
Khac-Khiem Nguyen, et al [22]	Matlab Simulink	PC
Fredy E. Hoyos, et al [23]	dSPACE DS1104	PC
Othman Bensaoud, et al [24]	PICAXE	Variable resistance

III. Hardware system required

A. Raspberry Pi 4B [25]

Raspberry Pi is a credit card-sized embedded computing system that works with a regular monitor or TV, mouse, and conventional USB keyboards; it is capable of performing any activity expected by a common desktop computer, from accessing the web and watching high-definition films to spreadsheets and word processing to video games.

Raspberry Pi 4B (Fig. 1) has the following hardware for its operation: A SoC (system on chip) is an integrated that incorporates all the components of the system. In the case of the Raspberry Pi, it has a Broadcom BCM2835 that includes: the processor (ARM1176JZF-S), the graphics card with 3D graphics, high definition video acceleration, 512 Mb of RAM, a stereo sound card, and a USB bus. A Network Card, RJ-45 Connector connected to an integrated SMSC lan9512 -jazz that provides 10/100 Mbps connectivity. Output Ports, two USB buses, SD memory input port, analog stereo audio output by jack 3.5 mm, HDMI digital video + audio output, RCA analog video output, general-purpose input, and output pins [6].

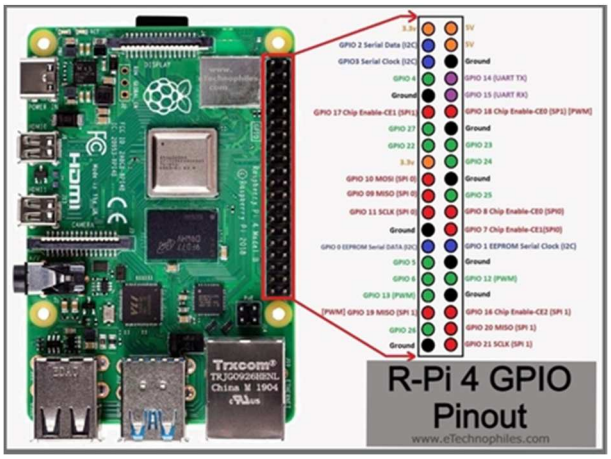

Fig. 1. Raspberry Pi 4B pinout [25].

B. L298N Motor Driver [26]

The L298N is a dual H-bridge motor driver that can regulate the speed and direction of two DC motors at the same time. The L298N Motor Driver Module is built on an H-bridge configuration (an H-bridge is a simple circuit that allows us to control the movement of a DC motor forward or backward). The L298N motor driver contains two screw terminal blocks for motors A and B, as well as many screw terminal blocks for the ground pin, motor VCC, and a 5V pin that can be input or output.

The L298N motor controller in Fig 3, as previously stated, has four inputs, which correspond to the four switches in the H-bridge figure above. There are two sorts of control contacts for each of the major channels that allow us to regulate the speed and direction of rotation of DC motors at the same time, viz. We can check whether the motor is rotating forward or backwards using the direction control pins. We can adjust the speed of motor A by removing the 5V jumper and attaching this pin to the PWM input. The direction of motor A is controlled by pins IN1 and IN2.

It regulates the motor speed by turning on and off quickly using PWM. When I say DC motor control, I'm referring to the ability to start, stop, rotate forward, reverse, increase, and reduce the rotation speed. Finally, we just transfer the motor's ultimate speeds or the PWM signal to the microcircuits to enable pins. The speed of a DC motor can be adjusted by sending a PWM signal to the enable pin of the L298N motor driver, as we saw earlier.

C. DC Motor [27]

A typical DC motor (Fig. 4) has two connecting wires, one for the negative and one for the positive. The three-terminal input circuit of the single-phase AC motor direction control relay is connected with a DC control signal, and two terminals are used to control the forward and reverse rotation of the single-phase bidirectional AC motor.

The direction of motor rotation can be controlled by applying HIGH (5V) or LOW (ground) logic to these pins. The speed controllers deliver periodic pulses to the motor, which, when paired with the smoothing effect generated by the coil's inductance, cause the motor to behave as if it were driven by a lower/higher voltage. To prevent sudden changes in direction, you need to import the Rate Limiter class, which slows down the sudden change in the direction mentioned above by introducing a ramp principle that gradually speeds up or slows down the speed of the motor, determined by the potentiometer.

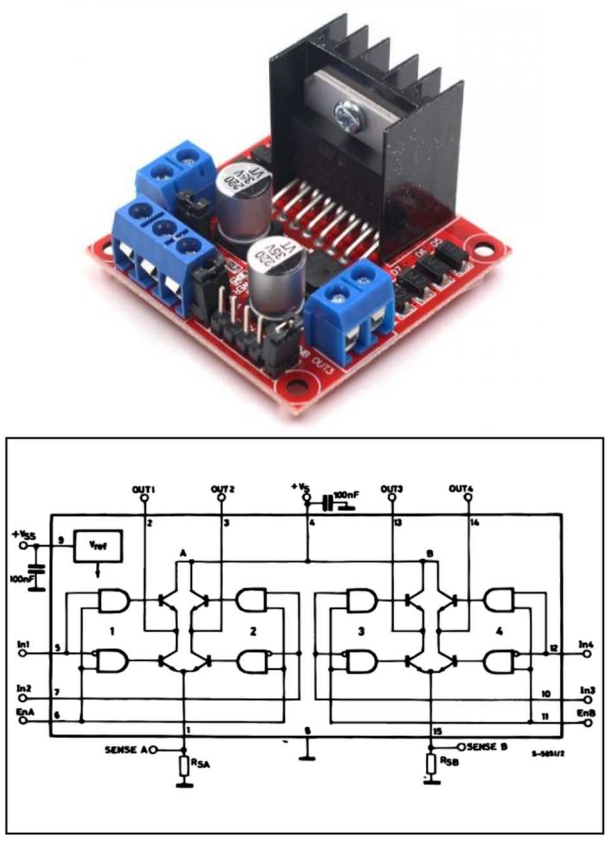

Fig. 2. L298N DC Motor Driver Circuit [26].

D. Python language [28]

Python is an interpreted programming language whose philosophy emphasizes a syntax that favours readable code. It is a meta paradigm programming language since it supports object orientation and structured programming. It is an interpreted and cross-platform language.

It is administered by the Python Software Foundation, and is licensed under an open-source license, called the Python Software Foundation License,1 which is compatible with the GNU General Public License as of version 2.1.1, and incompatible with certain earlier versions.

After the analysis of the aforementioned programming languages, the decision has been made to choose the so-called Python for the development of this work. It has been decided to use this programming language mainly due to:

1. It has the necessary characteristics to carry out the work that we are going to develop.
2. Its language can be considered familiar in the system controller and any hardware interfacing since it has been the main programming language used throughout the world.

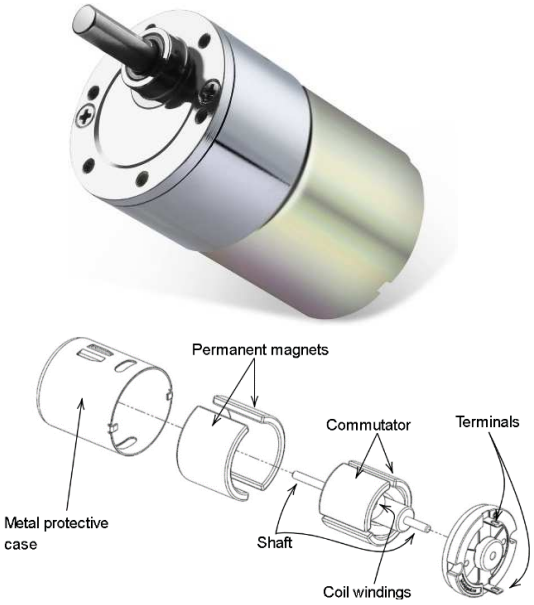

Fig. 3. The brushless DC motor is in its conceptual form [27].

IV. Full System Design and Results

We will utilize a technique known as Pulse Width Modulation to control the speed of a DC motor. In simple words, PWM refers to the ability to adjust the length of time that a voltage is high on a given pin. The duty cycle is the amount of time that the signal remains high, and it determines what percentage of power is given to the motor. As a result, this will control the speed of a DC motor in a non-resistive or without any form of power dissipation manner. The animated gif below will show you what PWM is and how it works.

One of the L293D's best advantages is that it can control two motors independently, each of which can run at different speeds or directions. Using just this one IC, you can quickly build a two-wheeled robot that can pivot, move forward, and move backwards.

The project's circuit wiring schematic is presented in Fig. 4. With the Raspberry Pi 4B and the L293D Motor Driver IC, we can quickly create this circuit and program it to operate two DC motors.

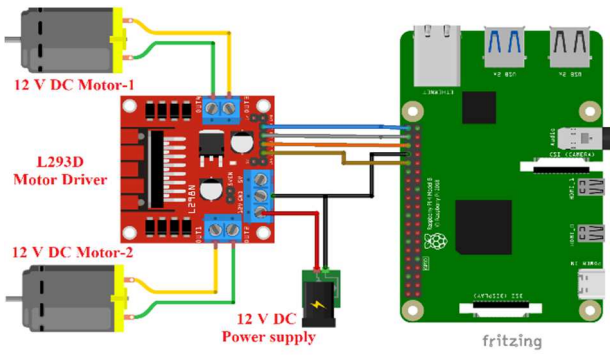

Fig. 4. Full schematic circuit for the proposed system.

The flowchart shows how to control through the program interface (Fig.5) and how to control by pressing the ON/Off key. After that, the required speed is determined for each motor alone. After that, the direction of rotation is determined by pressing one of the direction-setting keys, either clockwise or counterclockwise.

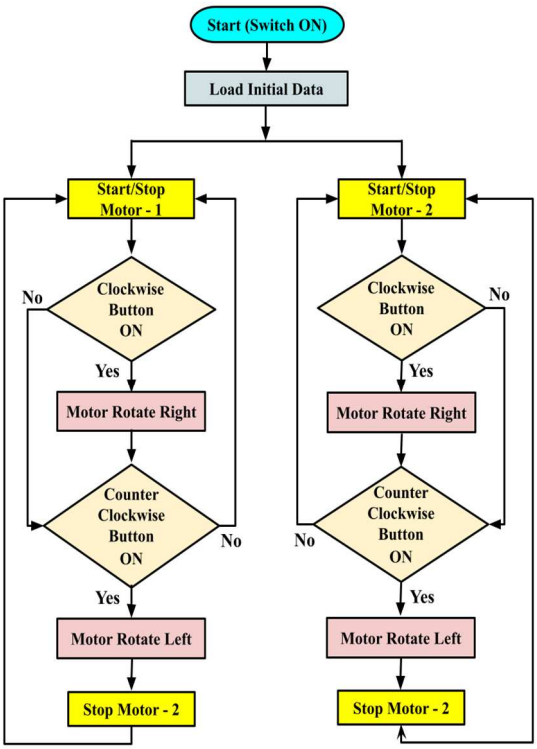

Fig. 5. The flowchart for the proposed system.

The GUI window in Fig. 6 represents the main interface during operation and shows how the speed is determined for the two motors and the control keys can be seen in the direction of the two motors (clockwise or counterclockwise).

Fig.7 depicts the final DC motor hardware system, which consists of four components: (1) the Raspberry PI 4B kit, (2) the L298N DC motor driver circuit, (3) two DC Motors (12V0), and (4) a 12V DC power supply. Fig. 7 depicts the connectivity of all components and how they operate together to provide data, as well as the GUI used for the controller.

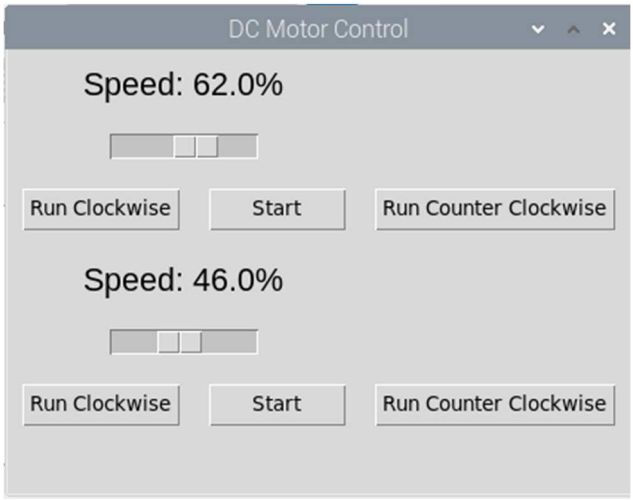

Fig. 6. The GUI window for the proposed system.

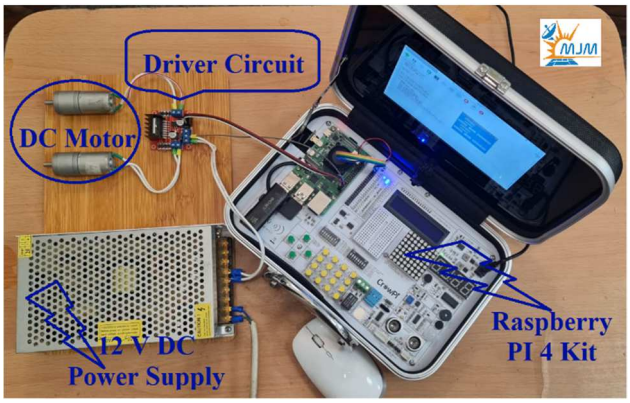

Fig. 7. Final hardware circuit for the proposed system.

V. CONCLUSION

Microcontrollers are now widely used to execute a wide range of activities in engineering and technology, thanks to the growth of microcontrollers and the concurrent increase in demand for new technology. In this paper, the authors' goal is to provide a basic grasp of Raspberry PI 4B programming and its use for operating a DC motor using a python-based GUI interface window. The Raspberry Pi 4B is capable of running and controlling a 12V DC motor with high torque using the motor driver L293D with very good results. Although it involves the use of GPIO pins and the RPi 4B module, the control technique is written in the Python programming language. The main program must contain the GPIO module. Finally, this research concludes that using a GUI to offer the control of a DC motor is possible. By writing simple lines of code, A GUI may be used to adjust the rotational directions as well as the speed of rotation. The GUI is generated with the Python programming language and coupled with the Raspberry Pi board.

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