



Study on Cabot's Arms for Color, Shape, and Size Detection

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DOI: 10.5281/zenodo.6474401

Submission Date: 14th April 2022 | Published Date: 20th April 2022

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Abstract

Due to their user-friendliness and meticulousness, the various aspects of human workplaces have been influenced by Cabot's. Currently, industrial activities have become more computerized, increasing proficiency while simultaneously plummeting human labor, production time, and the great risks involved in the process. With the recent developments in technology, electronic technology has advanced, and the definitive aim of such technological developments is to make robotic systems as human-like as possible. Due to this blessing of technological advances, Cabot's will perform jobs far more proficiently than humans in challenging or critical situations in which humans cannot work. In this paper, various papers have been reviewed, and we have seen the impacts and challenges of using Cabot's over human beings.

Keywords: Arduino, Color Sorting, Cabot's Arm; Servo Motor; Shape Detection

INTRODUCTION

With the recent and continued improvement of science and technology nowadays, human living standards have been enhanced worldwide ^[19]. It has likewise improved economic growth and life anticipation ^[15]. Therefore, with such progress, human beings' work habits have changed considerably universally ^[16]. The use of robots in several fields, such as military combat, industrial production, and many other applications in recent years, has received extensive consideration ^[1,20]. To minimize labor costs, production time, and possible dangers in different types of risky tasks, the usage of robots is also encouraged ^[2]. For example, robotic arms are now often employed in many cases to execute jobs that humans cannot or will not undertake due to the high risk surrounding their environment ^[17]. Besides, to assist disabled or elderly people, computer vision-based robotic arms have been utilized in recent times ^[3]. Computer vision is a current improvement in the field of artificial intelligence (AI), and it is widely employed in industrial automation, detection, automated technology, and object identification ^[21, 22]. Picking and placing products faultlessly with unswerving motions is important in an industrial setting ^[4]. Additional control systems, such as joysticks or controllers, and even manual programming are now used to maneuver the erudite robotic arm ^[5]. The robotic system may offer a range of devices (sensors) such as temperature, radiation, color, weight, and so on ^[23]. Nevertheless, there is a growing propensity to substitute all of these sensors with a single-lens camera and computer vision approaches to perform the responsibilities independently with enhanced precision ^[24]. In this method, an innovative control method is employed using computer vision to drive a robotic arm ^[25]. Thanks to artificial intelligence and computer vision methods, a cost-efficient, user-friendly, and highly efficient robotic arm can be built using such methods ^[26]. Artificial intelligence and computer vision have been brilliantly used to operate complex robotic systems in a variety of works. For example, in a new work ^[6], the authors designed an automated robotic arm-based assistance device by employing simple stereo matching and Q-learning optimization methods. This proposed device can perform five degrees of operation in a single instance and detect any object with the aid of stereo vision. The system likewise keeps track of an object's parameters. The stereo camera can recognize RGB color. In this work, the Q-learning framework ^[29] is employed to control the position of the robot's arm. Lastly, the paper presented experiments to detect an object's stereo vision and feature point. The downfall of this research is that it did not specify the precise distance between the objects. In ^[7], the authors present a new approach using a two-armed industrial robot for bimanual hybrid motion/force control and visual serving. This work

aims to develop a telerobotic system that can manipulate a grabbed item with both arms. The experimental test bed is a dual-arm industrial robot with fifteen degrees of freedom, a camera, a torque/force sensor, and a rubber contact pad on each wrist. The operator's orders are sent by gestures using a Microsoft Kinect sensor. Seven processes are running on three PCs, and they are connected via a local hub using the protocol called TCP/IP. In addition, this author added global planning approaches to manage local equilibrium and more complex redundancy resolution. In this current research ^[8], the authors established a fusion-based manipulation of sensory-motor and a robotic bionic arm, a control strategy for grasping for an automated hand-eye system. This anticipated device was developed through vision serving, motion optimization, and a hybrid force approach. The arm of the robot was designed by joining various motors with an Arduino and was controlled with the aid of a Point Grey Bumblebee stereo camera. The hand was working from a matrix calculation using epee polar geometry ^[30]. In this research, various types of information like joint, relaxation, and grasping time graphs are collected with the help of 3 finger forces and a 20 frame per second camera capturing the images. In ^[9], the authors explore the idea of building a robot that can track colored objects. The brightly colored object has a basic design. A wheeled robot has been designed by utilizing a motor and wheels. A Pixy-2-based wheeled robot with sensors is used to distinguish objects with dissimilar colors. This robot moves in the same direction as the thing it's attached to be moving. When it comes to movement, this robot has two wheels, one on each side (right and left). The Arduino microcontroller is in charge of controlling the movement of this robot. In this current research ^[10], the author designed a self-feeding assistive robotic arm with seven degrees of freedom (DOF) for people with severe incapacities. The system uses a robotic arm simulator to get the motion of the robotic arm. In the process, inverse kinematics equations ^[31] were used to control the robot's arm position. The research showed that the robot could efficaciously transfer the food to the appropriate location for its user. The author conducted further experiments by adding a web camera that is attached to the end-effector of the robotic arm to monitor whether food dropped from its edge was eaten or not. The research in ^[11] emphasizes employing a computer vision-based robotic arm that will perceive numerous objects by color sorting, grab that object, and place it in a specific place. The proposed system will likewise measure the width, length, and distance between objects and identify the objects' position with the help of the computer vision method. The arm will do the movement using a servo motor controlled by an Arduino microcontroller as the brain of the whole system.

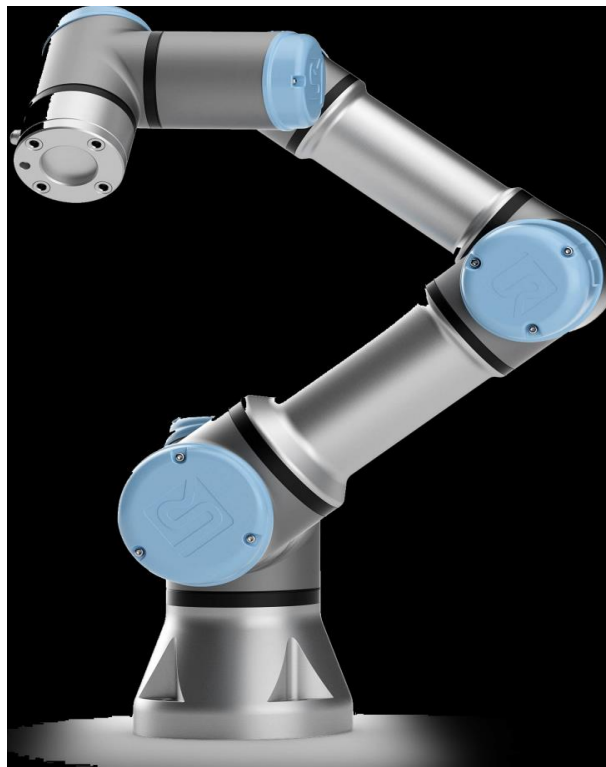


Fig. 1: The arm of the Cabot

METHOD ON HOW THE PROPOSED SYSTEM OF THE CABOT'S OPERATES

In this research, an automatic robotic arm has been built that can sort various items based on their shape, colors, and sizes. This proposed device can pick a selected object and place it in a specific place according to the desired distance. The subsequent paragraphs discuss the software and hardware elements utilized to design the proposed robotic device. A. Software Applications Arduino is a cross-platform IDE that allows programmers to amend code and then upload the code

to a board where it can be tested ^[27]. C++ and C are two major conformist languages for Arduino microcontrollers. As a result, the program primarily targets coders and developers who work in those two languages. In this research, we use this software to build the code, and with the aid of this software, we can control the robotic arm. Pixy Mon is a program that lets us specify the output port, set up the Pixy device, and control color signatures ^[28]. We can connect a universal serial bus (USB) connection to Pixy's back and run Pixy Mon to observe what Pixy sees when connected to the Arduino or other microcontrollers. With the aid of Pixy Cam, we use this software to perceive the colors of an object. Python is a programming language that enables connecting systems faster and more proficiently. We use this program to perceive the geometrical shape of an object. With the aid of easy Python language coding, we can load the image and calculate the geometrical shape of an object. The Anaconda is a Python and R programming language distribution that simplifies management systems to certify an installation in computer science. In this work, we use an Anaconda prompt to run the code and display the result for the shape detection of an object. The Arduino Mega 2560 R3 is a microcontroller board. It is based on the ATmega2560. It contains 54 digital input/output pins, 4 UARTs (hardware serial ports), 16 analog inputs, a USB connection, a power jack, a reset button, an ICSP header, and a 16 MHz crystal oscillator ^[12]. The use of this Arduino is to control the robotic arm through Arduino code. The Pixy CMUcam5 is a camera sensor that is compatible with Arduino and Raspberry Pi ^[18]. This camera sensor successfully loads the image where many other image sensors have failed. It is often challenging to utilize this sensor with a simple Arduino board-type central processing unit without getting drenched. We use this component for the color detection of a specific object. The Tower Pro MG996R is a servo motor consisting of metal gear. It has a maximum stall torque of 11 kg/cm ^[13]. It can rotate from zero to 180 degrees. This high-torque motor depends on the pulse width modulation (PWM) wave's duty cycle given to its signal pin, just like other RC servos. In this work, we used this motor to build the arm, grab the object, and place it in a destination folder.

Advantages of the Cabot's

1. Collaborative robots are flexible, easy to install and relocate.

Their small size makes them easy to assemble, disassemble, and relocate, moving them across the factory without changing the layout of the production. As for programming, kinesthetic guiding (hand guiding) makes robot programming accessible to everyone, not just engineers. Hand guiding allows the user to freely move the arm around in space, assigning the task himself. The demonstrated path is then recorded and can be accessed from the teaching pendant for further programming, which is usually intuitive. Such a process can take up to an hour. The quick change over time makes collaborative robots particularly interesting for SMEs (small-medium-sized enterprises) that have many different kinds of products produced at a low volume.

2. Cabot's are safer than industrial robots.

A major advantage of a Cabot over a six-axis robot is that they don't need a dedicated work cell, meaning there is no need for fences or light curtains (depending on the application, this is not always the case). That is because the robot's joints are force limited. This means that each joint is equipped with a force sensor that adds a quick reaction in case of collision, making the robot stop. Moreover, external sensors such as laser sensors can be added to slow down or stop the robot when a person approaches it.

3. Cabot's are cost-effective.

Collaborative robots may be cheaper than industrial robots (mainly because of their difference in size), although it's not only about the robots' cost but the investment as a whole. If all the side factors are taken into account, the difference in cost becomes even bigger. For example, as mentioned above, the lack of a need for a work cell and whatever that implies (hardware, human labor, and time) is cost-effective. In addition, employees do not need to undergo training, and there is no need for a robotics expert to be present to oversee or maintain the system. It is optional, as opposed to industrial robots. ROI (return on investment) takes less than a year for Cabot's, whereas for six-axis robots, it may take up to 18 months.

4. Cabot's can be two-armed and perform tasks even faster.

A feature that a few companies have added to Cabot's is a second arm, which is something not available in traditional industrial robots. The idea is that two arms can prove useful in delicate tasks like the assembly of small parts (e.g., electronics parts) or tightening screws, increasing speed and flexibility as a result. Parallel bin picking could be another application. Bin picking, the process of picking up small parts in random poses from a bin, can be executed faster with two robotic arms. A reason why two-armed Cabot's are not so popular yet is the complexity of coordinating the two arms to operate in tandem ^[35].

Disadvantages of the Cabot's

1. Cabot's are not a good choice when it comes to higher loads

Flexibility comes at a price. Cabot's typically handle small payloads of 3 to 10 kg, although some models can handle up to 35 kg. On the contrary, some six-axis robots have a handling capacity of up to 2 tons, but it also depends on the application. One thing is for sure: Cabot's are not meant for heavy-duty applications.

2. Cabot speed is limited.

As safety happens to be the main focus of a Cabot, it cannot be combined with high speed, especially when extra safety measures are taken, as mentioned above. A typical Cabot's speed is 250 mm per second, four times less than a traditional industrial robot. When users interact with the Cabot, its speed is reduced to embrace safety – at the expense of cycle time. Therefore, applications that demand high speed are typically not recommended for Cabot's.

3. Cabot's might not be as efficient as six-axis robots.

Programming with hand guiding might be convenient, but it also translates to human motions (demonstrated by the employee), which might not be the optimal solution in some cases. For example, if the task requires very precise and delicate movements, human users might not be able to instruct the Cabot properly. On the other hand, industrial robots create the trajectories internally through programming, producing faster and smoother, more optimized paths as a result.

4. Cabot's are not entirely independent.

A robotic-human synergy has its drawbacks. Even though a Cabot can work 24/7 (at least in principle), its need for human assistance or supervision is still there when everyone leaves the factory at night. In contrast, industrial robots can work at full capacity without human employees.

5. Safety approval of Cabot's can be troublesome.

The safety approval of a Cabot can be troublesome, not only because there exist a great variety of safety regulations, but also because the relocation and changes in the Cabot's tasks and/or change of tool may call for a new safety certification. This has to be done by a notified body as documentation of the CE-marking. For example, if the Cabot has a new gripper with pointy edges installed, its original function is considered changed. Therefore, one has to get a renewed safety approval, which costs time and money.

CONCLUSION

This paper presents the design and development of a computer vision-based automated system for sorting colors as well as detecting shape and size. It also proposed a method by which the Cabot's can detect the color of an object by utilizing a Pixy CMU camera sensor and pick and place the item in a specific place by employing an Arduino Mega and servo motors to control the robotic arm. The performance of the proposed intelligent device has been tested through the detection of random colored objects from all the papers I have reviewed. The proposed system is expected to reduce labor costs and increase productivity and efficiency in industries. Also, I have mentioned the impact and challenges associated with the Cabot's.

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CITE AS

Muhammad Ahmad Baballe, Mukhtar Ibrahim Bello, & Zainab Abdulkadir. (2022). Study on Cabot's Arms for Color, Shape, and Size Detection. *Global Journal of Research in Engineering & Computer Sciences*, 2(2), 48–52.
<https://doi.org/10.5281/zenodo.6474401>