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Robotic Arm Control Using Assistance in Kannada

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Abstract - The advance of Arduino-based technology has spurred innovation in the realm of robotic arm control, offering a cost-effective and accessible platform for enthusiasts and professionals alike. This paper presents the development of robot arm control using an Arduino controller. The work involves the integration of Arduino microcontrollers and sensors to enable precise and dynamic control of a robotic arm. The proposed robot is controlled by 4 servo motors, the motors rotate left, right, front, and back. The paper discusses the challenges encountered during the development process and proposes solutions, paving the way for further advancements in this burgeoning field. With Arduino's widespread availability and affordability, the presented robotic arm control system holds promise for expanding the accessibility of robotics education and fostering innovation in automation technologies. This paper provides a glimpse into the promising synergy between Arduino and robotic arm control, highlighting the contributions and implications of this technolThis thesis was commissioned for Saimaa University of Applied Sciences with the aim of understanding the control system for a robotic arm. The Robotic Arm in this case was from Saimaa .

1. INTRODUCTION:

Robotic arm control systems, especially when using assistance or guidance, involve a combination of hardware, software, and control algorithms. These systems aim to allow users to interact with and manipulate robotic arms more intuitively and effectively. Assistance can take various forms, including voice commands, gestures, or wearable sensors, which provide input for the control system to interpret and execute.

1. Hardware:

Robotic Arm: The physical arm itself, consisting of joints, actuators (motors or hydraulics), and an end-effector (gripper or tool).

Actuators: Motors (e.g., servo motors) or hydraulic systems that provide the power to move the joints and end-effector.

Sensors: Potentiometers, flex sensors, or other sensors provide feedback on the arm's position, movement, and force.

Controller: A microcontroller or PLC (Programmable Logic Controller) that receives input from sensors and sends signals to the actuators.

Communication Modules: Bluetooth, Wi-Fi, or other modules for communication with external devices (e.g., a smartphone app).

Software:

Control Algorithms: Algorithms that process input from the user and sensors, calculate the required joint movements, and control the actuators.

User Interface: A graphical interface (e.g., a smartphone app) or other method for users to interact with the system and provide commands.

Programming and Firmware: The code that runs on the controller to manage the arm's movements and respond to user input.

Assistance and Input:

Voice Commands: Users can give commands to the robot arm using voice through a microphone and voice recognition software.

Gestures: The system can interpret hand gestures using cameras or wearable sensors to control the arm's movement.

Wearable Sensors: Sensors worn on the body (e.g., a sensor glove) can be used to translate human movements into control commands.

Manual Control: The system can allow users to manually control the arm's movements using a joystick or teaching pendant.

Control Methods:

Joint Rate Control: Control the speed of each joint independently.

Position Control: Move the joints to specific target positions.

Trajectory Planning: Plan a smooth path for the end-effector to follow.

Inverse Kinematics: Calculate the joint movements required to achieve a desired end-effector position.

2. METHODOLOGY:

Robotic arm control using assisted methodologies leverages human input to guide the robot's movements, enhancing control and adaptability. This approach combines the robot's ability to perform tasks with the human operator's intuitive understanding of the situation, resulting in more efficient and versatile operations. Assisted methodologies offer various techniques to achieve this, including intuitive interfaces, teleoperation, and human-roboticcollaboration.

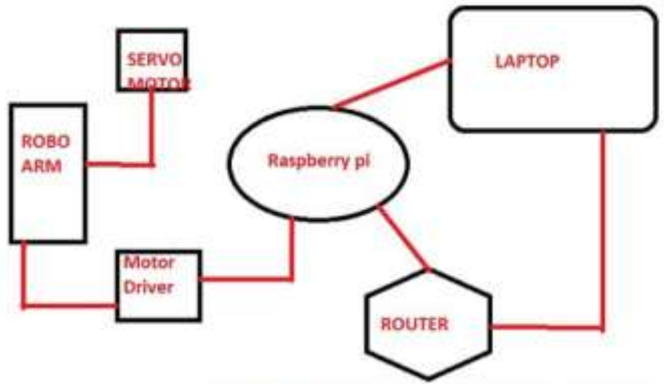

Fig:1 Flow chart

Human-like Inverse Kinematics (IK):
This technique aims to map human arm movements to the robotic arm's joints, mimicking the way humans control their limbs. It can be used to create intuitive control schemes for teleoperation, where a human operator can control the robot's end-effector by moving their own arm.

Two-Tracker System:
This system utilizes two sensors or trackers to map human arm motions to the robot's movements. One tracker can control the robot's end-effector, while the other drives a middle joint, mirroring how humans control their arms.

Trajectory Control:
This involves defining pre-programmed paths for the robot arm to follow, ensuring accurate and efficient movement. This can be achieved through techniques like smoothing functions to mitigate overshoots and optimize movement.

Servo Motors:
Robotic arms typically use servo motors, which provide precise control over joint angles and positions. These motors use feedback mechanisms to maintain desired positions and can be programmed to move to specific locations.

End Effectors:

These are tools attached to the end of the robotic arm, allowing it to perform tasks like grasping, picking, and placing objects. The choice of end effector depends on the specific task.

3. WORKING PRINCIPAL:

Robotic arm control relies on a combination of mechanical design, control algorithms, and actuators. The arm's structure, typically an open kinematic chain of joints, allows it to move and grasp objects. Control systems, often incorporating feedback from sensors, guide the actuators to execute desiredmovements.

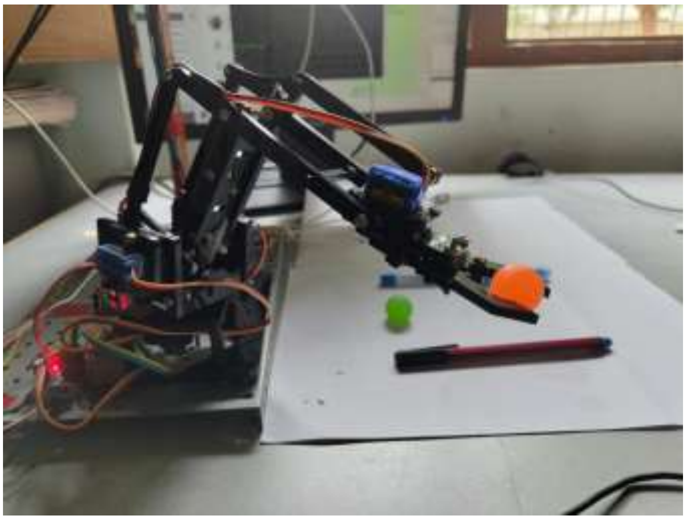

Fig:2 Model

- **Open Kinematic Chain:**

Robotic arms are typically designed as an open kinematic chain, where each link is connected to the next by a joint, allowing for rotational and/or translational motion.

- **Joints:**

Joints, like hinges or revolute joints, provide the degrees of freedom (DOF) that enable the arm to move in various directions.

- **Actuators:**

Actuators, such as servo motors or hydraulic systems, provide the force and motion needed to move the joints.

- **End-effector:**

The end-effector, such as a gripper or hand, is the part of the arm that interacts with the environment.

Control Systems:

- **Control Algorithms:**

Algorithms, like PID controllers or task-space control, determine the desired movements of the arm based on input commands or sensory feedback.

- **Sensors:**

Sensors, such as encoders or force sensors, provide feedback about the arm's position, velocity, and forces.

- **Controllers:**

The controller, often a programmable device like a microcontroller, receives commands, processes sensor data, and sends signals to the actuators.

Working Principles:

- **Programmed Instructions:**

The control system reads programmed instructions or user input and translates them into commands for the actuators.

- **Actuation and Movement:**

The actuators move the joints, causing the arm to perform the desired motion.

- **Feedback and Refinement:**

Sensors provide feedback, allowing the control system to adjust and refine movements for optimal performance.

- **Kinematics:**

Robotic arms rely on kinematics (forward and inverse kinematics) to calculate the position of the end-effector based on joint angles and vice versa.

- **Motion Planning:**

Motion planning algorithms, considering factors like obstacle avoidance and joint limits, ensure safe and efficient movement.

- **Task-space Control:**

This control scheme allows the robot to be controlled directly in terms of desired end-effector position and orientation in space, rather than individual joint movements.

Types of Control:

- **Joint-space Control:**

Directly controlling the angles or velocities of individual joints.

- **Task-space Control:**

Controlling the robot's movements in terms of its end-effector position and orientation.

- **Feedback Control:**

Using sensor feedback to adjust movements and maintain desired position or force.

- **Feedforward Control:**

Using pre-programmed trajectories or models to predict and anticipate movements.

Applications:

- **Industrial Automation:**

Robotic arms are used in various industries for tasks like assembly, material handling, welding, and painting.

- **Healthcare:**

Robotic arms can assist in surgery, rehabilitation, and pharmaceutical manufacturing.

- **Research and Development:**

Robotic arms are used in research for tasks like material science and robotics.

RESULT:

The project demonstrated effective integration of color and shape-based object detection with a robotic arm for pick-and-place operations. The use of a camera allowed real-time recognition of specific objects based on their visual characteristics, significantly enhancing the system's precision. By combining color and shape detection, the robot could distinguish between multiple items even within similar color groups, reducing errors. Kannada voice control added a hands-free interface with around 90% accuracy in controlled environments, while the GUI offered an intuitive manual control option. The acrylic sheet-based design ensured the robotic arm was both lightweight and durable. Experimental trials showed that tasks were completed within 6–8 seconds per cycle, indicating reliable performance. The addition of shape detection, particularly for identifying circles, rectangles, and squares, was a key improvement, minimizing false positives and improving target selection. Overall, the system showed strong potential for practical automation applications involving object sorting or handling.

CONCLUSION:

Robotic arm control assistance, such as through human guidance or AI, can significantly improve task performance and usability for various applications. By integrating these methods, robotic arms can achieve greater precision, flexibility, and efficiency in tasks. Robotic arm control assistance is a valuable approach for enhancing the usability, accuracy, and efficiency of robotic systems. By integrating various methods of assistance, robotic arms can become more accessible, versatile, and effective in diverse applications. The future of robotic arm control will likely see further advancements in AI-powered control, human guidance, and haptic feedback, further blurring the lines between human and robotic control. quiring both manipulation and guidance.

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