Chapter 7

MPU-based gesture-controlled dual six-axis robotic arms with a rover

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Abstract

The goal of this project is to build a twin 6-DOF gesture-controlled robotic arm with a rover for use in missions that demand human-like skill, such as mine- and bomb-defusing. Using a single modified PS2 joystick, two 6 DOF arms and the robot's rover may be controlled concurrently. This allows for simultaneous control of the arms and the rover. The joystick's MPU-9250 is installed there to detect push button interactions as well as the joystick's roll and pitch.

Keywords: *Six axis dual arm; gesture control; motion technology; servo motor.*

1. Introduction

The purpose of this project is to develop a customized right-hand driven joystick that can control a fully working, 12-DOF twin robotic arm that is mounted on a mobile platform. In it to recognize the operator's use of the joystick's roll and pitch. This project allows for simultaneous operation of one of the two arms and the movable platform, making it easier to work in more dangerous situations. The operator has complete control over the robot because a separate joystick is used to operate the left arm. The operator can have complete control over the robot (including the left arm, right arm, and mobile platform) and can manage every aspect of its functioning at once by utilizing both the left and right arm joysticks. While dual armed robots with gesture recognition joysticks may effectively use their two arms to accomplish the work with less time spent, a single arm robot that accomplishes the same operation takes longer to complete. The arm is lightweight and reasonably priced because mild grade aluminium was utilised to construct it.

There are numerous techniques for controlling robotic arms that make use of various sensors, including the usage of the Flex sensor, vision-based hand gestures, acceleration-based control, and the leap motion controller (pititeeraphab et al; pedroneto et al; jagdish et al; Juan et al; Bhuyan et al; syed et al). In the modern world, gesture control methods for robotic arm control are widespread, and two-arm robots with different degrees of freedom (DOF) are developing. The proposed robot is therefore not novel, but the method for controlling the 12 DOF robot with movable platform is. Robotic arms are frequently employed in many industries, including medicine, the military, manufacturing, and research. Numerous studies and advances are being conducted to improve robotic arm control with less complexity and effort by utilising various sensors.

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1.1 Proposed design system explanation

The proposed model is divided into three pieces (Fig. 1). Those are Robot with joystick, hub. The joystick part is the first and is used to control the robot from a distance. The project calls for the modification of a PS-2 joystick. Inside the joystick, a motion sensor MPU-9250 is placed to track the joystick's roll and pitch while it is used. An ATMega328P serves as the processing IC for each section. The data is transmitted from the joystick to the hub using a 433 MHz transmitter. The hub is the second portion that is utilised to extend a robot's operational range in an open area. The hub component has a 433 MHz receiver that receives data from the hub and transmits it to the robot through a 2.4 GHz NRF24L01 transceiver. The hub's 2.4 GHz NRF24L01 transmitter is utilised to increase the robot's operational range by up to 1 kilometer. The robot, which is controlled remotely, is in the third part. Through the 2.4 GHz NRF24L01 transceiver, the robot gets data from the hub and uses the ATMega328p microcontroller to process it. The data is then transferred to the 16 channel 12-bit servo controller to operate the servos on the robot's arms, and to the lm293d motor controller to control the robot's direction (Fig. 2).

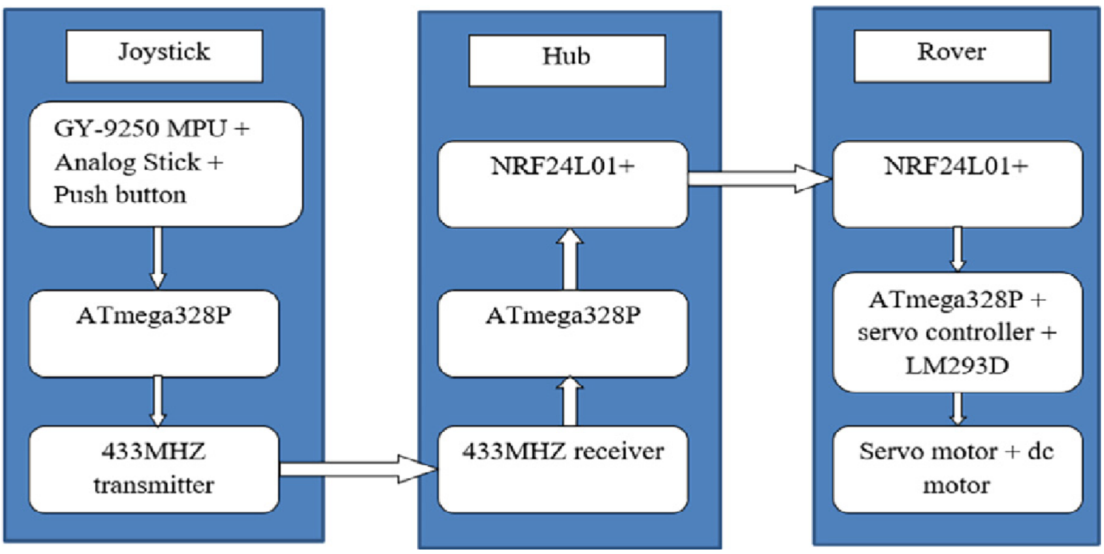

Fig.1 Flow of proposed model

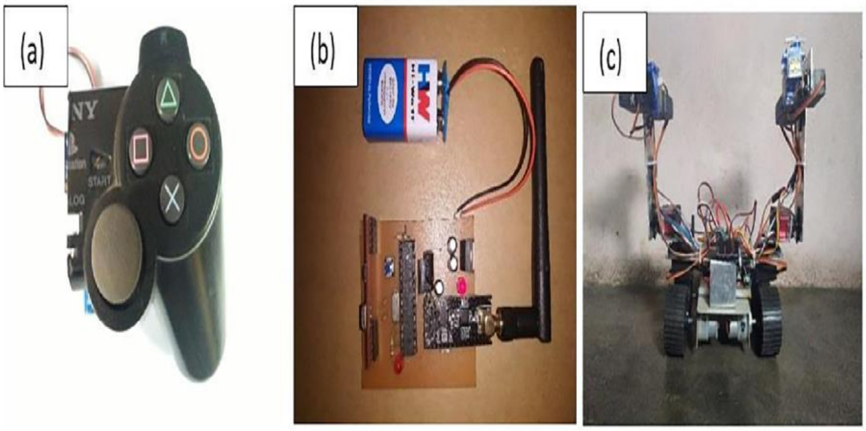

Fig.2 Joystick, hub, rover

1.2 Block chart

The joystick part includes a modified PS-2 joystick with a GY- 9250 MPU for sensing the operator's roll and pitch movements. Utilizing the pushbuttons and the roll and pitch of the joystick, the ATMega328P recognizes the operator's input and transmits it to the hub through a 433 MHz transmitter (Fig. 3).

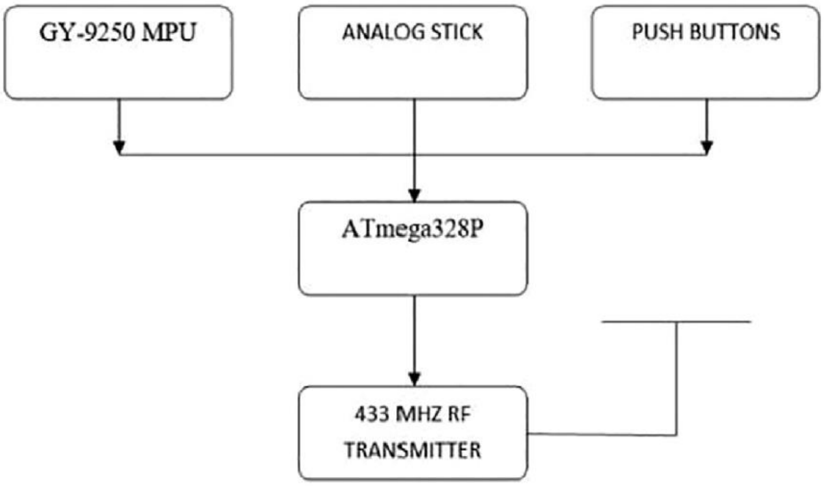

Fig.3 Flow of Joystick

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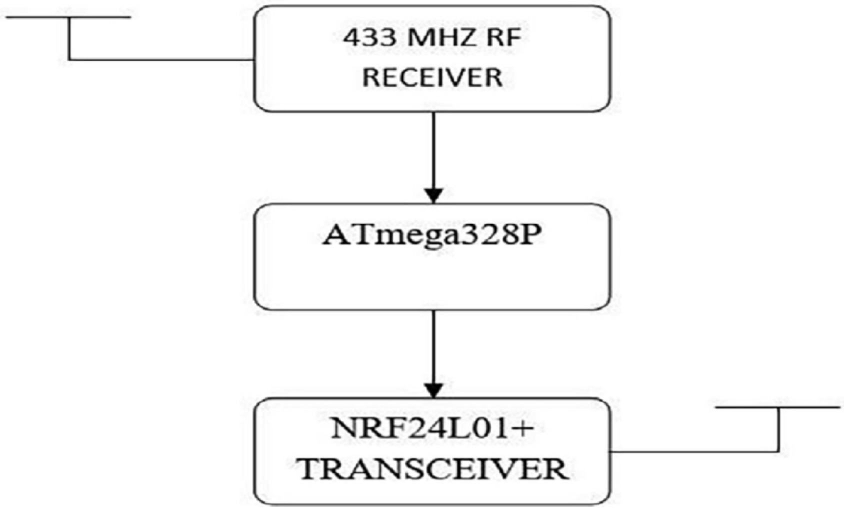

Fig.4 Flow of hub

The hub part has a 433 MHz receiver to receive data from the joystick and a 2.4 GHz NRF24L01 transceiver to broadcast it for a greater communication range. The operating distance of the robot can be increased by incorporating a second hub (Fig. 4).

The 2.4 GHz NRF24L01 transceiver in the robot segment is used to receive data from the hub. The servo controller, which controls the arm servo, and the lm293d IC, which regulates the robot's mobility, is both under the control of the ATMega328P microcontroller (Fig. 5).

2. Methodology and Driving Position

The primary controller is right-handed only, which makes it simple to use since most individuals are naturally inclined to use their right hand for most tasks. Three modes exist for the joystick. Those are

Arm-1 setting (right arm mode)

Arm-2 setting (left arm mode)

The joystick is in Arm-1 mode, which is right arm mode, by default. The two servos on the 6 DOF arm are controlled by the joystick's standard roll and pitch. The other two motions of the six degrees of freedom (DOF) arm are controlled by the roll and pitch of the joystick in conjunction with the pressing of the R1 button, while the robot's five servos and gripper are controlled by the R2 button in conjunction with the roll and pitch of the joystick.

The controller can be switched to left arm mode by pressing the "h" button. The left arm will now be controlled by the controller, with all other operations remaining the same as in the right arm mode. To return to the right arm mode, press the "O" button. When the arm is reset, all of the servos in the right and left arms are adjusted to a 90-degree angle by pressing the "4" button.

The controller can be turned "ON" and "OFF" by pressing the "X" button. The controller's analogue stick is used to steer the robot in the desired direction. The rover's arm and mobility platform may both be controlled at the same time, allowing the driver to operate the robot's one arm while moving the mobile platform.

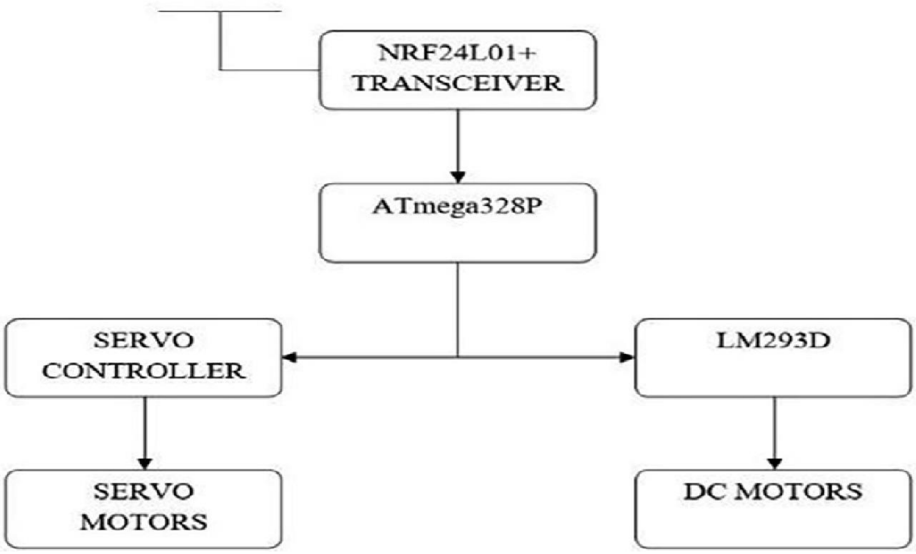

Fig.5 Flow of robot

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To control the left arm separately, a second left arm joystick is employed, allowing the robot's two 6 DOF arms and movable platform to be moved continuously and simultaneously. The robot's entire operation may be readily controlled without interrupting or stopping any other robot operation.

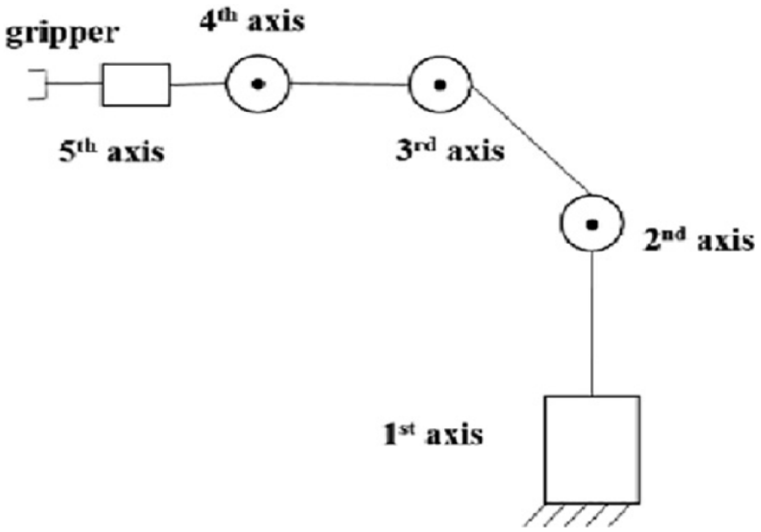

Fig.6 DOF robot arm depicted in two dimensions

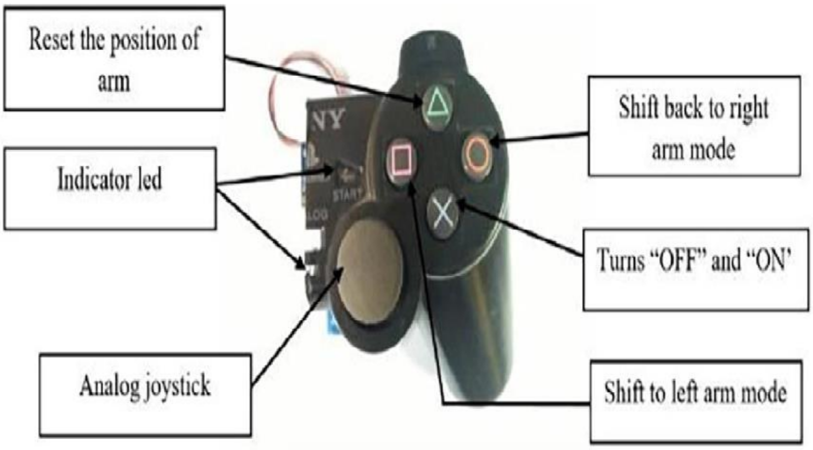

Fig.7 Descriptions of controller keys

2.1 Operational plan

This project has two arms, each with six degrees of freedom. Each servo motion is restricted to a range of 0 to 180, which can be increased further if needed. Every servo in the arm is initially at the 0 position. I++; and I in the code determine the servos' increment and decrement values.

The angle of the servo increases with a predetermined delay as long as the operator retains the controller in the increment position, and vice versa for the decrement value. Additionally, the delay can be adjusted based on the operator's expertise (Fig. 6).

The first axis' servo is the SR-6120MG.

The MG996R servo is utilized for the second, third, and fourth axes.

The gripper and fifth axis servo are both SG90 9g micro servos.

2.2 Use of controllers

The robot features a twin arm with six degrees of freedom, each servo having three degrees of freedom. The modified PS-2 joystick sends data to the rover's microprocessor (controller). The controller checks the operator-made roll, pitch, and button interface of the joystick with predefined data using the MPU GY-9250, and then transmits the matching data to the robot via hub (Fig. 7).

2.3 Driving technique

Along with the robot's arm, the mobile platform is controlled by the analogue stick on the joystick. The mobile platform and arm can both be controlled simultaneously. The middle button on the analogue stick's centre is used to switch from joystick mode to motion-controlled driving mode.

The gestures 2, 3, 4 and 5 are used to control the direction of the mobile platform in motion-controlled driving mode. The gestures 2 and 3 move the mobile platform forward, backward, left, and right, respectively. The gestures 4 and 5 turn the platform in the right and left directions,

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respectively. Three components make up the entire algorithm used in this work. They identify as Hub Joystick Robot. Gesture positions of servo are shown in figure 8 to 12.

3. Discussion

The two sets of persons, each containing ten people, were used to design and test the work that is discussed in this paper. The analysis of the test results reveals that the majority of participants can successfully run the robot and comprehend the controller approach. The findings demonstrate that no specialized knowledge or training is necessary to operate the suggested robot. The controller is entirely dependent on the operator's hand movements, concluding that the operator's surroundings cannot affect the robot's performance. The robot has two separate, six-degree-of-freedom arms that mirror the human arm, thus it is possible to operate both the primary and secondary controllers effectively.

By including a second hub, the robot's operational range can be increased even more. In order for the secondary hub to receive data from the primary hub and transfer it to the robot, the robot will position and turn on the secondary hub at the end of the primary hub's receiving range.

4. Conclusion

The created model proposed in this paper can be applied to military tasks including mine and bomb disposal, espionage, and other vital area repairs. It can also be employed in the fields of space, medicine, and research. The rover functions effectively in any working environment because to its two motion-controlled arms. The robot's functioning cannot be influenced by the operator's surroundings because the joystick uses a motion capture device to monitor hand motion. The developed model has an operational range of 1 kilometer in open space. Long distance operations can be carried out using wireless cameras to obtain real-time feedback from the robot. A 5.8 GHz, 40 channel video transmitter for an FPV camera allows the transmission of video up to 1.5 miles (2.4 km).

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