

## Robotic Movement Based on Color Detection

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### ABSTRACT

In recent times, to reduce human labor robots are being manufactured and used in various fields. Robots are the intelligent vehicles that are designed to work according to the instructions given to them by their creators. Some of these robots are also made automatic. The aim of the paper is to design and implement a robot to perform the act of monitoring as well as detecting specific colored objects in its path. This robot is generally an autonomous intelligent vehicle that recognizes the color of the object in its path and reacts according to the users instructions. While on its motion, the camera mounted on the robot helps for live video streaming so that operators can see the route of the robot. Integration of the robot can only be measured when it can overcome the obstacles in its route efficiently and reach its destination autonomously.

**Keywords :** Autonomous, Color recognition, Obstacle detection.

### I. INTRODUCTION

Robot is much like a human being that is it senses changes in the environment with the help of sensors thinks about what processes must be performed with the help of logic circuits and electronic components and finally performs required actions by actuating its mechanical parts. The autonomous robot is capable of operating for any application based on requirements. As the internet of things is newly introduced in the all field, the concept is about handling the things with the use of internet and the best model for these applications using raspberry pi. In this project, the robot receives a live stream video where it can detect obstacles of different color in its way, processes it accordingly to the program installed in the robot and moves in the direction specified by the user[1].

#### Concept of Surveillance:

CCTV security is based upon only CCTV cameras, DVRs (Digital Video Recorders), and TV monitors.

A group of operators is responsible to find out any abnormal situation if or when occurred, while looking over live camera images displayed on a series of monitors. Some modernized systems use CMS (Central Monitoring System) software to display live streams on monitors, which are typically used to provide an intrusion alarm.

In such an environment, operators are prone to failure to detect an abnormal situation due to human factors, and recorded images from DVRs were mostly referred only after an incident to search for clues or evidences for tracking criminals or intruders. Even if an operator successfully detects an event instantly, time delay is inevitable for intercepting an intruder by dispatching a counter response unit to the location [2].

Surveillance concept is based on monitoring human behavior, activities and other changes in the surroundings. The main purpose of surveillance is to gather intelligence and situation of the environment

in which the camera is fixed, to prevent crimes and protect people and organizations. Mode of surveillance robot is through direct observation using electronic equipment and direct interception of information.

**Obstacle Detection:**

If a robot is set to move autonomously, in real time, then it will surely come across obstacles in its way. Obstacles can be anything that blocks the way of the robot from reaching its destination. Some of the common obstacles in the remote area are people, books, wooden table and so on. As there are many obstacles that obstruct the robot from moving further, so there are many sensors to detect those obstacles[3]. In this project, the robot is designed to recognize the color of the object placed in front of the camera mounted on it. If the mobile robot recognizes the specific color, for example red, then the robot moves away from that particular object without getting jammed. In this way, the path of the robot can also be drawn by arranging the colored objects in a particular route.

**II. System Specifications**

Wheeled structure- moves in controlled path in ground using motorized wheels. This wheeled structure is mounted with a camera on its top to recognize color of the object and capture live stream video. The camera that is mounted is connected to the raspberry pi which decodes the commands and analyses the further direction of movement[4]. Raspberry pi is wirelessly connected to the pc or laptop where the video stream captured can be contemplated for better vision of the robotic environment. The color of the object is recognized using the computer vision concept which is discussed below.

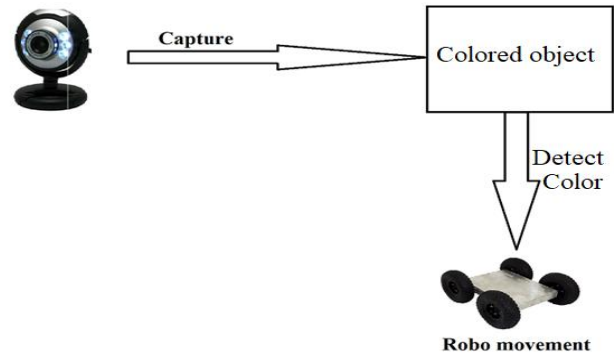


Fig1. System Architecture

**Computer vision:**

Automation of human Visual System- We humans, have a very robust visual system, which helps us to identify people and objects, play sports perform operations, drive vehicles, read, and so on. Although it might seem that we do not put any special effort to do most of these tasks, human visual system is fairly complex to replicate and implement. Computer Vision, in the simplest terms is the automation of such a visual system, so that computers or machines, in general, can obtain high level understanding of the environment from digital Images and videos. The applications of computer vision are Machine Vision, Object Identification and tracking, Detection of Events, Human-computer interaction devices, Mapping of Environments, Autonomous Navigation[5].

Area of application	Purpose
Industry Automations	Label readings on different packages, sorting of objects and parts on circuits, assembly lines. Inspection of circuit boards that are printed
Food markets	Identification of spoiled vegetables and fruits that are marketed in bulk.

Medical treatments	Inspection in x-rays, counting of blood cells, identification of any tumors inside the body.
Robotic engineering	Object recognition and avoidance of collision, monitoring of machines, determination of hazards.
Radar concepts	Providing guidance to helicopters, aircrafts and also missiles in remote areas.
Analyzing documents	Recognition of graphics, handwritten documents can be analyzed and characters are identified.

Table 1 : Applications of computer vision

**Computer Vision Pipeline**

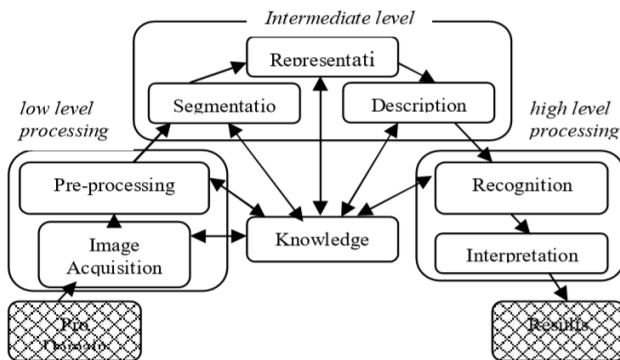


Fig 2: Different levels in image preprocessing

**Image Acquisition-** Image acquisition is the digital representation of the visual characters of the physical world. Image sensors are used to detect and capture the information required to make an image.

**Image Processing-**The signals in the acquired images are filtered to remove the noise or any irrelevant frequencies, if needed the images are padded and transformed to different space, so as to make them ready for the actual analysis.

**Image Analysis-** The processed images are then analyzed to extract useful information. This involves

pattern identification, color recognition, object recognition, feature extraction etc.

**Decision Making-** The high dimensional data obtained from all the above steps is used to produce meaningful numerical information, which leads to making decisions.

**Problems Solved by CV:** Object Recognition and classification, pose Estimation, Optical Character Recognition, Facial Recognition, Motion Tracking, Scene Recognition, image Restoration.

Image Segmentation for object detection is the most vital part of computer vision where the computer has to identify objects differently from the background whether it is a man or face simply static objects. If the contrast difference of the background with the foreground is high then the detection is simple. But if the background is chaotic and there is a little difference between the background and the object then it becomes difficult for the system to identify the edges from the background. Recent techniques for object detection are of two types: bottom-up approach and top down approach.

1. Top down approach includes a training stage to obtain class-specific model features or to define object configurations.
2. Bottom-up approach builds hypotheses from such features, extend them by construction rules and then evaluate by certain cost functions.

The current methods that are used is to combine these two methods mentioned above so that exhaustive searching and grouping can be avoided mostly and the consistency in object hypotheses can be maintained thoroughly [6].

**Hardware module:**

The Raspberry pi is a low cost, card sized device that can be plugged into a computer or a TV and can be operated by standard input devices such as keyboard and mouse. It is a capable computing device to explore and program in python or scratch programming languages. It is capable of doing

everything that is expected from the computer would do. Raspberry Pi has the ability to interact with the outside world through wired or wireless. The Raspberry Pi is used to control robot using any device from remote location. The time required for processing the commands from the device and responding accordingly is negligible. The Computer and Laptop make the system more reliable and easy to use. Two gear motors are sufficient to produce the movement of robot and the motor driver module is used to supply enough current to drive two gear motors which protects the Raspberry-pi module from the damage. The main advantage of using the minimum number of motors is minimizing the power consumption of the robot.

Types of models-

Model A has 1 USB, no Ethernet, SD card slot.

Model B has 2 USB ports, 10/100 Ethernet, SD card slot.

Model B+ has 4 USB ports, 10/100 Ethernet, Micro SD card slot.

#### Hardware of Raspberry pi:

- 10/100 Base T Ethernet
- HDMI Socket
- USB 2.0
- RCA Video Socket
- SD Card Socket
- Powered from Micro USB Socket

#### Technology in Raspberry:

- Powered by Broadcom BCM2835 System on chip
- Core frequency set to 700 Hz
- Video core 1V GPU with HDMI and composite output
- Ability to boot from SD card
- GPIO pins which can be used to run various electronic gadgets and appliances.

DC motors: A dc motor has a shaft which rotates at certain rpm based on the power supplied to it.

- Dc motors can generate high starting torque can start quickly and stop quickly.
- It is also possible to change the speed easily by changing voltage supplied

DC motors are widely used output device for many applications. The applications of Dc motors are numerous and are used in all fields, specially in robotics, embedded systems and IOT. Used for-high torque, quick starting and stopping, speed variation[7].

Advantages: low power requirements, minimal maintenance, constant torque over a wide speed application.

Applications: Elevators, Heavy Machinery, lathe machines, cranes.

Parts of a motor: permanent magnet, commutator ring, brush armature loop.

Dc motor working principle: When a current conductor is placed in magnetic field, it experiences mechanical force. The direction of force is given by Fleming's left hand rule. Force on each conductor is tending to rotate the armature in the anticlockwise direction. When the armature is perpendicular to magnetic field torque = 0. When the armature is parallel to magnetic field torque = maximum.

### III. Design and implementation

Raspberry pi is being used to analyze and control operations in the robot. It acts like the brain of the robot. There are various ways of connecting raspberry pi to the pc or laptop. The methods are both wireless and wired. In the case of a wired connection, the constraints in movement of the robot increases. The wired connection will restrict the many attributes like distance, speed and efficiency of the robot which leads to less utilization in real time. The wireless robots overcome these

restrictions and provide better efficiency compared to wired robots[8]. To connect the raspberry pi module to any device via wifi, there are certain protocols to be followed.

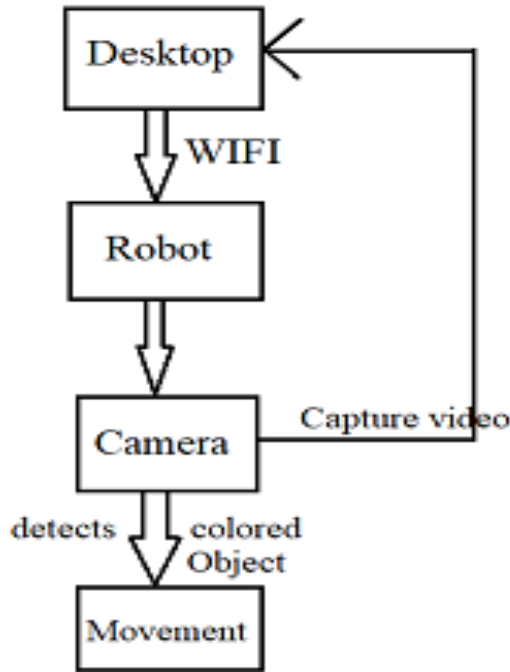


Fig 3:Data flow diagram

**Remotely accessing robot:**

The means of sending information among computers use different set of protocols or rules. When humans have conversation, they use the same language without strict adherence to grammar rules. But if computers want to communicate with each other then they have to know how the information is to be exchanged and the format of information in advance. To transmit the information among computers various kinds of standard methods are used. These standard methods are known as protocols which are designed with international agreement. Protocols ensure that computers present everywhere can communicate with each other. Some of the commonly used protocols are TCP/IP protocols.

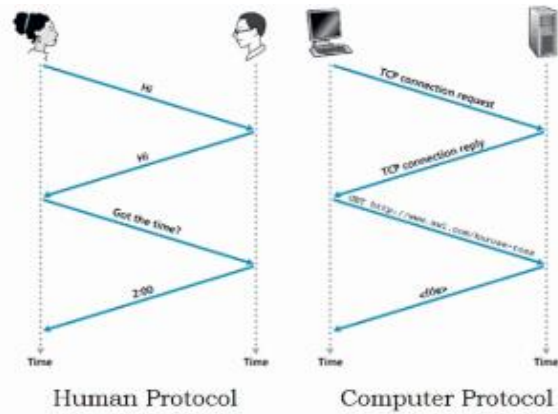


Fig 4

**TCP/IP Protocol:**

TCP/IP protocol are the abbreviate form for transmission control protocol and Internet Protocol respectively. These are two different procedures that are often linked together. In fact TCP/IP is normally used to refer to a whole set of protocols each with different functions. When information is sent through the internet, information is divided into smaller packets. The use of packets facilitates for IP transmission since different paths of the message can be sent by different routes and then reassembled at the destination. TCP is the means for transmission and putting them back together in correct order at the end. Every system on the internet has to have its unique address known as the IP address. These IP address help in sending to and receiving information at intended locations. The packets that are to be transmitted contain an IP address showing where it is supposed to go[9].

**Secure socket shell protocol:**

Secure socket shell protocol is widely known as SSH protocol. SSH protocol is used to access remote computer securely by unix based command interface. Both ends of the client-server connection are authenticated using a digital certificate and passwords are protected by being encrypted.SSH allows to connect to the server securely and perform Linux command line operations[10].

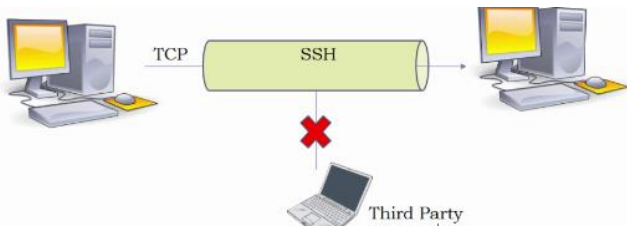


Fig 5 : SSH Protocol

**Object color detection:**

The color detection algorithm identifies the pixels in image that is matched to a specified color. The color of the detected pixels can then be changed to differentiate them from the rest of the image. When the video is captured from the camera, it identifies the colours of the object. Most of the color identification and recognition algorithms work on the RGB color extraction concepts. A RGB video or an image is a blend of three different color layer (red, blue and green). In this step, extract these color contents differently. These color contents are extracted by using some inbuilt functions or some commands in MATLAB.

```
Red = IMG ( : , : , 1);
Green =IMG ( : , : , 2);
Blue =IMG ( : , : , 3);[4]
```

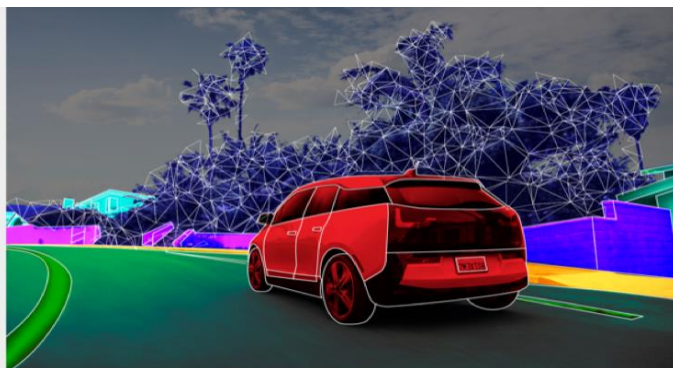


Fig 6: RGB color identification

A RGB has multiple colors with different color content (red, green and blue) value mixture for each pixel ranging from 0 to 255 for each color. Based on these different color combination values different colors in a RGB image is formed. For a pure white image these color content values are having

maximum range and for pure black they have minimum values. For maximum example for dark red color the red color content value has low value and for light red color red color content has maximum value. It is easier to find the combination value of each coloured content for any pixel, a cursor named data cursor is accessible in figure window of MATLAB to do so. By using this cursor find out the average value of the red, green and blue color content of the exacting that required extracting[11]. These average values are used for thresholding of that color. After thresholding is done, mask these thresholding values of each color contents for the color that is requisite to extract, by using logical and operators. The logical operators are altered according to the color shade required.

**Software Implementation:**

For the working of the raspberry pi that is brain of the robot, software programming languages like python are efficient. Python programming is interpreted and general purpose programming language. IDLE is python Integrated Development and learning environment. It has two windows. They are:

1. Shell window: code written and tested which are not saved.
2. Editor window: code written in the form of scripts which can be saved

The algorithm in the programming part is done in such a way that when a specific coloured object is encountered before the camera which is mounted on the robot, then the direction in which the robot is moving is changed. At first the robot detects an object. Then the color of the object is recognised and signals are sent to raspberry pi[12]. Raspberry pi analyzes according to the program that is previously uploaded in it. Change in direction of the robot is performed according to the instructions in the uploaded program. Also the programming part helps

to capture the live stream video and helps in saving the captured and recorded video.

#### IV. CONCLUSION

This paper on robot movement based on colored detection has a detailed description of implementation and design of an autonomous robot. This intelligent vehicle can both capture a video and transmit a live stream to the operators and also can move automatically. While on its motion, it can detect any obstacles in its path. One of the important quality of this robot is that it can also detect the color of the object and mould its direction according to the command given in the program. So this robot can be often referred to be an intelligent vehicle as it can analyze and act according to the situations.

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