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Design of Low-Cost Robotic Arm with Color Recognition Ability for Assistance in Surgical Environment

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Abstract*— Robotic arms are being utilized in diligence, boom effectiveness, productiveness and to provide perfection in the operations. This paper introduces the design and improvement of a Robotic Arm with Proximity and color Detection with the use of an Arduino microcontroller. This robotic arm has 3 degrees of freedom (DOF). This undertaking not only satisfies the criteria of being a substitute for difficult human labor but also a smart and multipurpose robot, because it can be used in choosing an item and object by performing a particular function. This color-recognition robotic arm can perform front and back operations, as well as actuation operations, such as grasping an object. This robotic arm is built based on Python software. It works on the basis of Python frame size, as it detects the color and performs the respective operation. This robotic arm may be very powerful in diverse fields, which includes clinical industries, Surgical motives. This allows the robot to pick the gadgets and make moves consistent with the entered instructions. By designing this robotic arm based on color sorting methods, we have executed actions based on the color detected which would possibly supply additional accuracy to the precise undertaking.

***Index Terms*— Low-Cost Robotic Arm, Color Recognition, Surgical Environment**

I. INTRODUCTION

These days, global robots and people work together to provide their given task the finishing touch. A selfgoverning, capable robot that can work autonomously to complete assigned tasks is referred to as an assistance robot. Some of the domains where such robots are being employed are industries, military initiatives, and medical industries. Dealing with molten metal when working on projects involving high temperatures or jobs like defusing explosives might be dangerous for individuals. Machines can therefore take the place of people in these kinds of dangerous occupations. The robotic arm is an automatable tool that can be programmed to carry out precise tasks in a variety of operations, including manufacturing, postal delivery, and home automation. It's undoubtedly a great logistical move. By allowing them to spend more time on other objectives, it is by far a great logistic robot for medical professionals, surgeons, the elderly, or perhaps even workers with demanding responsibilities. Based on its degrees of freedom DOF[3], a robotic arm may have a variety of designs. Assembly for Selected Compliance Based on the types of joints employed, including cartesian, cylindrical, round, and articulated, the Robot Arm (SCARA) was developed. Since the Covid-19 pandemic outbreak, all employees and workers have been required to practice social distancing in the workplace to reduce the risk of becoming enraged with one another. A robotic arm that resembles a human arm in this situation would be more relevant and practical than before. This is true for those who like first-hand receiving or searching for various gadget types in operating rooms, hospitals, and other related fields. current structure.

II. LITERATURE REVIEW

The literature survey of some existing systems is done:

- Norhazlan Abd Hamid, et.al. “An Overview of Robotic Simulation E-Learning”, In order to facilitate students' learning in a simulation environment, this study a summary of robotic simulation e-learning was given. The research will focus on developing a lab-based robotic simulation. Where lecturers utilizing conventional teaching methods questioned the problem-based learning (PBL) educational tenet.
- Mirella Santos Pessoa de Melo, et.al. “Analysis and Comparison of Robotics 3D Simulators”:— Validating robotics projects is a demanding task. It necessitates not just mental work but also the use of certain technology, making the proposed project expensive and, as a result, impractical to carry out. The usage of 3D simulators, which have been created with situations like architecture, gaming, and virtual reality experiences in mind but may also be used for robots, can improve this process.
- Roland Szabo, et.al. On a Raspberry PI, color recognition and robotic arm control will be shown. A little supercomputer, the Raspberry PI is appropriate for practically any embedded

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project. A Raspberry too. OpenCV, which is already loaded on the Raspberry PI, is used for color identification. Color-filtering bottle stoppers have permanently adhered to the joints of the robotic arm. These joints are connected by lines, and additional lines are drawn as reference points for specific calculations in mathematics. Based on these lines, a robotic arm's skeleton is built, giving the Raspberry PI information about the position of the robotic arm in space. The robotic arm may be maneuvered into the appropriate position with further computations.

- Paul Baksic, et.al. "Robotic needle insertion in moving soft tissues using constraint-based inverse Finite Element simulation": In this study, a technique for robotically guiding a flexible needle within moving and malleable tissues is presented. The technique uses a set of objective functions that enable the needle to be automatically guided along a predetermined route. A Finite Element is used to resolve an inverse problem connecting the motion of the robot end effector with the goal functions in order to follow the desired trajectory.
- Su Zhibao, et.al." A Robotic Simulation System Combined USARS " This work describes a novel USARS (Unified System for Automation and Robot Simulation) and RCS (Real-time Control System) library-based robotic simulation system. We are able to create 3D robot platforms and environments using USARS. Moreover, the RCS library makes it simple to create a modular onboard control system simulator that supports the real-time operation.

III. EXISTING METHOD

Manually sorting objects or products in companies that employ human labor takes time and energy, especially when there are many products to sort. It would save time and effort to replace human sorting operations with robotic ones. Also, it results in better effects. Similar to the human arm, a robot arm is a type of mechanical arm that can be digitally programmed to mechanically perform repetitive actions with excessive and exact precision.

IV. PROPOSED METHOD

Our challenge makes use of two effective technology merged collectively, Device studying and Robotics, to make a green device to aid in diverse applications. One of the maximum essential introducing is manipulators come under flexible Automation They may be updated and changed without problems. We have referred to several research papers which have been experimentally verified to take a look at the types of controllers used and special methodologies utilized by authors to determine the tiers of freedom of a manipulator used, for selecting an object and placing it at a designated function. Accordingly, gaining familiar knowledge after referring to these kinds of papers will assist in Designing the robot arm. Primarily based on the shade sorting strategy.

V. METHODOLOGY

The robotic arm's mechanical design is entirely based on a robotic manipulator with features like those of a human arm. Every such manipulator's links are connected by joints, allowing rotational motion and the hyperlinks to form a kinematic chain. The business ceasing of the manipulator's kinematic chain is referred to as the ceasing effector or ceasing of arm tooling and is comparable to the human hand. The usage of a commercially available gripper prevents the quit effector from constantly being incorporated into the design.

That is because the stop effector is one of the most difficult parts of the device, making it easier, less expensive, and more practical to utilize an industrial one than to manufacture one.

The robotic arm itself, the item placing mechanism, and the color block detection are the three main components that make up the prototype design. Tinkercad is a free online design tool that has been used for robotic arms. Its sliding and color blocks, color sensor, and servo motor positions are displayed in Fig.1 below:

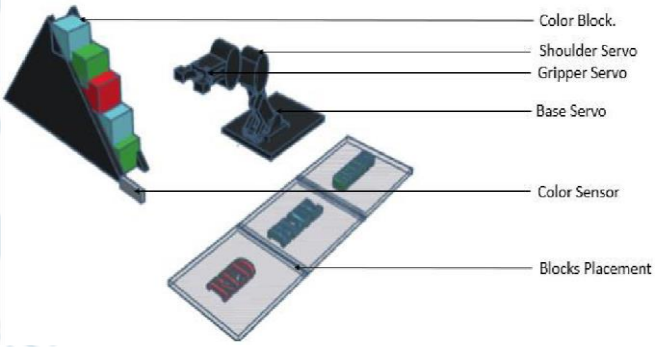

Fig. 1. Robotic Arm Design Prototype

Articulated design is used for types of joints. This is appropriate for motions with three degrees of freedom (DOF). The fundamental structure of the robotic arm is seen in Fig.2:

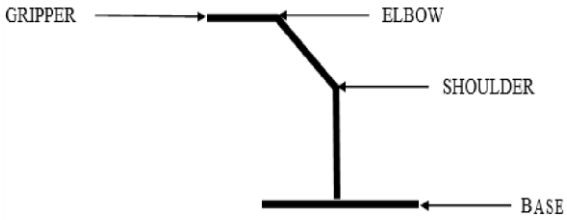

Fig. 2. Structure of Robotic Arm with 3 Degrees of Freedom

Color blocks do the sensing block's work. As seen in Fig.3, the color blocks are 1 cm cube-shaped. The blocks' hues are red, blue, and green, which matches the hues that the sensor can discern.

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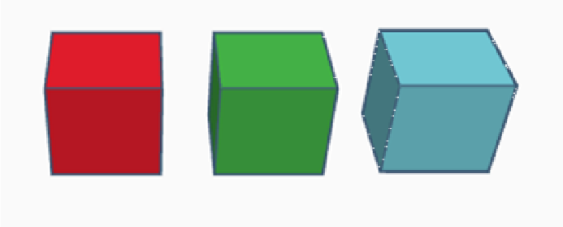
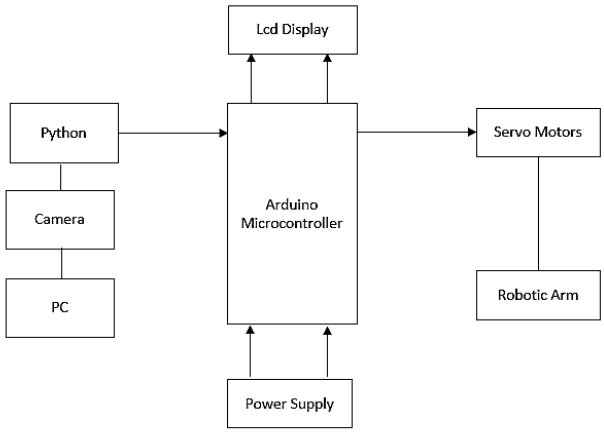


Fig. 3. Colour Blocks

VI. BLOCK DIAGRAM



VII. VII. RESULT AND DISCUSSION

A microcontroller and TCS3200 color sensor are used to detect color changes depending on their wavelength for the purpose of sorting colors. The 8x8 photodiode arrays on this robotic arm use four distinct filters to change light into current. Arduino is used to measure output frequency. The color sensor is extremely sensitive to changes in ambient light since it has two control pins. Readings will vary depending on how the light and distance are changing. As a result, the distance was set at 1 cm, and other tests using various light intensities were run.

VIII. CONCLUSIONS

To sum up, we have developed a sensor system in this project that can categorize items according to color and be integrated into various machine kinds. Given that the sensor can identify the color frequency under every circumstance. It may be applied to both indoor and outdoor settings. Analysis of the data in warm and neutral lighting reveals that the arm can sort objects across any environment in changing light intensities and that it can identify 95% of the time in bright conditions. Depending on the quantity of each color block recognized, the data counted is correct. All the goals were met, and this arm will be extremely beneficial for college students hoping to swiftly master a robotic arm system.

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