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NAVIGATING ROVER ON A PRE DEFINED PATH FOR INDUSTRIAL APPLICATION

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ABSTRACT:

In Industry for material transport predefined paths are provided with signs, speed limits, and warnings. Its mandatory to follow all the rules. To transport material from one place to other rovers can be used. The proposed system is designed to program a rover for navigation to transport material from one place to another like stores to assembly line. As the rover has to move where the work is going on it has to be programmed to navigate in a pre-defined path so that no collision and accident takes place. It can be controlled with a remote and can also be autonomous. This project demonstrates the feasibility of using low-cost hardware and opensource software to develop a simple yet effective rover navigation system for specific application like in industrial application to supply materials.

Keywords: Rover C Pro, M5 Stick C Plus, Arduino, N20 Gear motors, ESP 32

INTRODUCTION

In the realm of technological progress, the concept of navigating rovers along pre-defined paths has emerged as a remarkable breakthrough with far-reaching implications for industrial applications. This innovative fusion of robotics and artificial intelligence has given rise to a new era of automation, where rovers can seamlessly manoeuvre through complex environments, adhering to predetermined routes with unparalleled precision and efficiency. This development led to an improvised methodology to get any work done. Such automation is required in many sectors related to Industrial, Healthcare, Automobiles etc. Automation with robots refers to the use of robotic systems and technology to perform tasks and processes without direct human intervention. This field had gained significant attention in various industries due to its potential to increase efficiency, accuracy, and productivity while reducing labour costs and human error.

1."An Approach to Acquire Path-Following Skills by Industrial Robots From Human Demonstration," in *IEEE Access*, vol. 9, pp. 82351-82363, 2021 by Rodriguez-Liñan, Angel and Lopez-Juarez, Ismael and Maldonado-Ramirez, Alan and Zalapa-Elias, Antonio and Torres-Treviño, Luis and Navarro-Gonzalez, Jose Luis and Chiñas-Sanchez, Pamela [1] explores the implementation of acquire a path-following skill by a robot in the low-level stage which deals with the correspondence of mapping links and joints from a human operator to a robot so that the robot can actually follow a path. The approach is validated using a motion capture system as ground truth to assess the spatial deviation from the human-taught path to the robot's final trajectory.

2. A. M. Sakti, A. I. Cahyadi and I. Ardiyanto, "Path Planning and Path Following Using Arrival Time Field for Nonholonomic Mobile Robot," *2017 International Conference on Advanced Computing and Applications (ACOMP)*, [2] the Arrival-time-field based method for path planning of non-holonomic mobile robot is proposed in this work. Path following strategy using kinematics control is also presented. Collision-free path is obtained by applying gradient descent to the arrival time field. In order to generate smoother and safer path, speed function variation is added into the arrival time field. Mobile robot is also driven to follow the previously generated path using kinematics control based on simplified kinematics model of mobile robot that has been converted to polar coordinates.

3.Raja, Purushothaman, and Sivagurunathan Pugazhenthi. "Optimal path planning of mobile robots: A review." International journal of physical sciences 7.9 (2012): 1314-1320 [3] explores the challenges and the scope for developing the algorithms that will yield better quality paths addressing the optimal techniques, collision free path.

This project aim is to develop a rover that works on the pre-defined path following all the specifications and the layout given by the user and move with according specifications using different sensors that help in detecting the objects and prevent collisions and help in moving through the dangerous areas without physical human presence. This can be operated through the Bluetooth device as well.

This system uses M5 Stack Rover C Pro, M5 Stick C Plus and a USB cable along with Arduino IDE software for the programming of the specifications accordingly.

WORKING PRINCIPLE

The navigating rover on a predefined path works on the principle of mechanics forward and inverse kinematics. The path for the robot to move from one location to another location is to be decided. For the robot to move in all directions a model called Rover C Pro had been chosen that comprises of Mecanum wheels which allows the robot to move in all the directions that is Forward, Backward, Sideways, Rotate on its own axis and so on. The directions in which the robot can move can be programmed as the model Rover C Pro is a programmable device.

The robot can be moved in the desired direction that may vary according to the user. The user can themselves make changes to get to their target location. Since the Rover C Pro is a programmable device, one can modify the program and commands using the platform ARUDINO IDE. The IDE platform includes certain libraries which are to be installed and the program is written, compiled, run.

Entire program written can be dumped into the microcontroller, that belongs to ESP32 family series and an extended model of M5STACK. It follows the name M5STICK C PLUS. The wheels of the Rover C Pro are connected to the motors which are miniature servo motors called N20 Worm Gear Motors. These motors are rotated according to the program that has been written.

M5Stack RoverC Pro is a programmable Mecanum wheel omnidirectional mobile robot base. Compatible with M5StickC/M5StickC PLUS, it can be initialized by just inserting M5StickC/M5StickC PLUS. The main control chip is STM32F030C6T6, and it incorporates four N20 worm gear motors to drive the wheels directly by the motor driver. The PRO version provides a gripping mechanism controlled by a servo for gripping objects. The base provides two dedicated servo control drivers. In addition, it also provides two Grove-compatible I2C connectors to facilitate the expansion of other modules. The base is compatible with Lego and can be expanded structurally. There is an 16340 (700mAh) battery on the back, from which the battery can be replaced. It can be recharged through M5StickC/M5StickC PLUS. The power of the base is controlled by an independent switch. It allows Flexible movement in all directions.

M5StickC PLUS is powered by ESP32-PICO-D4 with Wi-Fi with a bigger screen, portable, easy-to-use, open source, IoT development board. This tiny device will enable you to realize ideas, enrich creativity, and speed up the IoT prototyping. It Makes Development Process easier, integrated with infrared, Microphone, LED, Buttons, etc., battery capacity from 95mAh to 120mAh. It improves control efficiency and requires minimal PCB area. M5Stack offers an Arduino-compatible development environment that allows to program the M5StickC Plus using the Arduino IDE. The program is dumped into this M5STICK C PLUS (ESP 32) Microcontroller and as soon as the program executes, it establishes the connection with the motor drivers and indirectly with the Mecanum wheels. It has Plus had a built-in Li-Po battery, making it suitable for portable and battery-powered applications. The board features a color LCD screen that allows the user to display information, graphics, and user interfaces for the project.

Gear Motor is a miniature DC motor with integrated gearbox. Worm gear motors are a type of mechanical power transmission system that combine a worm gear and a worm wheel (also known as a worm gear and worm gear shaft) to provide controlled and efficient torque and speed reduction. This configuration is widely used in various applications where a high torque output is required at a lower speed.

This USB Cable is used in this project as a source of connection between the software platform and the hardware device. The code written in the Arduino IDE platform is verified and compiled by which the entire code is written to the device with the help of the USB Cable.

Here, the major roles are played by the ESP32 Microcontroller, Mecanum wheels, Servo Motors which drive the robot that is Rover C Pro accordingly as per the given set of instructions written on the IDE platform.

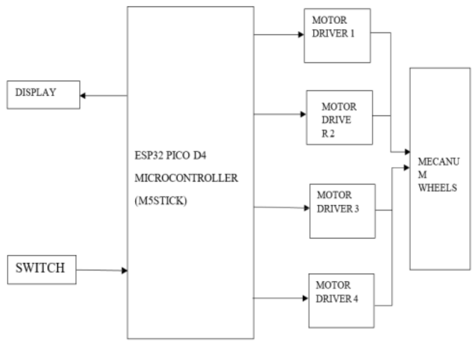

Fig.1. Block diagram of interface of Rover C Pro with M5 Stick C Plus

The block diagram consists of a microcontroller that connects with the four motor drivers to which four N20 worm gear motors are connected respectively. The gear motors are also directly connected to the Mecanum wheels. The Fig.1.illustrates the interface of Rover C Pro with the M5 Stick C Plus.

The switch present on the rover, when it is on, triggers the microcontroller and makes it ON. The ESP32 controller triggers the motor drivers in order to make the motors rotate.

The rotating motors will automatically change the axes of the wheels and ultimately the wheels start moving. The servo motors both ends are connected to the respective pins on the motor drivers. Each motor is connected to one of each motor drivers respectively.

The motors may rotate the wheels in the circular motion or towards right or left or, make them move forward or backwards. To achieve this the rover has to be programmed, which can be done by dumping the code into microcontroller through the USB Cable.

The predefined path is usually given by the user from start point to the destination point. The servo angle of the motor and the set speed for the directions x, y, z along with the expected delay are the specifications given by the user for moving of the rover.

Initially the rover interfaced with the M5 Stick C Plus is turned on, then based on the commands or the specifications given in terms of set speed, servo angle and the delay the rover starts moving based on the possible 12 directions and reaches its destination point.

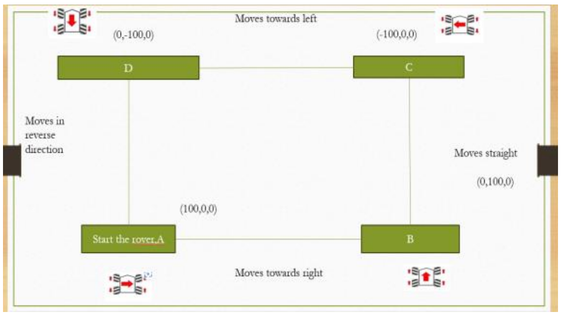

Fig.2. Predefined path for a square field path

The Fig.2.illustrates the predefined path for a square field.

RESULT AND DISSCUSION

The successful development of a system designed to follow a predefined path was a significant milestone in our project. It has been observed that the rover effectively navigated from its initial location to the designated destination along the user-defined path. The integration of the rover with the M5 Stick C Plus is illustrated in Fig.3.

Fig.3. Rover When interfaced with M5 Stick C Plus

In the initial phase of our project, the code has been loaded onto the M5 Stick C Plus, which was subsequently integrated with the Rover C Pro. This integration allowed the rover to execute movements on a square field along a predefined path. It has been observed that the rover efficiently responded to the provided commands. Notably, the rover's motion along the predefined path with the command (100,0,0), indicating a rightward movement, is depicted in Fig .4.

Fig.4. Rover moving towards right

At the outset of exploration, the rover commenced its journey by moving in a forward direction. After a brief pause of one second, it continued to move straight from that position in alignment with the provided command, specified as (0,100,0). A visual representation of this sequence is presented in Fig.5.

Fig .5. Rover moving straight

CONCLUSION

In conclusion, a promising development in automation and robotics is the employment of the M5 Stack Rover C Pro and M5 Stick C Plus in industrial applications to guide a rover along a predetermined course. These adaptable and small gadgets provide an economical and effective way to achieve accurate and dependable navigation. They enable industry professionals to optimize procedures, boost output, and guarantee safety in demanding settings thanks to their strong hardware and intuitive programming environment. The M5 Stack Rover C Pro and M5 Stick C Plus offer a strong base for accomplishing accurate and repeatable movements, making them an important tool in the quest for automation in industrial settings as technology advances.

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