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Solidworks Based 5 DOF Robotic Arm

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Abstract- The arrival of the Robotics arm has significantly influenced manifold divisions, such as transportation, Industries, and healthcare. A 5-Degrees of Freedom (DOF) robot would be able to move in five different directions, kind of a basic human arm. A precise 3D model using SolidWorks technology. It allowed us to visualize exactly how all the components would go together and move before ever laying hands on a physical component. The Arduino Microcontroller is acts like a Human brain because writing code that instructs each of the servo motors to perform their task, and just to make it even more awesome, add a PC application. That allowed us to control the arm from a PC, a desktop, or a mobile and smartphones. Imagination runs wild, getting the arm to pick up small objects and objects and push them around the table, all without any annoying wires. Ultimately, this paper is an electromechanical system providing us with a supremely practical and educational experience. The conclusion of this paper will be implemented to pick and drop the materials which can be electronics or any things. The mechanism of this paper is followed by the solidwork technology for implementations and 3D printing.

Keywords- Microcontroller, 3D printing, Motor's Bluetooth Module, SolidWorks,

I. INTRODUCTION

Robotic-arms are implemented in manifold divisions such as industrial automation, medical healthcare, automobile industries, surveillance, etc. This is very interesting when we think about how robots have changed our world. It made our life so easy, they have stepped in to handle those tough, repetitive jobs, making things more precise and keeping people safe from danger. These robotic arms are electromechanical devices which is designed to mimic the movement and activity of a Human being. As we push for smarter, more adaptable automation, we need to design robots that can be quickly imagined, tested, and put to work. There are some characteristics of Robotic-arm- Degrees of freedom (DOF), end effector, control unit, sensors, working envelope, payload and speed, accuracy, and repeatability. Programmability, safety features, etc. Robot programmers visualized and tested the behavior of the robotic-arm in different types, ie, Cartesian, Cylindrical, Spherical, polar, etc [1]. There are many solutions to handle the inverse kinematics problem, like geometrical, algebraic and numerical probabilities,
FABRIC methods [2].

The analytical method is very tough, but iterative methods are easily used in many applications [3][4]. Recently studied many papers related robotic-arm sareas. Lidong M et al. invented a multidimensional sspace microgravity ground simulation system [5]. RVIZ and Movelt designed a robotic-arm and realized their simulation of robotics features. Richard Tatum et al. realized the process of 7-DOF arm to make easy the inverse kinematics. With the help of RVIZ they visualized the robotics arm activity in 7 angles [6]. We have designed and put through its paces a 5DOF robotic-arm, all within the powerful world of SOLIDWORKS. We choose 5-Degrees of freedom because it is a sweet spot-enough flexibility to do a lot of different tasks, like picking things up or putting small part's together without any complicated. And solidworks is like a digital playground for any engineers. It lets us sculpt the arm in 3D, put all the pieces together, watch it move, even test its strength of all before we ever cut a single piece of metal.
Our goal here to show just how smooth and efficient robotic arm development can be truly harness solidwork, and finally founded its movements and testing virtually in solidworks. This kind of virtual prototyping are low cost and ecofriendly. In the following sections, we'll dive deeper into the arm's design, how it moves, what our simulations showed, and some exciting ways it could be used.
Functionality: A robotic arm's performance is fundamentally determined by its end effector and the sophistication of its control system programming. This design is super flexible, so it's great for all sorts of tasks. Think of it is a helpful assistant that can handle delicate tasks like painting a masterpiece, precisely welding a complex structure, or even efficiently picking and dropping items exactly where they need to go. Its made to adjust to whatever you need it to do. Effector's programing methods like track-pendant programing and offline programing enables the operation of the robotic arm. Think of a robotic arm as a highly skilled dancer, following a
precise choreography.

Every move, from gracefully reaching out to firmly grasping an object and then gently letting it go, is meticulously pre-programmed, ensuring everything happens in the right order.
Just like people come in different shapes and sizes with varying strengths, robotic arms do too! We can categorize them based on how they're built, how far they can reach, and how much they can lift. The most common types you'll encounter are:
 Articulated robots: These are the most human-like, with their multi-jointed "arms" allowing them incredible flexibility and freedom of movement. Imagine an acrobat, twisting and turning with ease – that's an articulated robot! They're ideal for jobs where you need a robot to be really nimble and reach everywhere.
. Their application include material handling, Panting and welding.
Cartesian robotic arms, characterized by their rectangular workspaces, excel in tasks demanding precise and repetitive movements. Handling repetitive tasks like
packaging products, meticulously assembling components, or efficiently picking items up and placing them precisely where they need to go.

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Fig-1 Embedded System Framework

I. DESIGN

For designing the robotic arm we will use SOLIDWORKS.

Fig-2. 3D model of robotic arm

Fig-3. Exploded 3D view of the robotic arm

Calculation- The total degrees of freedom (DOF) are determined by considering the individual degrees of contributed by its actuators. Specifically, there are five spinning actuators, each contributing one degree of freedom. The gripper's opening and closing mechanism, while an actuator, does not count towards the kinematic degrees of freedom of the arm's motion in space.

II. LITRATUREREVIEW

Manual material handling and sorting, common in many industrial settings, are labor–intensive and inefficient, particularly with high product volumes. The manufacturing sector has largely overcome these challenges through industrial automation, which boosts production rates and efficiency while lowering costs.

Robotics units have become crucial for effective material handling, increasingly replacing human works on production lines.

Material handling and sorting can be a real grind, Imagine spending all day moving and organizing mountains of products by hand. It's not just boring; it's also incredibly slow, especially when you're dealing with a huge amount of stuff. You can see how relying on people for that kind of work quickly becomes a bottleneck, making the whole operation less efficient[1] . Automation has been a game-changer for manufacturing, letting factories crank out more products faster and cheaper. Robotic arms are a big part of that, stepping in to handle all those repetitive tasks on the production line that humans used to do. It's like they're the new workforce for the monotonous jobs, freeing people up for other things[3,4] . Robotic arms as the ultimate multi-taskers in factories. They're everywhere because they're incredibly good at jobs that demand pinpoint accuracy, extreme precision, doing the exact same thing over and over again (repeatability), and doing it all really fast. That's why you see them handling everything from painting cars and welding parts to drilling holes and, of course, moving materials around. They're built for those exact kinds of demanding tasks[2,5].FEA as a digital testing ground for your robotic arm. Before you even cut the first piece of material or weld anything together, designers can use this powerful computer tool to virtually "stress test" their creation. They can see exactly where the arm might bend or break (deformations), where the most pressure will be (stresses), and how much of a safety margin they have. It's like having X-ray vision for the arm's structure, allowing them to fine-tune the design, make it stronger, lighter, or more efficient, all without wasting time and money building physical prototypes that might fail. It's a huge advantage for getting the design right the first time[1,6].It's made up of different sections, or "links," that are all connected by "joints"– just like your shoulder, elbow, and wrist. These links and joints work together to create a chain of movement, letting the arm reach, twist, and turn in all sorts of ways.This end-effector can be swapped out depending on what the robot needs to do. So, if it needs to pick things up, it might have a gripper[9,11].It's a bit of a double whammy: first off, they're often just too expensive for smaller businesses to afford. And then, there's also this worry about whether these sophisticated machines will actually hold up over time. It's a tough sell when you're thinking about investing a lot of money into something that might not last as long as you need it [5,7].Robotic arms are getting smarter and more versatile all the time, thanks to ongoing research. Folks are looking into all sorts of ways to use them, like building systems controlled by tiny computers to pick up and place objects, helping out in medical surgeries, sorting things by color, and even creating assistive technologies to lend a hand to people who need it[6,9]

There's a lot of work being done, both by private companies and the government, to make automation more accessible and affordable. It's like a big push to bring these advanced solutions within reach of even smaller businesses. So, even though it's been a challenge so far, the future looks brighter for places like India to adopt these helpful robotic arms[17].

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III. METHODOLOGY

Figure 4. To ensure a clear understanding of the robotic arm's physical structure, the actual model was constructed using 3D printing. This tangible representation allows for a direct visualization of the individual links and their spatial arrangement.

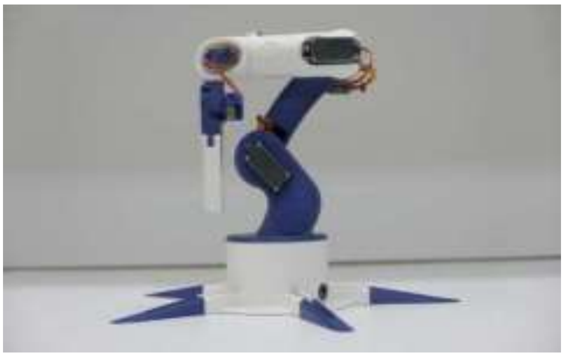

Fig-4. Robotic arm model lateral view

A. HARDWARE CONNECTION

A custom-designed circuit board was developed to meet the specific requirement of our robotic arm. This board facilitates the necessary connections for both the servo motors and their corresponding drivers, as detailed in the provided circuit diagram.

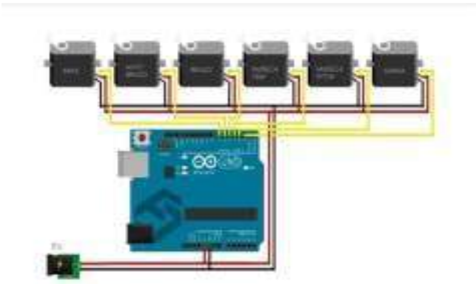

Fig-5. Electric circuit diagram connection

B. CODE

This section cover the programing for the robotic arm. The application is called the Arduino IDE (Integrated Development Environment) which stands for integrated development environment. The programming language we will used is the c are supported to the software. Programmers have access to a variety of input and output method using the software libraries provided by the Arduino IDE. One way to include a library that is used to identify mathematical equation while programing is by adding # include math. h> to the command line of the Arduino IDE for example. We created four programmers that show how the arm sensor work with various contemporary industrial forms of production by looking back at prior research.

```
#include <Servo.h>
#include <SoftwareSerial.h>
Servo servo_0; // Object declaration for the first servo
Servo servo_1; // Object declaration for the second servo's control
Servo servo_2; // The third servo's object declaration
Servo servo_3; // Declaration for the fourth servo object
Servo servo_4; // Object declaration to operate the fifth servo
Servo servo_5; // Object declaration to operate the sixth servo
Servo servo_6; //declaration of object that controls the seventh servo
(not utilized in this project)
```

Fig-6. Sample code for Arduino in C

Arduino Uno – Arduino – The open-source Arduino board, a microcontroller board, is based on a Atmega 2058 CPU. The growing environment of this board runs the processing or wiring language. Thise boards have revived the automation industry because of their user friendly platforms, which enable anybody with little to no technical experience to start by learning the skills required to operate and program the Arduino board.

Fig-7. Arduino UNO

For the PC application, we utilized the Fabric Creator App inventor, which streamlined the backend coding process through its convenient block-based interface.

The PC application facilitates the movement of the robotic arm, connection to the system via a wired connection. Once the interface was coded, the files were converted into a downloadable APK, enabling easy distribution and used across Multiple PCs and desktops.

Fig-8. PC Application

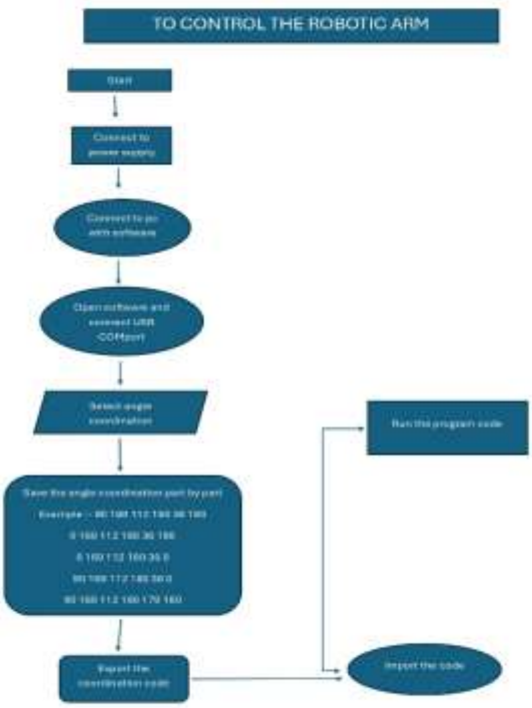

Fig-9. Flow chat

CONCLUSION

We've built a robotic arm that's incredibly flexible, with the ability to move in five different directions. At its tip, we attached a mechanical gripper that allows it to securely pick up, hold, and move objects from one place to another. To bring the arm to life, we used an Arduino board as its brain. The Arduino is a great tool for this because it gives us a

straightforward way to control all the motors that power the arm's movements. After running several tests, we're happy to say the arm works exactly as designed. One of its most useful features is the ability to record and save specific positions. This means we can teach it a sequence of movements and have it repeat them on its own, which is perfect for automating tasks.

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