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Collaborative Robotic Arm

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Abstract: *This project is all about creating an affordable and user-friendly Collaborative Robotic Arm(Cobot) that works alongside humans." Using Arduino, servo motors, and sensors, the robotic arm can automate tasks while adapting to human input in real time, ensuring safety and efficiency. Designed with small and medium-sized businesses (SMEs) in mind, the system makes automation more accessible. By utilizing open-source software and widely available components, this project aims to bring the benefits of collaborative robotics to a broader audience without the high costs typically associated with such technology.*

Keywords: Arduino uno, Servo motor, Power supply, Touch sensor, Buck convertor module, PVC pipe

I. INTRODUCTION

A collaborative obotic arm is a type of robotic system used in various fields, including industry, education and research These in Robotic arms can handle tasks like assembly, pickand -place operations, welding, and painting. When combined with the Arduino an open - source microcontroller platform, they are affordable and use - friendly option for both beginners and Professionals. A collaborative robotic arm is a sophisticated system built to function alongside humans in automation education, and research. By integrating with Arduino, an open-source microcontroller, these robotic arms become more accessible, cost-efficient, and easy to program for users of all skill levels. A collaborative robotic arm, or Cobot, is a robotic manipulator designed to work in close proximity to humans. Unlike traditional industrial robots, Cobots are equipped with safety features such as force sensors, soft actuators, and controlled movement speeds, ensuring a safer and more efficient working environment.

1.1 Hardware Description

A collaborative robot arm (also referred to as a cobot arm) is a robot manipulator that is meant to work in conjunction with human beings in a shared environment. Contrary to industrial robots, which are usually found operating in stand-alone conditions, collaborative robot arms have integrated sensors, force-limiting capabilities, and artificial intelligence control systems to allow safe interaction with humans. These arms are used in applications such as assembly ,material handling, quality inspection tending in industries like manufacturing, healthcare, and logistics. Their flexibility, ease of programing and industrial automation.

Arduino Uno

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The Arduino Uno is used for robotic arms because it is easy to use , cost-effective,and highly versatile. It can control motors (especially servos), read sensors , and various components like input devices. Its wide community support, built-in libraries, and ample Input ,output pins make it ideal for both beginners and advanced users, enabling quick prototyping and precise control of robotic arms.

Servo Motor

Working :- Servo motors in cobot control joint movement with precision, ensure accurate positioning, enable speed and torque adjustments, provide real-time feedback, and enhance safety for human robot collaboration. They are vital for tasks requiring precision, flexibility, and realibility.
Construction :- The servo motor consists of two winding stator and rotor windings. The stator winding is wound on the stationary part of the motor, and this winding is also called field winding of the motor. The rotor winding is wound on the rotating part of the motor and this winding is also called the armature winding of the motor.

1.2 Software Description

The Brain of the Robot

The robot runs on an operating system, just like your computer or phone. Some use ROS (Robot Operating System), an open-source system that helps control the robot, while others use custom software made by the manufacturer.

How It Moves

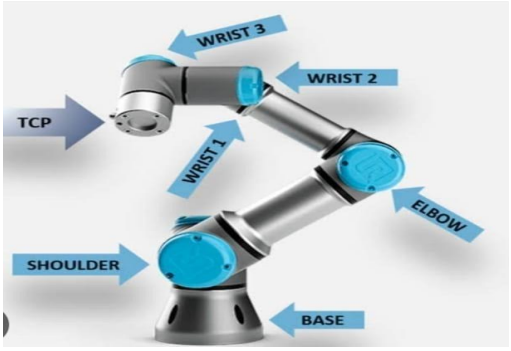
The robot figures out how to move its joints to reach a certain spot—this is called inverse kinematics (kind of like how your arm bends to grab a cup).
It plans smooth movements so it doesn't jerk around. If it touches something unexpected (like a person's hand), it can adjust its movement instead of pushing through.

How It Sees & Feels

Some cobots have cameras and sensors to recognize objects, scan barcodes, or even understand hand gestures. They combine different sensor data to be more precise, like how our brains use both our eyes and touch to understand the world.

Staying Safe Around Humans

If the robot bumps into something, it can sense the impact and stop immediately.
It operates at safe speeds and power levels to avoid hurting people.



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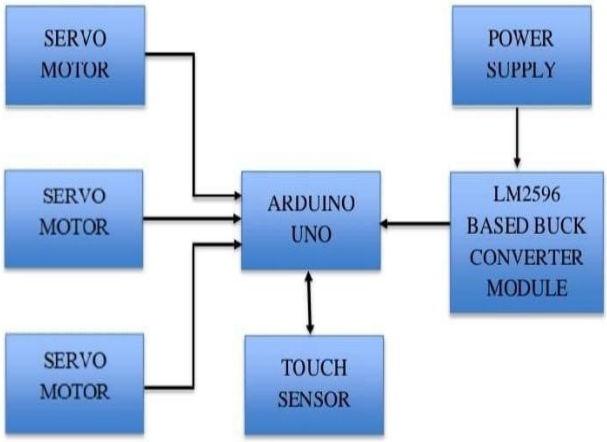
1.3 Software Description



" Block Diagram of collaborative Robotic Arm "

Power supply –
Provides electrical electrical power to the components . The LM2596- based buck converter module is used to Regulate the voltage and provide a stable power output To the Arduino and other components.

Arduino Uno –
Acts as the main controller.
Receive input from the touch sensor.
Process the input and sends control signals to the servo Motors.

Touch Sensor –
Detects touch and send the signal to the Arduino.
The Arduino reads the signals and determines whether to Activate the servo motors. A capacitive or resistive touch sensor used as an input device.triggers specific arm movements or actions when touched.

Servo motors-
Contolled By the Arduino based on the touch sensor's Input . The motors move accordingly to perform The required task (e.g. rotating a robotic arm , opening A mechanism, etc).

LM2596-
ADC-DC step down voltage regulator .
Convert the power supply voltage to suitable level for the Arduino and other components

1.4 Result

A collaborative robotic arm powered by Arduino offers an affordable and efficient way to automate tasks across different industries like manufacturing, education, healthcare, and agriculture. It helps boost productivity by handling repetitive work, reduces physical strain on humans, and enhances safety with smart sensors that detect obstacles and prevent collisions .Because Arduino is open-source, it's accessible to students, researchers, and small businesses, making it a great platform for learning and innovation in robotics, AI, and IoT. This project proves that smart automation is not only possible but also scalable and practical, paving the way for better collaboration between humans and robots in the future.

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" Actual Collaborative Robotic Arm "

1.5 Application

Industrial Automation
Picking and Placing – Used in factories to sort and assemble products efficiently.
Packaging and Labeling – Helps automate repetitive tasks like packing boxes and labeling items.

Education & Research
STEM Learning – Helps students learn about robotics, programming, and automation in a hands-on way.
Robotics Research – Used to explore AI, machine learning, and

II. CONCLUSION

An Arduino-powered robotic arm with pick-and-place and sensing capabilities offers an affordable and flexible way to automate tasks. By using sensors to detect objects and avoid obstacles, it ensures precision and safety, making it perfect for manufacturing, logistics, and education. Since it's built on an open-source platform, users can easily customize and expand its capabilities to fit their needs. As technology advances with AI, IoT, and machine learning, this robotic arm could transform industries by boosting productivity and enabling smoother human-robot collaboration.

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