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GESTURE-ENABLED ROBOTIC ARM ON ROVER FOR PRECISE REMOTE MANIPULATION

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Abstract—
The development and realization of an articulated, gesture controlled robotic arm system with interfacing onto a rover [1] for accurate remote handling functions in this study. Gesture recognition is a key technology that enables such interactions to be natural and intuitive, which make them as applicable in remote areas as elsewhere. The design of the robotic arm emphasizes precision and dexterity enabling for delicate tasks of extreme accuracy, which can be done remotely. Moreover, the rover has mobility apparatuses and perception appliances that facilitate efficient navigation and interaction with the envi environment. Sensors capture human gestures that are interpreted by the gesture recognition system in order to command the robotic arm's movements and actions. By using this technique, it is possible to achieve efficient control [3] of remotely located or dangerous objects using a remote manipulator. The system has been tested under simulated and real world conditions and is able to achieve accurate manipulations, suitable for space expeditions, traversal of dangerous environment [2], and remote operations. In summary, the gesture enabled robotic arm on a rover platform exhibits encouraging performance in precise remote manipulation via intuitive human-robot interaction. Moreover, future developments and extensions can make the device applicable in different areas that involve remote operation and accuracy of handling in hard conditions.

Index Terms—gesture-enabled, manipulation, robotic, precision,

I. INTRODUCTION

The field of next generation technologies have witnessed the pinnacle of the intersection between robotics and remote manipulation. Make an introduction into the Gesture-Enabled Robotic Arm on Rover, a new invention that will revolutionize accuracy in remote tasks. The wonder of engineering combines the strength of robotics with natural human interfacing for effortless remote control.

This robotic arm is at heart the epitome of accuracy and versatility, tailor-built to execute the most delicate operations. It has a gesture-enabled interface that is one of the complex systems which decipher human gestures into meaningful in structions and allows operators to control the arm movements with simplicity.

This innovation mounted on a rover goes beyond barriers and makes it possible to carry out distant exploration, repair and complex actions [4] in different places and conditions. The adaptability makes this item essential in situations where human intervention could simply be impossible or even unsafe, thus demonstrating its usefulness in anything from space exploration to earth disaster recovery programs.

Gesture recognition technology in combination with robotics enhances efficiency, yet transforms man-machine in interaction into a simple affair. The Gesture-Enabled Robotic Arm on Rover is an embodiment of human genius that portends a future where there will be a marriage of precision, remote operation and surmounting of physical boundaries for the good of industries and the society in large.

II. METHODOLOGY

A. Existing methodology

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Robotic manipulators perform reliably and quickly in the current approach; the same goes to industries that need quick and accurate outcomes. These efficient devices are, in essence, automated systems that do not require to be tired or sleep, like the humans do. Such machines are being used today and were in the past, however, they have developed very much due to the emergence of complex sensors. The current robotic arms are equipped with different sensors that enable them to move around and respond promptly in their working fields. It discusses a low-cost, automatic robotic arm operated by human hand gestures. This suggested system includes an Arduino mega micro controller that collects accurate data from all sensors and correctly regulates the servomotor. The hand glove has all the necessary sensors for controlling the numerous servos on the robotic arm. In this system, a robot arm is driven by two flex sensors. A flex sensor at the glove's forefinger area controls a claw part of the arm and at the glove's middle finger area manages a wrist part of the arm. An electronic gyroscope is embedded on a glove for tracking the movements of the forearm as well as the base. This leads to clockwise and counterclockwise motion of the base servo when the hand glove is tipped right or left. On the other hand, if the hand glove is tilted upwards or downwards, the gyroscope data would make the forearm servo to move either clockwise or anti-clockwise. The servo motors rotational degrees are transformed by converted from the sensor's values. The values of the sensors are changed into the rotational degrees for the servo motors. The claw, wrist, fore-arm servos, as well as the bas are capable of rotating 90°, 45°, 120°, and 180°respectively.

B. Proposed System

The proposed methodology on gestured-enabled rover for remote manipulation incorporating computer vision and robotics. There is a dependable gesture recognition system that uses the deep lean's model to interpret the gestures recorded onboard cameras. The first one is a set of command gestures that tells a robot arm what to do. The rover has different types of sensors and mapping algorithms that take it through the different terrains simultaneously.

These gestures then translate into the system of precise movements that the robotic arm performs. They employ mod ern algorithms for kinematics and this enables them to perform precision tasks in far territory. In addition, haptic feedback makes it possible for an operator to feel the arm impacts, furthering control and precise operations. Low-latency networks permit real time communication that results in faster response to command.

It emphasizes the need for smooth coordination of gesture detection, steering of the robotic arm, rover navigation and the user's feedback. The purpose is to improve the accuracy and ease usage of the robotics arms in operations such as explorations, building, and hazardous grounds.

III. WORKING

A. Working of Robotic Arm

A hand glove-based controlled robotic arm with working operation is comprised of multiple connected parts, offering the possibility of intuitive manipulation via hand gestures. In general, this means that we are transmitting an overall signal over Bluetooth from the Robotic Glove to the servo motor. When a value has been received, a signal will be sent to a specific servo motor, for example a Robotic Arm. While in

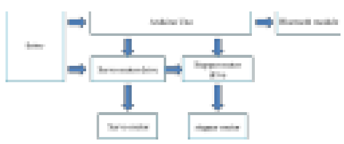

Fig. 1. Block Diagram of Robotic Arm

the sending end we use accelerometer to detect movement of robotics's arm in six axes. The sensing glove to be worn by human has this accelerometer firmly attached to it. This device yields six analog readings derived from the movement of a human hand. The analog input

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pins of Arduino Uno receive this accelerometer reading as the input. Fingers having slide potentiometer are attached to the sensing glove. To this end, they are also used as input to the analog pins of Arduino board. During finger motion, the slide potentiometer value changes and it also enables detection of different finger motions. The data obtained from the sensors is used to make motions on the motors using Arduino mega board. We use servo motors for the actuation techniques. Servo-motor PWM signals are provided via the PWM output pins of Arduino Mega. The values received from sensors, which are located on the gloves, give the PWM.

B. Assembly Parts

Servo Motor: Servo motor is a special type of motor designed for accurate control of angular positioning. This comprises of a motor which includes a feedback path (for example a potentiometer or an encoder) that continually sup plies information on the motor shaft's present position. High accuracy, high-torque, and position-maintaining servo motors.

Working Principle: A servo motor changes its shaft position based on the signal sent to it to be moved to a certain location. These are usually pulses with high frequency, or PWM signals. The length or duration of the signal pulse identifies the desired position on the motor shaft.

Usage in Robotic Arms: Rotational movements of the joints of robotic arms are often controlled by servo motors. Some may even have individual servo motors devoted to moving that specific joint into the exact position required.

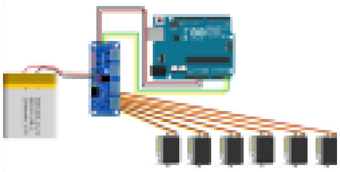

Fig. 2. Circuit Connection of Servo Motor and Motor Driver

Servo Motor Driver: Servo motor driver, or controller is an interface between the servomotor and control system. It receives commands from the control system and converts them into intelligible signals meant for the servo motor.

Functionality: Usually, input signal can be in form of control pulse and then is amplified by the driver to provide enough energy for servo motor. Based on the control signals it receives from the main control system, it controls and regulates the voltage and current fed into the servo motor.

Features: Some servo motor drivers have some extra features like speed adjustment, adjustment of torque, heating or over loading shields. In a robotic arm system:

- Each servo motor could be dedicated to one joint in the arm.

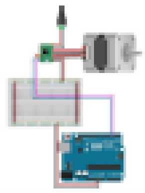

Fig. 3. Circuit Diagram of NEMA-17 and A4988 Driver

- The servo motors are controlled by servo motor drivers that are operated by specific signals from the control system or micro controller.
- The servo motors are moved with accuracy to respond to commands with a specific amount of torque and precision necessary for the arm movements.

NEMA 17: The NEMA 17 is the name of this sizing system for stepper motors. It means a stepper motor that has a face plate with a height of 1.7 inches and width of 1.7 inches. This standardizes the mounting dimension and hence it can be easily fitted into various systems. A stepper motor performs its operations by splitting a full turn into a multiple number of steps. It is known for precisely controlled increments, where a motor will move incrementally to about 1.8 degrees per step. It has this characteristic and therefore can be

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applied in controlling precise positions like robotic arm joints. However, the power output of the NEMA 17 motors varies from one model to another. They typically supply medium torque for most robotic arm joints, particularly small to middle size arms or components not subjected to high load. A NEMA 17 stepper motor may be considered appropriate for an intended specialized application of a robotic arm, especially, for joint movements, which require high precision and accurate positioning. Nevertheless, the choice should be done after taking into consideration the distribution of arms weight, load-bearing abilities, the required range of motion, and general design to ensure that the motor meets the performance demands efficiently. Apart from that, necessary drivers and control systems are required for achieving best performance.

C. Assembly of Circuitry

The Robotic Glove consists of the following components: • Flex Sensor – Based on the bend of the finger, the current changes which we could use to send a signal to the Motor • Accelerometer (MPU6050) – We can control the Motor by mapping human gestures from X, Y, Z plane • LED – The LED will light up when a human gesture control has been sent to the Arduino

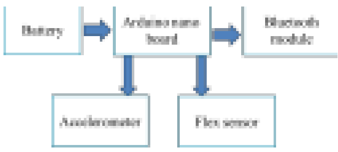

Fig. 4. Block Diagram of Hand Glove

• Bluetooth (HC-05) Module – Sending data to Robotic Arm HC-05 Receiver Arduino Nano – The micro controller would perform as the brains of the Robotic Glove

Configuring of the Bluetooth (Master and Receiver).The Arduino Robotic Arm communicates over Bluetooth using the HC-05 modules.

- Robotic Glove HC-05 - Master
- Robotic Arm HC-05 - Slave

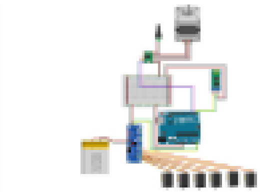

Fig. 5. Arduino Diagram of Full Assembly of Robotic Arm

Arduino Micro-controller: The Arduino Uno and Nano are both powerful micro-controllers that excel at programming robotic arms. With the Arduino IDE, you can easily begin by defining the ideal pin configurations for the servo motors that will control the various joints of the arm. To streamline motor control, take advantage of the available servo libraries. By creating functions for each arm movement, such as rotation or elevation, you can easily utilize servo.write commands to precisely set the desired angle for each joint. For optimal precision, incorporate sensor integration to provide feedback for accurate positioning. To promote code readability and flexibility, it is recommended to organize the code into modular sections. Additionally, practical tools such as loops for repetitive tasks and conditionals for decision-making can greatly enhance the arm's functionality. Safety should also be a primary concern when handling robotic arms, so be sure to prioritize error handling and implement necessary safety measures within the code. Once you have completed programming, simply upload the code to the Arduino board and test the arm's capabilities.

D. Working of Rover

Utilizing an innovative Arduino and a state-of-the-art Blue tooth module, the rover effortlessly navigates through a sophisticated system that seamlessly integrates these cutting-edge technologies for superior remote control and seamless data transmission. As the main control hub, the Arduino expertly manages all aspects of the rover's operations with unparalleled precision and efficiency. With the aid of Bluetooth communication, the rover receives user commands and performs various actions, such as directional movements [5], speed adjustments, sensor readings, and specialized tasks like arm manipulation, all in perfect harmony. Through the advanced Bluetooth module, the rover effortlessly communicates with its controlling device, whether it be a smartphone or a computer, providing a seamless and wireless connection.

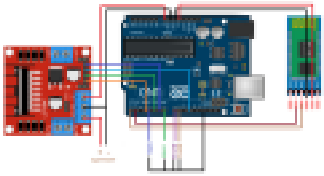

Fig. 6. Circuit Connection for Arduino and Bluetooth Module

With seamless integration and dynamic communication, a cutting-edge Bluetooth module works in tandem with Arduino to facilitate wireless control and interaction between a user's device and a motorized system. Acting as the intermediary, the Arduino effectively receives and interprets instructions from the Bluetooth module, then translates them into precise actions for the connected motors. First, the Bluetooth module establishes a wireless connection using specialized communication protocols with a paired device, such as a smartphone or computer. Once the connection is established, the Arduino receives commands or directives transmitted from the device through the Bluetooth module. The Arduino then decodes these signals and translates them into precise motor control instructions, seamlessly directing the behavior of the motors. Through the incorporation of suitable motor drivers or H-bridge circuits, the Arduino flawlessly delivers these instructions to the connected motors, effortlessly operating the system with unparalleled precision and efficiency.

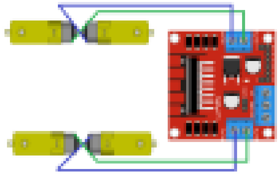

Fig. 7. Circuit Connection of Bluetooth and Motors

E. Modelling

Creating a gesture-enabled robotic arm for precise remote manipulation on a rover is no simple task. It involves integrating a series of interconnected systems to achieve optimal performance. It all begins with designing the rover's chassis, which must not only fit the robotic arm but also house all the necessary electronic components. At the core of this sophisticated system is the Arduino micro controller. Acting as the conductor, it coordinates both the rover's movements and the robotic arm's actions. Through specialized sensors, such as accelerometer or flex sensors, which capture the gestures and relay them to the Arduino. Then, using a Bluetooth module, these gestures establish a vital link between the user interface and the rover itself. Of course, achieving precise and fluid movement from the robotic arm requires careful kinematic analysis and design considerations. Each joint of the arm [6] must be meticulously calibrated to ensure maximum dexterity and accuracy in its movements. After all, every movement counts in the realm of remote manipulation.

Fig. 8. 3D Model of Robotic Arm on Rover

IV. CONCLUSION

In conclusion, incorporating a gesture-enabled robotic arm on a rover is a monumental leap forward in remote manipulation technology. This revolutionary system offers precise and seamless control, significantly enhancing the rover's capabilities for a range of tasks in demanding environments. With the aid of gesture recognition, operators can effortlessly guide the robotic arm, facilitating intricate and flawless movements from a distance. This advancement greatly amplifies the rover's efficiency [7] in activities like gathering samples, manipulating equipment, and executing complex maneuvers in unreachable terrains, ultimately broadening the horizon of exploration and research opportunities. Furthermore, the integration of robotics and gesture control reduces the likelihood of human error and streamlines operations, resulting in a more seamless and efficient process.

REFERENCES

[1] McMorran, Darren; Chung, Dwayne Chung Kim; Li, Jonathan; Mu radoglu, Murat; Liew, Oi Wah; Ng, Tuck Wah (2016-02-16). "Adapting a Low-Cost Selective Compliant Articulated Robotic Arm for Spillage Avoidance". Journal of Laboratory Automation. 21 (6): 799–805. doi:10.1177/2211068216630742. ISSN 2211-0682. PMID 26882923.

[2] Jandura, Louise. "Mars Science Laboratory Sample Acquisition, Sample Processing and Handling: Subsystem Design and Test Challenges" (PDF). JPL. NASA. Retrieved 2012-08-21.

[3] "Curiosity Stretches its Arm". JPL. NASA. 21 August 2012. Archived from the original on 22 August 2012. Retrieved 2012-08-21. M. Karthikeyan, M. kudalingam, P.natrajan, K. planiappan and A. Madhan prabhu,"object tracking robot using raspberry pi with open CV", IJIRD, Vol3(3),ISSN:2394-9343

[4] Staff (Sandia National Labs) (August 16, 2012), "Life-like, cost-effective robotic hand can disable IEDs", R&D Magazine, rdmag.com, retrieved September 13, 2012 Fang, W.; Zheng, L.; Deng, H.; Zhang, H. Real Time Motion Tracking for Mobile Augmented/Virtual Reality Using Adaptive Visual-Inertial Fusion. Sensors 2017,17, 1037. [5] "Curiosity Rover - Arm and Hand". JPL. NASA. Retrieved 2012-08-21. [6] Billing, Rius; Fleischner, Richard (2011). "Mars Science Laboratory Robotic Arm" (PDF). 15th European Space Mechanisms and Tribology Symposium 2011. Retrieved 2012-08-21.

[7] Hille, Karl (2018-11-16). "OSIRIS-REx is Prepared to TAG an Aster oid". NASA. Retrieved 2018-12-15.