

Review on Motion Control of Departmental Information Robot

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Abstract

The design and development of a departmental information robot using a differential drive system is presented in this work. To offer interactive user support, the system combines voice control, mobile application control, and simple robotic motions. A three-wheel setup is used to accomplish the motion system, with two wheels powered by DC motors and the third serving as a passive caster for stability. By regulating the driving wheels' speed and direction, the robot may go forward, backward, turn, and rotate. The suggested design maintains efficient motion while being more straightforward, economical, and controllable than intricate omnidirectional systems. The findings show that the suggested system provides a dependable and affordable option for departmental and academic support applications.

Keywords: Stepper Motor Driver, Wheel Mechanism, Mobile Robots, Arduino Uno, DRV8825 motor driver.

INTRODUCTION

Mobile robots have become increasingly important in a number of industries, including healthcare, education, business, and services. These robots help people by completing chores quickly and offering interactive assistance. Robots are becoming increasingly intelligent, user-friendly, and multifunctional thanks to developments in embedded systems and artificial intelligence. A departmental information robot is a type of service robot that is intended to offer assistance, information, and interaction in institutional settings like offices and universities. A mobile robot's mobility system is one of its most crucial components since it dictates how well it can traverse. There are numerous motion mechanisms, such as differential and omnidirectional drive systems. Although they provide versatile movement, omnidirectional robots are expensive and complicated. A differential drive system is employed in this work to strike a compromise between performance and simplicity. The robot's three

wheels allow it to go forward, backward, turn, and rotate. Two of the wheels are powered by DC motors, while the third wheel serves as a passive caster for stability. The goal of this project is to create a departmental information robot that is both effective and easy to use, with dependable mobility and interactive features. The suggested system shows that realistic solutions for real-world academic applications can be obtained with a straightforward and affordable design.

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LITERATURE REVIEW

Numerous studies have been conducted on mobile robot navigation, particularly in wheeled robotic systems. Omnidirectional and differential drive systems are popular motion mechanisms.

Omnidirectional robots are highly flexible and may move in any direction. They usually have three independently driven wheels. Nevertheless, these systems need several actuators and intricate control. Three-wheeled omnidirectional robots, in which each wheel is driven by a different motor to enable multidirectional mobility, have been examined in a number of research. Even while these designs provide greater mobility, they are more expensive and need intricate kinematic modelling. In certain setups, the third wheel serves as a passive support for stability when only two wheels are actively pushed. Omnidirectional robots offer great versatility and can move in any direction. They usually have three independently driven wheels. Nevertheless, these systems need several actuators and directional robot's intricate control. Three-wheeldomini, in which enable multidirectional mobility, have been examined in a number of research. Even while these designs provide greater mobility, they are more expensive and need intricate kinematic modelling. In certain setups, the third wheel serves as a passive support for stability when only two wheels are actively pushed. This preserves basic motion capabilities and balance while lowering complexity. Differential drive systems are therefore favoured for straightforward and useful applications because of their ease of control, reduced cost, and dependable performance in fundamental movements including forward, backward, turning, and rotating.

Components ESP32

A popular system-on-a-chip (SoC) microcontroller for embedded and Internet of Things applications, the ESP32 (Figure 1) is inexpensive and low-power. It was chosen for this project because of its strong computing power, built-in wireless connection capabilities, and adaptable input/output ports. A dual-core Tensilica Xtensa LX6 processor with a clock frequency of up to 240 MHz powers the ESP32, allowing for effective real-time computing. It has integrated Bluetooth (Classic and BLE) and Wi-Fi (802.11 b/g/n) compatibility, enabling smooth wireless communication for data exchange and mobile application control. The microcontroller can be used to control motors, sensors, and other external devices because it has a variety of peripheral interfaces, such as GPIO pins, UART, SPI, I2C, PWM, and ADC channels. It improves energy efficiency in battery-operated systems by operating at a voltage of 3.3V and supporting several power-saving modes. Furthermore, the ESP32 has an adequate memory configuration with support for external flash and SRAM, enabling the execution of intricate control algorithms and multitasking tasks. The ESP32 functions as the core control unit for the robot's mobility system, voice command processing, and communication modules because of these features.

DRV8825 Stepper Motor Driver

Texas Instruments created the DRV8825 Stepper Motor Driver (Figure 2), a motor driver integrated circuit intended to regulate bipolar stepper motors in embedded systems. It facilitates accurate motion and effective current control by acting as an interface between a high-power stepper motor and a low-power microcontroller.



Figure 1. ESP32.

As long as proper thermal management is maintained; the device can deliver up to about 2.2 A per coil while operating within a supply voltage range of 8.2 V to 45 V. It regulates current using a pulse-width The DRV8825 improves motion smoothness and positional precision by supporting several micro stepping resolutions, such as full step, half step, and up to 1/32 step. The motor may be controlled via a straightforward digital interface made up of STEP and DIR signals, which makes it compatible with microcontrollers like the Arduino Uno and ESP32.

To ensure safe and dependable operation under a variety of circumstances, the driver also includes a number of protection features, such as thermal shutdown, undervoltage lockout, and over current protection. The DRV8825 is extensively utilized in robots, CNC machines, and 3D printing systems because of its small size, simplicity of interface, and sophisticated control features.

JK42HS60-0406StepperMotor

Precision motion control systems use the JK42HS60-0406 (Figure 3), a NEMA 17 hybrid bipolar stepper motor, as their main actuation component. Because of its capacity to transform electrical pulse signals into distinct mechanical movements, it is ideal for applications that call for precise placement and consistency.

With a step angle of 1.8° , or 200 steps per revolution, this motor allows for fine angular resolution without requiring a feedback system. It uses two phases and a specialized driver circuit to regulate the direction of current flow via the windings because it is a bipolar stepper motor. With a holding torque of about 0.6–0.65 Nm, the JK42HS60-0406 usually runs at a rated current of about 0.4 A per phase, ensuring stable operation under moderate load situations. It is appropriate for embedded and space-constrained systems because to its tiny design and 42 mm frame size (NEMA 17 standard).

In this project, controlled stepping enables exact mechanical component location through the use of a stepper motor for precise rotational or linear motion control. A stepper motor driver, which creates the necessary pulse sequences for motion control, interfaces the motor with a microprocessor.



Figure 2. DRV8825 stepper motor driver.



Figure 3. JK42HS60-0406 stepper motor.

Wheel Mechanism

The proposed robotic platform's wheel motion mechanism (Figure 4) is based on a differential drive configuration that consists of two driving wheels and one castor wheel. The two primary wheels are connected to stepper motors, which generate the robot's motion, while the castor wheel supports and stabilizes the chassis. This configuration enables the robot to achieve directional movements efficiently while maintaining balance during operation. In the proposed system, the wheels' rotation is controlled using a microcontroller-based motor control system; the stepper motors receive control signals through motor drivers, allowing for precise control over wheel rotation and direction. Through motor drivers, the stepper motors receive control signals that allow for accurate wheel control. direction and rotation. The robot can travel in a variety of ways, including forward, backward, left, and right turns as well as full rotation, thanks to the differential wheel driving mechanism. Due to their ease of use and efficient navigational capabilities, similar wheel-based motion systems have been extensively employed in mobile robotic platforms [1, 2]. Controlling the left and right wheels' independent rotation determines the robot's movement. The robot advances when both wheels rotate at the same speed and in the same direction. The robot turns to the right if the left wheel rotates while the right wheel slows down or stops. direction. Similarly, the robot turns left when the left wheel slows down and the right wheel rotates [2]. By turning the two driving wheels in opposing directions, the robot can also complete a 360-degree rotation [3-6].

SOFTWARE IMPLEMENTATION

The C++ programming language is used in the ESP32 development to implement the robot's control systems surroundings. The ESP32 microcontroller's software is in charge of producing the control signals needed to run the stepper motors via the motor driver module. The DRV8825 motor driver, which regulates the stepper motors' rotation, receives step and direction signals from the ESP32. regulates the stepper motors' rotation [7-10]. The software controls the robot's mobility by adjusting the number of steps and rotational orientation. The robot can move in a variety of directions, including forward, backward, rotating, and turning, thanks to the independent operation of its left and right motors. The software is made to precisely time and regulate the stepper motors, guaranteeing the robot moves smoothly and steadily. Voice command control and mobile application-based control are two further capabilities that can be added to the control method [11-13].



Figure 4. Wheel mechanism.

CONCLUSION

The design and development of a departmental information robot based on a three-wheeled differential drive system, incorporating contemporary embedded technologies and AI-enabled processing, is presented in this study. The suggested robot can react to voice commands, mobile application inputs, and simple robotic actions thanks to its intelligent mobility and interactive user support. With two motorized wheels and a passive caster wheel, the differential drive design offers a reliable and effective locomotion system that permits rotating, forward, backward, and turning motions. Unlike more complicated omnidirectional robots that need several actuators and intricate kinematics, our straightforward design guarantees cost-effectiveness and ease of control. The robot's accuracy, dependability, and real-time performance are enhanced by the choice of hardware, which includes ESP32, DRV8825 stepper motor drivers, JK42HS60-0406 stepper motors, and NVIDIA Jetson Nano. Peripheral interfacing, wireless connection, and motor control are handled by the ESP32 microcontroller, and real-time data analysis and intelligent decision-making are made possible by the Jetson Nano's high-performance AI processing. The robot travels smoothly and responsively in its surroundings thanks to motor drivers and stepper motors, which translate processed data into precise mechanical motion. The combination of these elements shows how embedded AI platforms can greatly improve the performance of inexpensive robotic systems. Differential drive systems provide an ideal mix between performance and simplicity for indoor service robots, as demonstrated by a review of the literature and system implementation. Although omnidirectional systems offer more versatility, they are more costly and difficult to operate. The suggested design is perfect for departmental and academic support jobs, such as providing information, directing guests, or offering interactive assistance in office or campus settings, because it maintains crucial mobility functions while lowering complexity. Overall, the study demonstrates that commercial embedded systems and AI platforms can be used to create inexpensive, energy-efficient, and intelligent mobile robots. The suggested robot is an example of how dependable, interactive, and autonomous functionality can be achieved by combining effective hardware, AI processing, and straightforward mechanical design. By adding sophisticated computer vision, autonomous navigation, and multi-robot coordination, future research can build upon this design and improve the robot's capacity for more difficult service jobs and wider applicability in institutional and educational settings.

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