Spectrum of Engineering Sciences
ISSN (e) 3007-3138 (p) 3007-312X Volume 3, Issue 5, 2025

DESIGN AND IMPLEMENTATION OF AN AI-DRIVEN OBJECT TRACKING ROBOT WITH HUSKY LENS INTEGRATION

Afnan Ahmed[1], Verda Tul Zohra[2], Ali Mujtaba Durrani[3], Abdullah Hidayatullah[4], Salman Anjum[5], Abdul Subhan[6], Syed Junaid Saleem[7], Muhammad Shahzaib[8], Romaisa Shamshad Khan[9], Abdul Aziz[*10]

[1, 5,6,7,8,*10]*Department of Electrical Engineering, CECOS University of IT and Emerging Sciences, Peshawar, Pakistan*
[2,3]*Department of Electrical Engineering, CECOS University Peshawar, Pakistan*
[4]*Department of Computer Sciences, CECOS University of IT and Emerging Sciences, Peshawar,*
[9]*Department of Electrical Engineering, NFC Institute of Engineering and Technology Multan, Pakistan.*

[1]ahmedafnan613@gmail.com, [2]verdaaah@gmail.com, [3]ali@cecos.edu.pk, [4]abdullah.hidayatullah1@gmail.com, [5]salmanlibra6@gmail.com, [6]abdulsubhan@cecos.edu.pk, [7]jsultan9050@gmail.com, [8]muhammadshahzaibkhan487@gmail.com, [9]romaisa1khan@gmail.com, [*10]abdulamiruet@gmail.com

DOI: https://doi.org/10.5281/zenodo.15411407

Keywords
Artificial Intelligence, Machine Learning, AI, ML, Robots, Object Tracking, Huskylens, Arduino.

Article History
Received on 05 April 2025
Accepted on 05 Mayl 2025
Published on 14 May 2025

Corresponding Author: *
Abdul Aziz

Abstract

The era of Artificial Intelligence has arrived, with robotics as its most significant application. This paper introduces an object-tracking AI robot programmed to follow a specific object. The robot uses the AI-powered camera HuskyLens to sense and track the objects. The robot is such that it is first trained to learn the object. Once discovered, the robot is able to track and follow the specific object. The HuskyLens senses the object, and the information is passed to the Arduino, which then enables the motors via the motor driver to follow the object. Some existing techniques for controlling object tracking robots are IR sensors, LDR, and RGB sensors. As most of these sensors are not designed for object tracking, these techniques are often not useful enough to meet the requirements of accurately tracking the object. Huskylens, with its AI-powered smart camera alone, can be used as the only sensor in the system to control movement and fulfill the functionality required for object-tracking robots and their various applications.

INTRODUCTION

The world is heading towards evolution; everyone wants a job done smartly. With the development of human civilization and technologies, human life has changeda lot in the past few decades. Less effort, short duration, security, high performance, and accurate results are needed. Automation is a concept introduced that integrates these to fulfill the needs. Anything that requires less effort and provides the demanded output is a brilliantjob. A manual job takes longer and more effort, and may encounter any unwanted situation. To reduce it, automation is a concept that replaces the manual system.

Furthermore, intelligent robots are now used daily for entertainment, medical care, home security, and services in other fields. Intelligent robots integrate electronics, mechanics, control, automation, and communication technologies. Different types of robots have been developed in recent years to meet various needs. The development of robot systems combines the theoretical expertise of many professionals. Related studies and applications are

extensive, Including obstacle avoidance, path planning, and visual image processing [1]–[4].
Moreover, computers can already solve problems in limited realms. The basic idea of AI problem-solving is straightforward, though its execution is complicated. First, an AI robot or computer gathers facts about a situation through sensors or human input. Then, this information is compared to stored data, and what the information signifies is decided [5]. In [6], [7], the computer runs through various possible actions and predicts which action will be most successful based on the collected information. Some modern robots can also learn to a limited capacity. Learning robots recognize if a specific action (moving its legs in a certain way, for instance) achieves a desired result (navigating an obstacle). The robot stores this information and attempts to take successful action the next time it encounters the same situation. Again, modern computers can only do this in minimal situations. They cannot absorb any information like a human can. Some robots can learn by mimicking human actions [8], [9].
Additionally, some robots can interact socially. Kismet, a robot at MIT's Artificial Intelligence Lab, recognizes human body language and voice inflection and responds appropriately. Kismet's creators are interested in how humans and babies interact, based only on tone of speech and visual cues. This low-level interaction could be the foundation of a human-like learning system [10]–[12].
The primary goal of our work is to design and fabricate a robot that tracks the target and moves towards it while doing so. To perform this task accurately, the robot needs a mechanism to visualize the object and act accordingly.
Likewise, the main hindrance in this kind of work is the sensitive target detection. The object must be unique for the robot to recognize and carry out the objective.
This paper consists of five sections: Section 2 is about architecture and design, in which we discuss the components we used in our project, including a circuit diagram, block diagram, and flow chart. Section 3 discusses the workings of our project and the tasks that the project can perform. Sections 4 and 5 discuss the experiments' conclusions, respectively.

I. SYSTEM ARCHITECTURE AND DESIGN

A. Components Used

The components used are given as follows:
1) Arduino UNO: Arduino UNO is a micro-controller board based on the ATmega328P as shown in Fig.1. It has 14 digital input/output pins of which six can be used as PWM outputs, six analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. UNO means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The UNO board and version
1.0 of Arduino Software (IDE) was the reference version of Arduino, which has now evolved to newer releases.

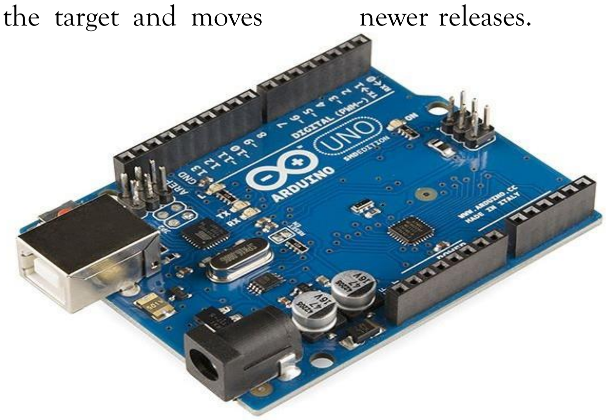


Fig. 1. Arduino UNO.

2) Huskylens: Huskylens is an easy-to-use AI machine vision sensor with seven built-in functions: face recognition, object tracking, object recognition, line tracking, color recognition, tag recognition, and object classification, as shown in Fig. 2.

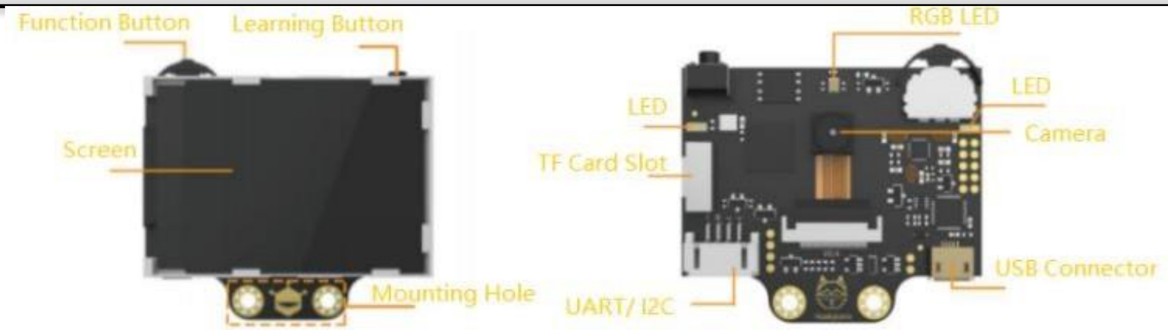


Fig. 2. Huskylens.

Connectors: A 4-pin Connector in UART Mode, as shown in Table I, and a 4-pin Connector in I2C Mode, as shown in Table II, respectively.

TABLE I
4PIN CONNECTOR IN UART MODE

Numbers	Label	Pin function	Description
1	T	TX	TX pin of Huskylens
2	R	RX	RX pin of Huskylens
3	+	VCC	Positive(3.3-5.0v)
4	-	GND	Negative(0v)

TABLE II
4PIN CONNECTOR IN I2C MODE

Numbers	Label	Pin function	Description
1	T	SCL	Serial clock line
2	R	SDL	Serial data line
3	+	VCC	Positive(3.3-5.0v)
4	-	GND	Negative(0v)

3) General Setting: The general setting can be done through Huskylens, as shown in Fig. 3, through the internal setting of the lens.

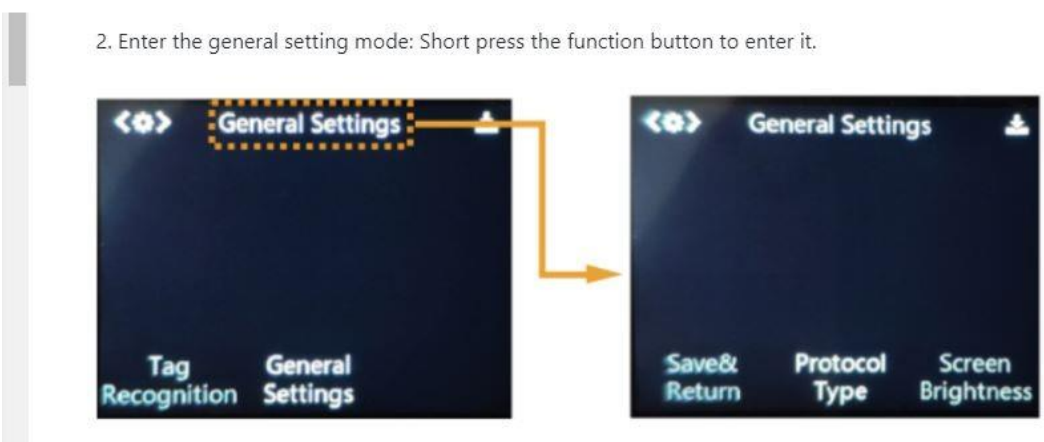


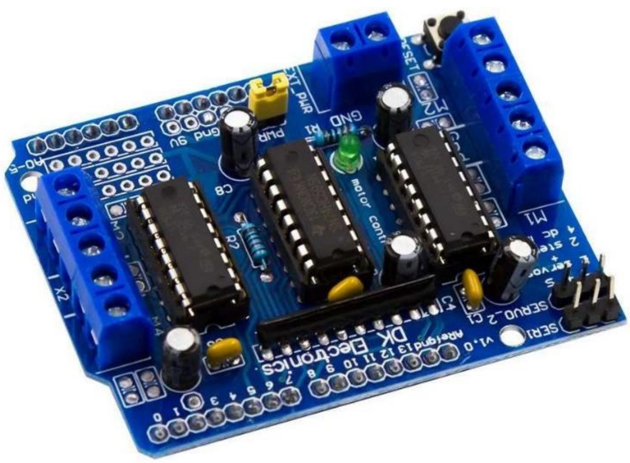
Fig. 3. General setting of Huskylens.

4) L293D Motor Driver: The L293D is a 16-pin Motor Driver IC that can control two DC motors simultaneously in any direction. It is designed to provide bidirectional drive currents of up to 600 mA per channel at voltages from 4.5 V to 36 V at pin 8, as shown in Fig. 4

5) Wheel Robo Chassis: The 4-wheel robo chassis consists of a chassis body with two separate plastic boards, one at the top and one at the bottom. Both of these are attached with nuts and bolts. As per the name, 4-wheels, which means it contains 4 DC motors to control each wheel separately. In our robot, these motors are connected with the L293D motor drive shown in Fig.5.

B. Circuit diagram

The circuit diagram consists of the AI component Huskylens. Huskylens consists of 4 pins, two for power and 2 for communication. Huskylens' red and black wire is used for VCC and GND. These pins are connected at '+' and '- 'on the L293D motor drive. The circuit diagram consists of the AI component Huskylens, shown in Fig. 6. Huskylens consists of 4 pins, two used for power and 2 for communication. The red Moreover, Huskylens' black wire is used for VCC and GND. These pins are connected at '+' and '- 'on the L293D motor drive. The green and blue wires are used for communication, as we are using I2C mode for communication. So, the green wire will be SDA connected at port A4 of the motor drive, and the blue wire will be SCL connected at port A5. The motor drive is also associated with four DC motors of the robo chassis at ports (M1, M2, M3, M4) as defined in coding. Themotor drive is placed over Arduino UNO. The whole circuit is powered by four rechargeable battery cells (lithium-ion) connected in parallel, with each cell having a voltage of 3.7V and a current of 2600mAh.



C. Block diagram

The block diagram shows the basic Architecture of our robot, as shown in Fig.7. The first thing is the power supply, which powers up every component on the robot. The power supply in our robot gives a voltage of 7.4 volts.It is directly connected to the Arduino. Arduino is further connected with the L293D motor drive and Huskylens. The motor

Fig. 5. 4-wheel Robo Chassis.

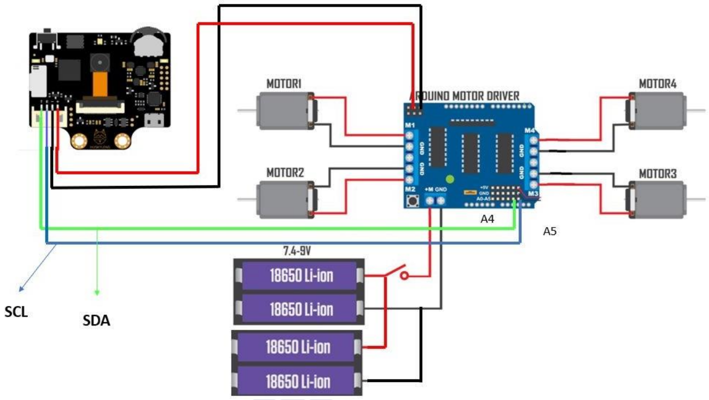


Fig. 6. Circuit diagram.

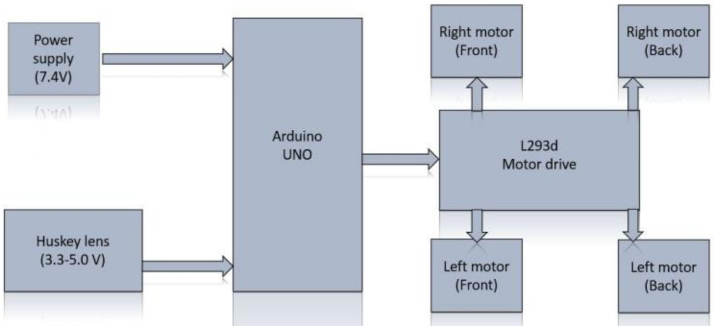


Fig. 7. Block diagram.

The drive is connected with the four-DC motor of the robot, which controls wheel movement. As per the diagram, we can see that data collected by Huskylens is sent to Arduino continuously, where decisions are made about how the robot will respond to the data. Then, from Arduino, instructions are given to the motor drive to move the robot forward, left, or right as per the position of the object.

D. Flow Chart

The flow shows the primary process and steps of coding, or we can also say that it is the pictorial form of the coding shown in Fig. 8. The first step is to check the connectivity of Arduino with the Huskylens and Arduino connection with the motor drive, after making sure everything is correct. The next step is to set the parameters, which include importing Husky libraries, defining pins for the motors on the motor drive, motor speeds, displacement, and offsets. The next thing is to determine which module of Huskylense we are using in our case, Object Tracking. After setting everything up, Huskylens and Arduino start the main work. Arduino will first acquire from Huskylens, and then Huskylens will learn any object.

If it's not there, an orange square will appear on the screen, the husky's screen, which first makes the husky learn an object. Now, coming towards the following condition, Arduino will acquire the object's position from Husky if it is a yes. If the object is in the center, far from the robot, the Arduino will instruct the motor drive to move the robot in a forward direction. If the object is in the center, close to the robot, the Arduino will instruct the motor drive to stop. If the object is present to the left, the Arduino will instruct the motor drive to increase the speed of the right-side wheels and prevent the left side wheels from turning the robot towards the right. If the object is present to the right, the Arduino will guide the motor drive to increase the speed of the left wheels and stop the right ones, turning the robot towards the right. This process will continue until the robot is turned off or a new object has been learned.

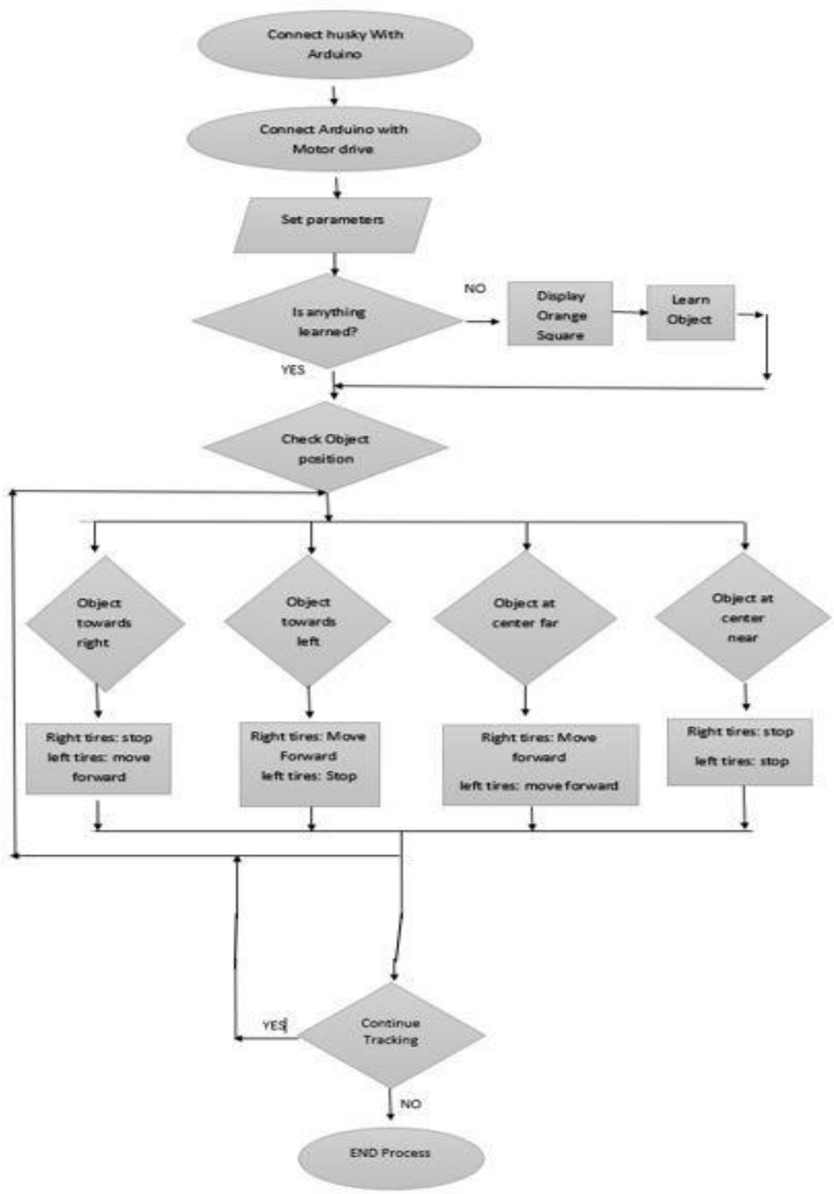


Fig. 8. Flow Chart.

HARDWARE IMPLEMENTATION

A. Project Model

The robot contains a four-wheel chassis and four DC motors, running all the wheels individually. The[scale=0.4]re is a motor drive (L293d) that controls all four motors' movement. The motor drive is placed over Arduino UNO. These are both collectively put in the middle of the chassis. The AI module Huskylens is placed in front of the chassis with its bracket. Huskylens consists of four pins: a ground (GND), a positive voltage (VCC), a Tx pin, and an Rx pin for data exchange between Arduino. The VCC and GND of Huskylens are connected with the motor drive as shown in Fig.9. The Tx and Rx pin is connected with the clock cycle and data pins of the motor drive. The robot consists of 2 batteries (cells) that power Arduino, the motor drive, and Huskylens.

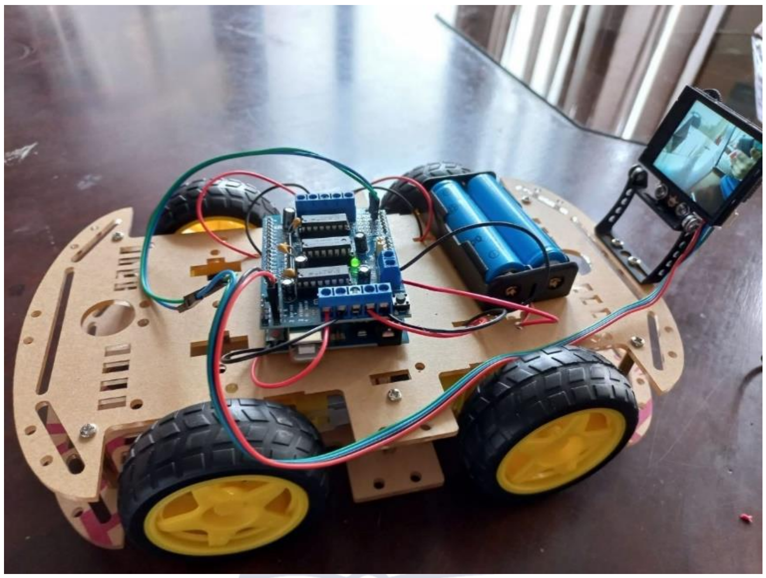


Fig. 9. Project Model.

B. Working

First, all the connections are checked. After checking all the connections, the power switch is turned on. The first thing to do is to set up Huskylens by selecting its communication mode, i.e., I2C, and choosing the data rate. Now select the object detection mode. Now starts the learning process after an object is learned by the Huskylens, which is stored in the memory. The learning process uses a machine learning algorithm. After learning, Huskylens checks whether the learned object is within its radius. If present, Huskylens calculates its position and sends data to Arduino continuously, as shown in Fig.10. If the object is in the center. Still, far, Arduino moves the robot towards the object with the help of the motor drive. If the object is in the center, but near the robot stops. If the object is present towards the left, the Arduino, through motor drive, stops the rotation of the left side motors and increases the speed of the right-side motors to turn the robot to the left. Similarly, if the object is towards the right, Arduino, through the motor drive, stops the rotation of the right-side motors and increases the speed of the left-side motorsto turn right.

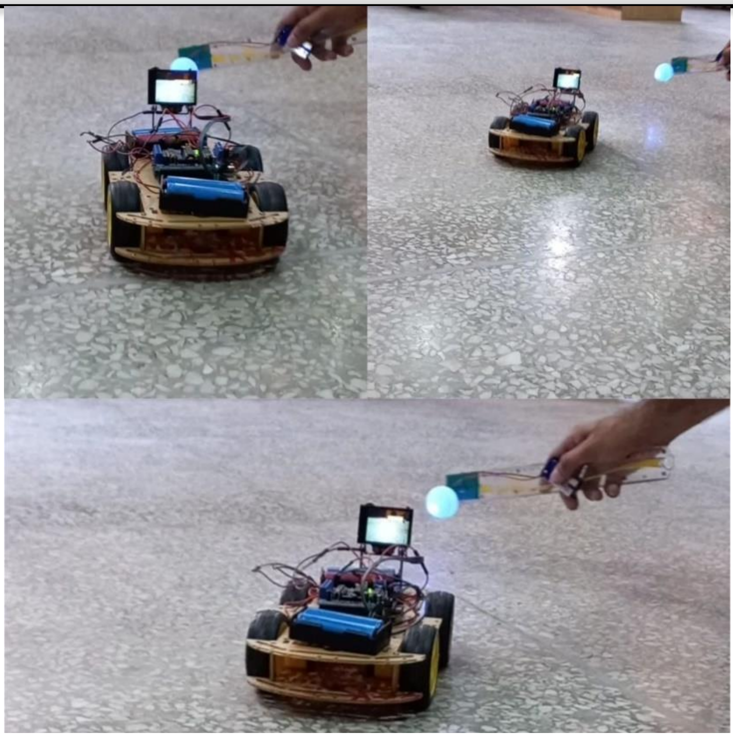


Fig. 10. Performing AI Object Tracking.

C. Other Tasks Robot Can Perform

Besides object tracking, the robot is capable of performingother tasks too. The robot is capable and efficient enough to learn more than one object and follow it using same object tracking phenomena shown in Fig.11. The robot is capable to perform line following it is done by just changing the mode in Huskylens from object tracking to line following and by defining the line following algorithm in the code. The robot can also detect and follow that specific color through artificial intelligence. The robot can also be used for obstacle detection. Previously, it was done by ultrasonic sensors, but this robot can perform the same task more efficiently through artificial intelligence. The robot can also learn a single face and multiple faces, and can follow them too.

II. CONCLUSION

AI-based Object Tracking Robot is a proposed solutionand a human companion. It is also a remedy for our daily lives, commercial routines, and job helpers. The goal was to introduce a machine that could help perform our daily life tasks. It is designed and developed to be used for both home and commercial purposes.

The project proposed introducing a method to find an object using object-following techniques. While working on this robot, we used several techniques to fill the requirement gap. The first requirement is to search for an already learned object. Now we had to face several challenges, like the object having a clear visibility could not pick up the segments due to very low or high light exposure, plus the scene captured by the robot could not be recognized because of its size

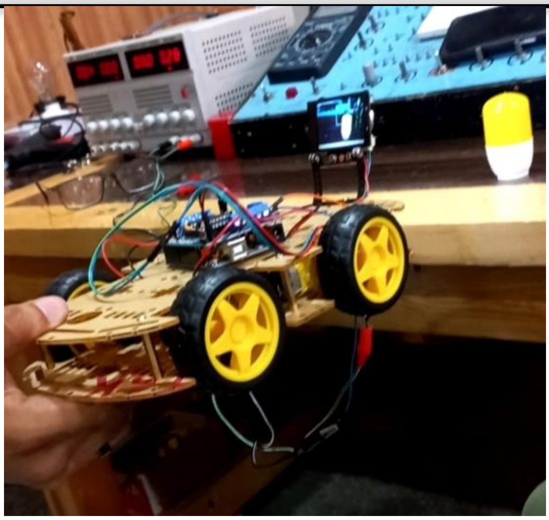


Fig. 11. Performing AI Color Detection Tracking.

Color combinations, texture, and dimensions. Any similarity had confused the robot several times, but using different techniques, we could minimize almost all of them and meet our goal to some extent. The set of techniques comprises line following, object detection, color similarity, segmentation, conversion of colors to gray scale, and binary. It is used in the robot's movements to maintain the motion intact and keep on working unless the searcher part completes its work and finds the object.

It was challenging to minimize them all, but our hard work and consistency made it possible, and we have successfully developed as proposed. Furthermore, it is planned to attach arms and respective components to help a person physically.

REFERENCES

[1] Hassan, Muhammad Sarmad, Mafaz Wali Khan, and Ali Fahim Khan. "Design and development of a human following robot." In Student Re- search Paper Conference, vol. 2, no. 15. 2015.

[2] Shih, Cheng-Han, and Jih-Gau Juang. "Moving object tracking and its application to an indoor dual-robot patrol." Applied Sciences 6, no. 11 (2016): 349.

[3] Hasan, Kazi Mahmud, and Abdullah Al Mamun. "Implementation of vision-based object tracking robot." In 2012 International Conference on Informatics, Electronics Vision (ICIEV), pp. 860-864. IEEE, 2012.

[4] Russell, Stuart J. Artificial intelligence a modern approach. Pearson Education, Inc., 2010.

[5] Michalski, Ryszard Stanislaw, Jaime Guillermo Carbonell, and Tom
M. Mitchell, eds. Machine learning: An artificial intelligence approach. Springer Science Business Media, 2013.

[6] Perkowitz, Sidney. "Digital people: From bionic humans to androids." (2004).

[7] Garc ́ıa, Daniel Herna ́ndez, Pablo G. Esteban, Hee Rin Lee, Marta Romeo, Emmanuel Senft, and Erik Billing. "Social robots in therapy and care." In 2019 14th ACM/IEEE International Conference on Human- Robot Interaction (HRI), pp. 669-670. IEEE, 2019.

[8] Miller, Tim. "Explanation in artificial intelligence: Insights from the social sciences." Artificial intelligence 267 (2019): 1-38.

[9] Cockburn, Iain M., Rebecca Henderson, and Scott Stern. "The impact of artificial intelligence on innovation: An exploratory analysis." In The economics of artificial intelligence: An agenda, pp. 115-146.

University of Chicago Press, 2018.

[10]Adam, Amit, Ehud Rivlin, and Ilan Shimshoni."Robust fragments-based tracking using the integral histogram."In 2006 IEEE Computer society conference on computer vision and pattern recognition (CVPR'06), vol. 1, pp. 798-805.IEEE, 2006.

[11]Nebehay, Georg, and Roman Pflugfelder."Consensus-based matching and tracking of keypoints for object tracking."In IEEE Winter Confer- ence on Applications of Computer Vision, pp. 862-869.IEEE, 2014.

[12]Babenko, Boris, Ming-Hsuan Yang, and Serge Belongie."Robust object tracking with online multiple instance learning." IEEE transactions on pattern analysis and machine intelligence 33, no. 8 (2010): 1619-1632.

[13]Garc ́ıa, Daniel Herna ́ndez, Pablo G. Esteban, Hee Rin Lee, Marta Romeo, Emmanuel Senft, and Erik Billing. "Social robots in therapy and care." In 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), pp. 669-670. IEEE, 2019.