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Open CV System Study for Robot System Path with Black Box Barrier

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Abstract: Obstacle avoidance robot is a project implemented to avoid obstruction of black box objects that can be detected by robotic cameras. Obstacle avoidance robot is one of the robots competed in the FIRA Malaysia robot competition, especially for the avoidance challenge category. The problem faced by the Obstacle avoidance robot team RIG PPD robot team is to process the image of the black box barrier data and the robot movement is not smooth. The imaging process system has been improved using Open CV. The robot vision system will process the robot's front view and avoid obstacles to the black box object in front. The control system for this obstacle avoidance robot involves input and output hardware, controllers, interface and programming. The robot control movement part uses the Arduino microcontroller programming platform.The new vision system can avoid obstacles more smoothly than the old robot system.
Keywords: robot, avoidance challenge, camera, obstacle avoidance, OpenCV

I. INTRODUCTION

Robotics is a branch of engineering and interdisciplinary science that includes mechanical engineering, electronics, information technology, computer science, and others.

The technical features of robots relate to the design, construction, operation, applications, computer systems for their control, sensor feedback, and information processing. Robotic technology today is used to develop machines that can replace humans and mimic human actions. The development of robot technology has also led to international competitions that mimic sports competitions such as soccer robots and so on

The FIRA world football robot competition began in 1995. The first international tournament was held at KAIST, Daejeon, Korea in 1996.

The FIRA International Football Robots Association was established in June 1997 with the basic goal of developing science and robotics technology to ordinary people and the younger generation, through the game of robot football. Football robots can be described as an advanced robot technology competition in a confined space. It offers a challenging arena for the younger generation and researchers working with autonomous mobile robot systems.

The Port Dickson Polytechnic robotic team known as the RIG PPD (Robotics Interest Group Polytechnic Port Dickson) has been involved in robotic competitions at the national and international levels. Achievement results in the avoidance challenge category are not very consistent every year.

The Port Dickson Polytechnic robotic team in 2016 was selected to represent the Malaysia B team at the FIRA Roboworld competition in Beijing, China. The big challenge for this team is technically to face the teams of other countries like Taiwan and South Korea at that time.

Following this there are many things on robots that need to be modified to improve performance to earn medals consistently every year in the avoidance challenge category. For that reason, modifications need to be done carefully to ensure the robot is in good condition and able to perform brilliantly.

The application of the RoboRealm program as a visual program of the robotic system sometimes causes the data processing system to enter the microcontroller takes a long time. It also creates many host connections for each level of visual processing.

The problem is solved with development steps and identifying system objectives. Designing and developing a robot model avoids more effective vision system barriers, using appropriate tires, new software and programming.

The scope of project development involves studying and building the type of robot that only involves the type of avoiding obstacles. Study the python Open CV program and use this program to develop a robotic vision system. In addition, the robot barrier path plan with certain technical parameters is developed as well as analyzing the results of the robot movement

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II. LITERATURE REVIEW

The design of the Obstacle avoidance robot system design allows the robot to navigate in an unknown environment by avoiding collisions [1]. The study to develop this project focuses on the types of Obstacle avoidance robots, central control systems, vision control systems and mechanical driving elements. Nowadays, there are several types of obstacle avoidance robots that have been developed with different technical aspects in terms of input, controller and system output elements. Robots require a combination of elements of sophistication of intelligence, movement, mobility and navigation [2]. The development of visual technology using cameras has been used for this type of robot. The installation technique of a single camera mounted on a moving robot allows the object to be detected and subsequently the movement can be controlled [3]. A microcontroller is a cheap small computer and is built to facilitate the task to be done either automatically or manually. The study of microcontrollers used focuses on Arduino brand manufacturers. The Arduino is an open source microcontroller that can be easily programmed, deleted and reprogrammed at any time [4]. Arduino MEGA Arduino Mega is a micro controller board based on ATmega1280 (strands) as stated on. It has 54 digital input / output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (serial port hardware), a 16 MHz crystal oscillator, USB connection, power jack, ICSP header, and reset button. The technical aspect as a microcontroller controller, requires a network connection to the computer with a USB cable or power with an AC to DC adapter or battery to start. The overall movement function of the robot is controlled by the Arduino program The program is developed using the concept of Language C where the input signal from the visual program and the program for the output signal to the robot mover i.e. the motor is processed according to the needs and requirements of this robot system. A robot vision system is a robot equipped with one or more cameras that are used as sensors to give a secondary feedback signal to the robot controller to move more precisely to the changing target position. A robot vision system needs to be equipped with a programming system and a camera device.

A webcam is a video camera that captures or streams images in real time to or through a computer to a computer network. Fig. 2.0 below shows an example of a webcam that can serve as an input element to be connected to a microcontroller and computer system. Digital cameras like webcams basically have three functions, to capture images we call data, to store image data, and to represent this data. Today images are stored and processed in the form of digital data in bits.

Fig. 2.0 Webcam

The operation of webcam is connected to a micro-control system such as the Arduino. The control system needs to be developed in conjunction with programming. Among the programming used for webcam operations such as RoboRealm and Open CV. Robo Realm is an application for use in computer vision, image analysis, and robotic vision systems. RoboRealm provides a Windows-based GUI for experimenting with different modules that can be customized to achieve the desired results. The main goal of Robo Realm programming is to translate visual input signals into controller commands to control the movement of robots or provide feedback based on what the machine sees. Open CV (Open Source Computer Vision Library) is a source of information for programming functions for the purpose of real time computer vision. Computer Vision (CV) applications require extensive knowledge of digital signal processing, mathematics, statistics and perception [4]. The mechanism of movement of the robot is influenced by the type of tire and the design of the wheel position on the robot. The omni wheel, or poly wheel, is a wheel with a small disk around the circumference perpendicular to the direction of rotation [5]. The effect is that the wheels can be moved at full force, but can also slide sideways easily. These wheels are often used in holonomic drive systems. The design of the wheel position depends on the number of wheels and determines the direction of movement of the robot. Fig. 2.3 shows an example of a three- and four-wheel design with a three-wheel design, it is impossible to get 100% efficiency from the wheels. This is because in three wheel designs, no more than one wheel will ever be parallel to the direction of motion. But with four wheels, two wheels can move at 100% efficiency, while the other two wheels remain idle, for more efficient full-speed movement. All other angles will also be more efficient than with the three wheel Omni robot wheel.

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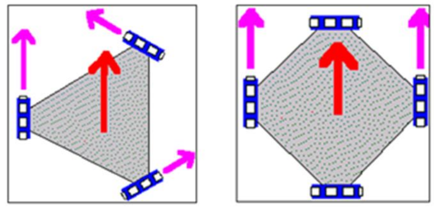

Fig 2.1 Three-wheel and four-wheel design

The position of the four wheels is at 90 degrees from each other, while the three wheels are at 120 degrees angle. The four-wheel design has wheels that are opposite to each other, which means that a pair of wheels requires only a single calculation, with one wheel receiving negative numbers while the other positive. Three wheel designs do not have a pair of wheels, meaning three calculations are required. Fig. 2.2 describes the operation of a rotating three-wheeled type.

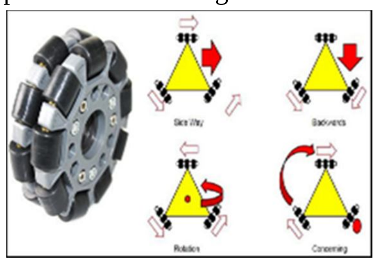

Fig. 2.2 The operation of a rotating three-wheeled type.

III. METHODOLOGY

In developing robot obstacle avoidance, some technical aspects need to be prioritized before the next process is carried out. Technical features include the basic structure of the robot chassis platform, robot movement, control system, program in vision and actuators as well as obstacle course plan. The first thing to think about is the basic structure of the robot chassis platform. This part will play a major role in moving the body structure of the robot. A three-wheel drive robot chassis platform was selected for the design of this robot project as shown in Fig. 2.2.

For this project, the movement of the robot structure to avoid obstacles is planned and tested with two methods namely pan and left or right displacement. The purpose of this movement is developed to determine the appropriate movement to be used in the situation of the position of the black obstacle object during the competition. The barrier object measures the length and width of the site which is 45cm while the height is 70 cm as shown in Fig. 3.0. Fig. 3.1 below shows the idea of basic robot movement to avoid black objects.

Fig. 3.0 Black box obstacle

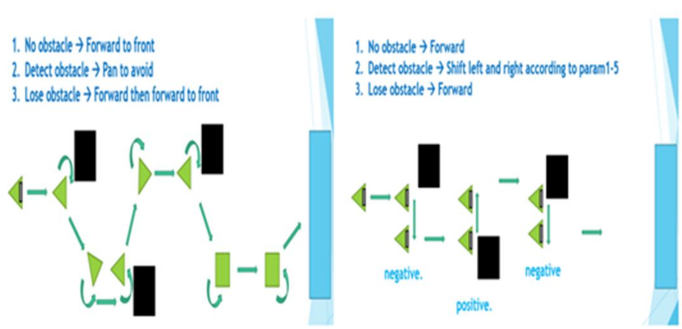

Fig. 3.1 The basic movement of the robot to avoid black objects

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The control system for this obstacle avoidance robot involves input and output hardware, controllers, interface and programming. The hardware part involves the input of the control system is. web cam. The output hardware is three units of DC motor that serves as the main driver of the structure controlled by the interface part which is DC motor shield. For the centralized control unit it involves the use of a laptop where it controls the operation of the Open CV vision program and in the robot control movement part uses the Arduino microcontroller programming platform. The function of the Arduino microcontroller is to receive the output signal that has been processed on the Open CV program. The signal that has been declared with a value will be received by the Arduino for the process of controlling the movement of the robot by sending a signal to the DC motor shield. Fig. 3.2 shows the Obstacle avoidance robot control system for this project.

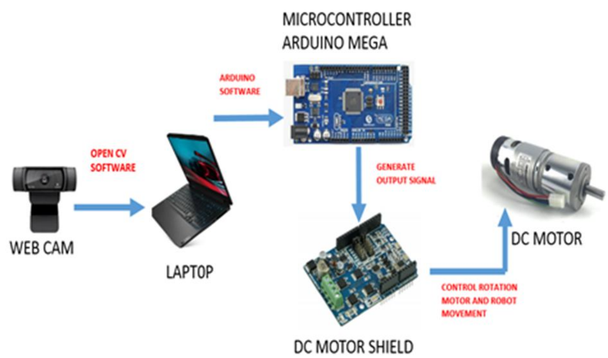

Fig. 3.2 Obstacle avoidance robot control system

Object recognition is widely used in machine vision industry for inspection, registration and manipulation tasks [6]. The robot vision system will process the robot's front view and avoid obstacles to the black box object in front. Open CV is used as a program to process images in front of robots. The imaging process involves several steps as shown in Fig. 3.3. The result of image processing produces several situations where the output of the value will be processed at the Arduino program stage to control the movement of the robot.

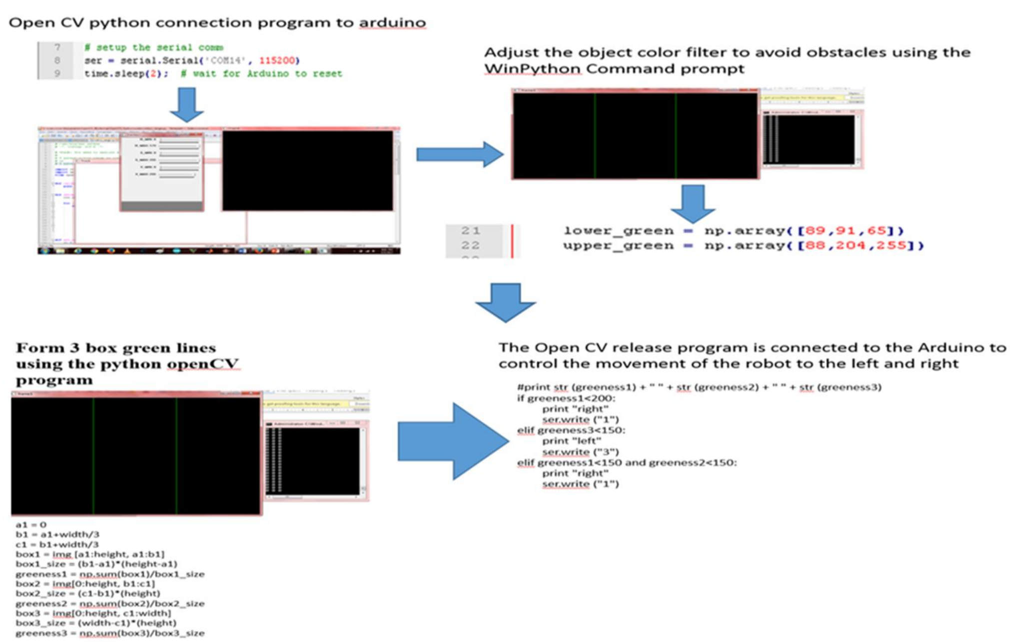

Fig. 3.3 Box barrier imaging process on Open CV program

The output of the processed signal value will vary depending on the situation when the robot camera is confronted with a black box. This results when the output that has been identified in the Open CV program is set to a value in the step in Fig. 3.3 previously used as a reference to the WinPython command prompt output. The output of this process is used to connect to the Arduino program as shown in Fig. 3.4 below.

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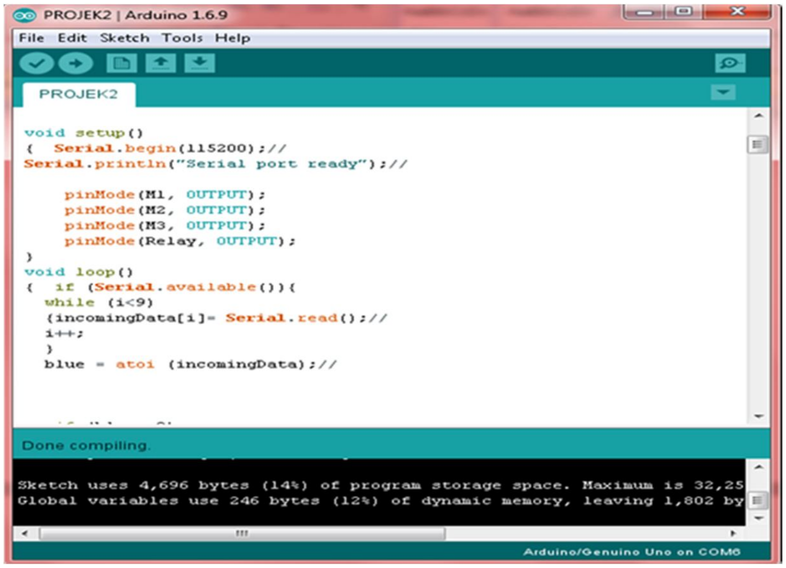


Fig. 3.4 the concept of Incoming Serial Data program connects Open CV output to Arduino

IV. ANALYSIS AND RESULTS

Robot movement tests to avoid black box obstacles are carried out using 2 forms of route challenges. For the movement mode the robot avoids obstacles using the left or right shift method when the robot approaches the black box. The speed of movement of the robot is controlled by the PWM value on the Arduino program which is 30,40 and 50. Fig. 4.0 shows the barrier path plan A and Fig. 4.1 shows the barrier path plan B.

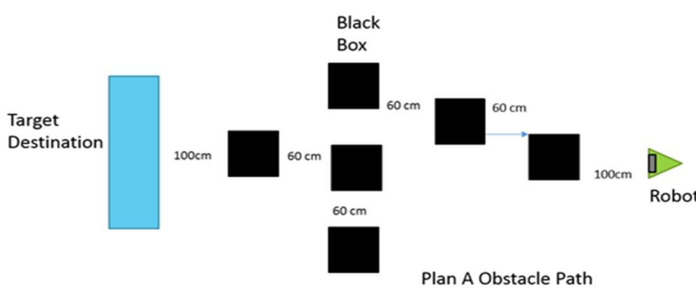


Fig. 4.0 Plan A Obstacle Path

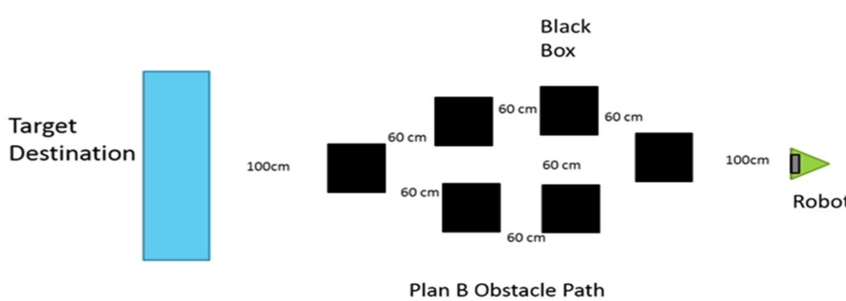


Fig. 4.1 Plan B Obstacle Path

The movement of the robot avoids the obstacles of the black box with a distance of 60 cm and 100cm. The motor speed values set in the Arduino program have been tested for the two forms of the barrier path. The motor speed set in the pulse width modulation value program affects the robot's ability to pass the existing black box. The time taken from the starting point of the robot moves up to the target. Table 1.0 shows the time and ability of the robot to overcome obstacles in Plan A Obstacle Path. Table 1.1 shows the time and ability of the robot to overcome obstacles in Plan B Obstacle Path.

Table I Motor speed on the robot avoids 6 obstacles for a distance of 4 meters for Plan A Obstacle Path

Value pwm	First attempt(time in second)	Second attempt (time in second)	Third attempt (time in second)	Purata (s)	**Successfully overcoming obstacles**
30	15	15.2	15.2	15.1	100%
40	13.2	13.1	12.9	13.1	100%
50	11.1	10.8	10.9	10.9	85%

Table II The speed of the motor on the robot avoids 6 obstacles for a distance of 4 meters for Plan B Obstacle Path

Value pwm	First attempt(time in second)	Second attempt (time in second)	Third attempt (time in second)	Purata (s)	**Successfully overcoming obstacles**
30	15.4	15.5	15.3	15.4	100%
40	14.2	14.5	14.7	14.5	95%
50	11.1	10.8	10.9	10.9	75%

The results of the robot movement test over obstacles for Plan A and Plan B routes can be concluded that the stable speed factor and not necessarily speed can pass all the black boxes that are used as obstacles. Technical factors such as alignment on the tires, motor speed signals set in the Arduino program for all three tires, parameter adjustments in the Open CV program need to be considered. The results of this test can be used to prepare the Port Polytechnic RIG team to compete in national and international FIRA tournaments. The obstacle avoidance robot RIG PPD is shown below in Fig. 4.2.

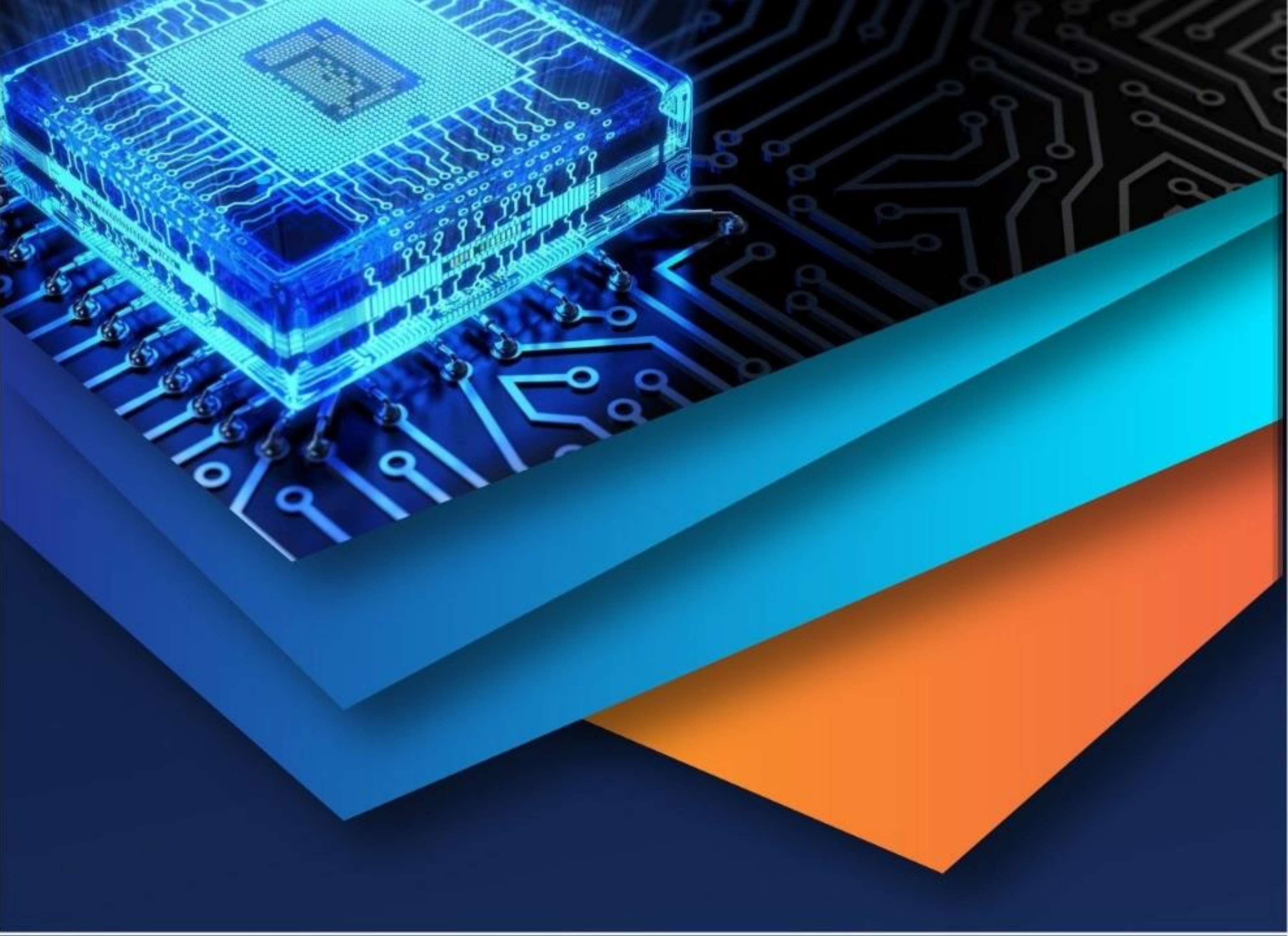
Fig. 4.2 Obstacle avoidance robot RIG PPD

V. CONCLUSIONS

Based on the results of programming analysis and development of this project, this design could benefit the RIG Polytechnic Port Dickson robot team by winning a medal in participating in the FIRA competition in the robot obstacle avoidance event. Overall, this project meets the objective of modifying the visual system "Obstacle Avoidance Robot" with the Open CV application so that the speed of the visual program process occurs more efficiently and the robot control movement is more stable.

REFERENCES

[1] Kirti Bhagat, Sayalee Deshmukh, Shraddha Dhonde, Sneha Ghag, Obstacle Avoidance Robot, International Journal of Science, Engineering and Technology Research (IJSETR), Volume 5, Issue 2, 2016
[2] K. Kannan, Dr. J. Selvakumar, Arduino Based Voice Controlled Robot, International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue, 2015
[3] Jeongdae Kim, Yongtae Do, Moving obstacle avoidance of a mobile robot using a single camera, Procedia Engineering 41, 911 – 916, (2012)
[4] Leo Louis, Working Principle Of Arduino And Using It As A Tool For Study And Research, International Journal of Control, Automation, Communication and Systems (IJCACS), Vol.1, No.2, 2016
[5] N. J Uke and R. C Thool, Cultivating research in computer vision within graduates and post-graduates using open source, International Journal of Applied Information Systems, vol. 1, no. 4, pp. 1-6, February 2012.
[6] Sanket Soni, Trilok Mistry,Jayesh Hanath, Experimental Analysis of Mecanum wheel and Omni wheel, IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 3, 2014
[7] Lowe, D.G. Object recognition from local scale-invariant features. In Proceedings of the Seventh IEEE International Conference on Computer Vision, Kerkyra, Greece, 20–27; pp. 1150–1157, September 1999.



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