Low-Cost Multipurpose Real Time Target Detection Rover Based on IoT

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***Abstract*— Real-time object detection based on the Internet of things is more suitable as it conserves small are to perform the task. Efficient and accurate object detection is more important in computer vision systems. Multiple deep learning techniques help to develop a system to predict precise object detection. Detecting an object and trail that object is one of the essential tasks that can be used in multiple application. In this paper, we are going to describe low-cost, real-time video surveillance personal assistant rover that is developed using the Raspberry Pi can track the target. In result, Object detection and Image classification problem can be resolved. This can be used for personal as well as industrial purpose.**

Keywords—Internet of Things, Raspberry Pi, Deep learning, Tensorflow, Friendly Robot.

I. INTRODUCTION

Robotics Engineering is the interdisciplinary subdivision of engineering and science that includes computer science, mechanical engineering, electrical engineering. Robots used in numerous applications which individuals would instead leave to robots. For surveillance, industrial, medical, entertainment they took place, and it is more convenient as it can be operated wirelessly.

Raspberry pi series computers can be accessed remotely, and it offers many features which are perfect to create a personal robot that able to do serval tasks and make human work easy. There are multiple algorithms developed and implemented using different microcontroller such as beagle bone black, Arduino UNO, raspberry pi etc. as raspberry pi is a series of small single board computer use Linux based operating system make it more attractive and competitive for use especially for the robotics purpose as it supports internet as well as Bluetooth services. Security and surveillance are an important part of our routine life. If a Remotely accessible robot is capable of roaming inside the area of surveillance, then more object can be observed using the low budget [1]. Raspberry Pi supports various sensors such as humidity, temperature, air quality, etc. by combining these sensors a well optimize model can develop to collect the necessary data for the different situation.

II. RELATED WORK

Internet of things is the current trending technology which allows interacting with numerous things around us in unique ways. It can be a system or machine [2]. The internet of things (IOT) is an internetworking of physical devices, vehicles embedded with electronics and network connectivity that able to perform a diverse job. Field of object detection has seen significant evolution because of deep learning. Deep learning has turned out to be a remarkable asset for image classification.

The internet of things (IOT) is an internetworking of physical devices also known as a microcontroller. The IoT practice low-cost computing devices where there is fewer energy ingesting and inadequate influence to the environment [3]. Raspberry pi series computers are more popular in the market as it is low cost and that easily plugs into a monitor or TV. It is capable of ensuring everything that can be done on a regular computer as it can connect with the outer world. People using it to make diverse ventures in their way.

Raspberry Pi support OpenCV is an open source library for image and video analysis, open the way for image processing. OpenCV library has more than 2500 optimized algorithm developed by several programmers [4]. This library gives vision to the raspberry pi help to create a flexible, cost-efficient and timely system with the good quality of service. In [5], the system develops that has the ability of image recognition with the low-cost localization infrastructure. It can analyze the video frame captured and identify the target object with high accuracy and reliability. The concepts of neural networks and deep learning used in [6], which allow the computer to learn from observational data and provide the best solution for the problems of image recognition. Where conventional neural networks (CNNs) can be viewed as an alternative to Deep neural networks (DNNs), a real-time process captured by the device's camera and to distinguish the representation and TensorFlow figures the name of the dominant entity within a single frame. The incorporation of image recognition capabilities with a low-cost localization structure allows achieving the desired goals.

In [7], the triple-layered architecture used for motion detection which outcome by the video stream directed to the FTP server. If there is any change between the previous frame and the current frame, it notifies about the motion.

In this project, we have developed a rover based on raspberry pi can detect and monitor the position of the object to track it. Rover can be controlled by using a smart device such as a computer, iPad using the internet. Both rover as well as a device connected in the same network to stream a live video that can be accessible from the device. It uses the concept of Deep learning used in [6] for the image processing and can identify an object from the video frame.

III. MOTIVATION AND BACKGROUND

They are exploring new IoT technologies to create smart environment help to implement new models which make work easier. A person can predict the object by observing that or merely looking at that. A model can be developed using deep learning technique has the same efficiency as human to identify the purpose. Surveillance can be done by using CCTV cameras. It gives a view of a certain area as it attached to the one fixpoint. A small rover can be developed which can extend the range for the surveillance and can be accessed remotely as well as provide a live video stream

IV. A PROMINENT FEATURE OF THE PROJECT

Following are the Features of the project:

- Rover will able to move freely in all direction as it has two servo motor which can control the movement direction and way.
- The webcam provides a clear real-time view of the area.
- Rover can be accessed remotely which extends its range for the surveillance.
- It can easily detect an object in the frame and able to follow that object which makes this rover more convenient.
- Video stream data can be processed by using deep learning technique and rover can able to identify the object.
- Rover also displays how much accurate the detected object is.
- The video stream can be accessed form the device uses to operate the rover.
- The proposed system is compatible with any modification in the future.

V. METHODOLOGY

The real-time object detection and identification system can be understood by the Block diagram shown in figure 1.

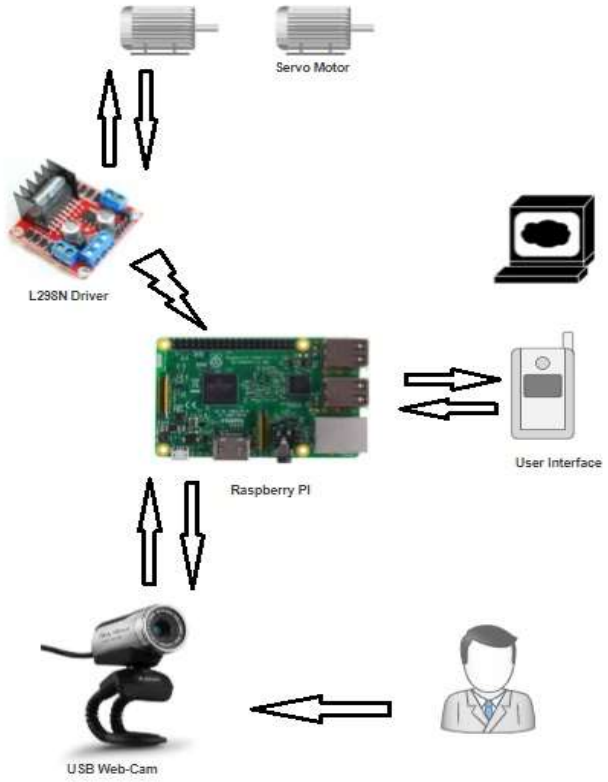

Figure 1

The whole purpose system divided into several parts. Raspberry Pi is a core component of the rover as it can do multiple functions related to image processing. A webcam attached to the raspberry pi capture the visual data that will be transmitted to the brain of the rover Pi. Smart devices such as a computer, iPad user can get access to the raspberry pi. Using deep learning technique pi will process the video stream and identify an object in the video frame. L298N motor driver attached to the raspberry pi via GPIO pins to operate servo motor which allows moving rover in different condition and task can be achieved. Figure 2 shows the process of object detection can be achieved by the rover.

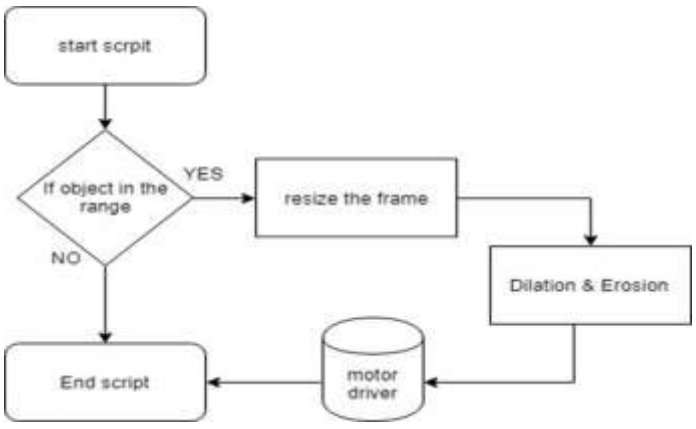

Figure 2

Object detection is the primary goal of this proposed system,

it can be achieved by using the OpenCV, TensorFlow and Imutils library used for better efficiency. Pre-trained model use for classifying an object in the frame [8]. By resizing the frame provide a higher frame rate for a video stream. Dilation and erosion function use for eliminating noise from the Visual data.

VI. HARDWARE AND SOFTWARE USED IN THE PROJECT

For implement the proposed system we used hardware to accomplish our goal. Following are the hardware component used for our project:

i. **Raspberry Pi:** Raspberry Pi is a single board computer with 1.4 GHz CPU with 1 GB RAM. It is a very cheap computer which runs on a Linux operating system which is open source. Comes with built-in Wi-Fi and Bluetooth making it the most compact and standalone machine. Another unique feature it provides is GPIO (General Purpose input/output) pins that allow you to control electronic components for physical computing**.**

Figure 3: Raspberry Pi Model 3

ii. **L298N Motor Driver:** L298N is a Dual H-Bridge. The L298N Motor Driver Module is a high voltage Dual H-Bridge. H-bridge drivers are used to driving inductive loads that require forward and reverse function with speed control such as DC Motors, and Stepper Motors. L298N motor driver receives signals from the microprocessor and transmits the relative signal to the motors.

Figure 4: L298N motor driver

iii. **Servo Motor:** servo motor is work on the principle of pulse width modulation (PWM). The duration of the applied pulse controls its angle of rotation to its Control PIN. It is a product of DC motor which is controlled by the potentiometer and gears. For our system, we use two servo motor which allows the robot to move easily. As a motor is capable of speed control, it is more suitable for this system.

Figure 5: servo motor

iv. **Webcam:** A webcam is a video camera used for stream image in real time to any compatible device such as a computer, raspberry pi, etc. unlike IP camera which requires ethernet for the connection it can be connected by a USB cable this feature makes this device more convenient.

Figure 6: USB webcam

v. **Power supplier:** As raspberry pi needs a continuous power supply to turn on, portable batteries such as power bank use circuity to control power supply. We use a power bank with 20,000 mAh. Regular USB cable use for making a complete circuit between raspberry pi and power bank. We also use four healthy power cells by combining them to produce 12V power for the servo two servo motor.

vi. **Jumper Wire:** Female to Female and Male to Male jumper wire required to connect L298N motor driver with the raspberry pi as well as servo motor with the motor driver.

Figure 7: jumper wire

vii. **Parts for Rover:** Fr the chassis of the robot car I used parts which are available on the amazon.ca which help me to construct the base of the robot.

Figure 8: chassis for rover

viii. **VNC viewer:** For operate the robot car and perform any operation on the raspberry pi I use VNC viewer which provide a very user-friendly interface. It offers wireless access to the raspberry pi which is more convenient for this project. The only condition is that both device and raspberry pi must connect in the same network which creates a virtual network.

ix. **Raspbian OS:** Raspbian OS is based on Debian optimized for the raspberry pi hardware. I have more than 35000 packages, pre-compiled software bundles. Raspbian stretch is optimized for the best performance on the raspberry pi module [8].

x. **OpenCV:** OpenCV is an open source library for image and video analysis. It is an essential tool for the proposed system. More than 2500 optimized algorithms have been developed for this library related to visual data [4].

VII. CONFIGURATION OF COMPONENT

For creating a remotely accessible rover all the hardware, as well as a software component, has to work together to give a proper output. For establishing a connection between raspberry pi and L298N motor driver GPIO pins used. We used GPIO numbering for the association which shown in figure 10.

Figure 9: GPIO numbering

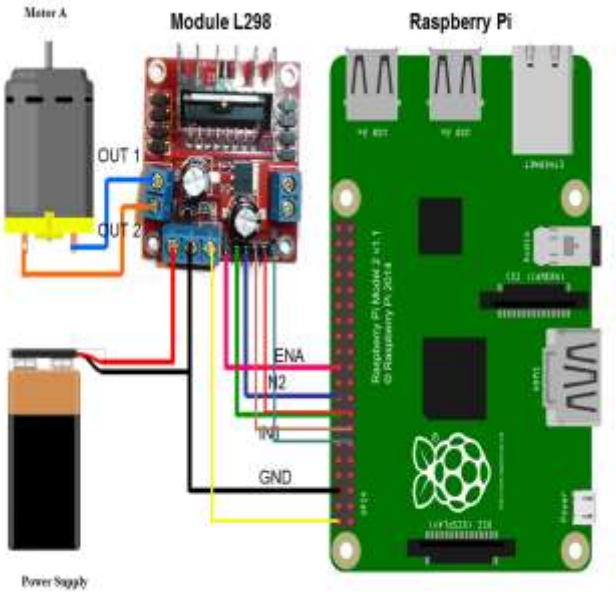

Figure 10: connection b/w motor driver and Pi

Figure 11 shows the connection between raspberry pi and L298N motor driver. 9V power externally supplies to L298N motor driver to run two servo motor that allows the rover to move. Once everything setup successfully rover is ready to perform the task. For that, both raspberry pi and the operating device has to connect in the same Wi-Fi network. Then python script will allow accessing of a webcam and according to user's command rover will perform the movement.

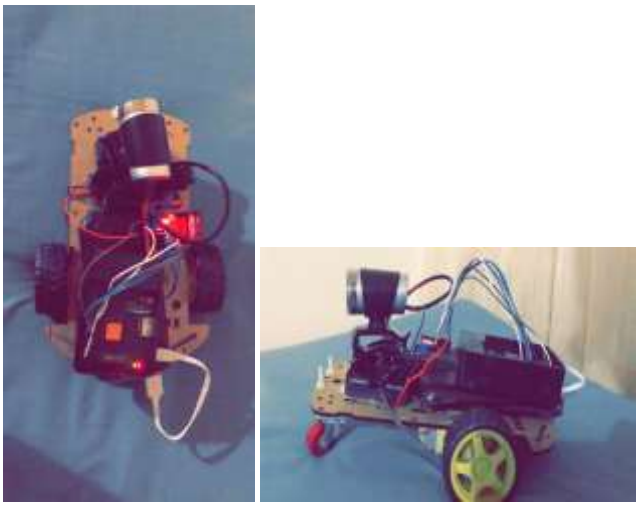

Figure 11: Multipurpose rover

VIII. RESULT

Rover can easily access and perform the necessary task of moving forward, backward, right and left which is helpful for surveillance task. It can also play the job of tracking an

object as shown in figure 12. Using a deep learning technique rover able to identify an object in the frame with accuracy. Figure 13 shows the rover performs object identification.

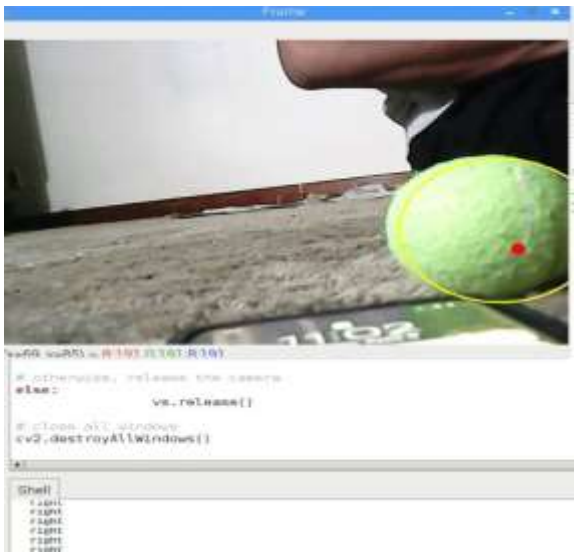

Figure 12: rover able to perform the object detection and tracking task

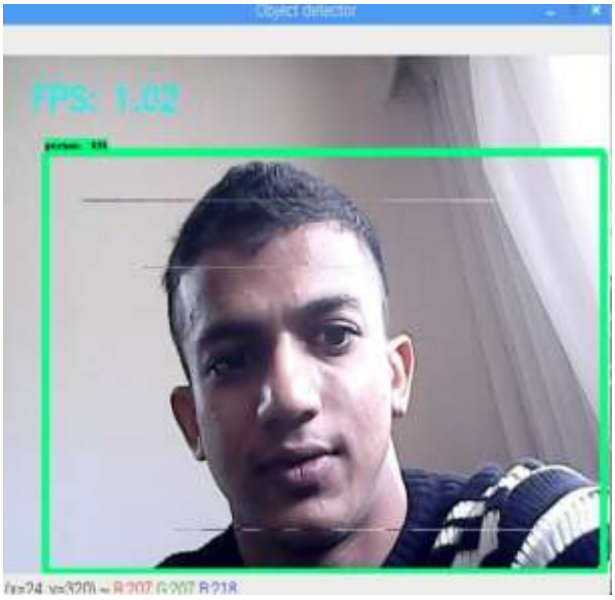

Figure 13: Object classification using TensorFlow

Our proposed system works very well, and it can perform several tasks, and a summary of that task is as follow:

- It provides a live video stream of the area cover by the webcam.
- It is easily accessible from the computer, iPad and accept the command from that and perform basic functionality of moving.
- It can detect an object in the video stream and perform the moving function to follow that object.
- By using a deep learning technique, it can predict a particular object in the frame with its name.
- It also displays the accuracy of the prediction of that object.

IX. FUTURE SCOPE

For the future work proposed system can be extended in multiple ways which shows below:

- By employing arm to the rover, it will able to collect an object used for numerous applications.
- According to several tasks, different sensors and module can be attached and modified the rover to accomplish tasks in the factories to monitor a huge area.
- Rover can be controlled using a voice command or by the gesture instead of controlling via smart device will make rover more compatible for individual use.
- Using deep learning and face recognition algorithm can be implemented which allow a rover to work as a smart security guard and it will more appropriate to the technical work.
- A solar panel can be attached to the rover which provides renewable energy to operate rover and make it sustainable.

X. CONCLUSION

The development of this project is inexpensive and provide very superior performance. It is multipurpose rover which can be used for surveillance of a particular area and provide video stream to the device which uses for accessing the rover. It also works to detect an object in the video frame and decently follow that object. Another feature of this rover is identifying an object using a deep leaning and display the accuracy of the prediction. This all feature make rover more suitable for the IOT applications for the subject of security and surveillance services. The following project can be used for household or commercial persistence.

XI. REFERENCES

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https://www.raspbian.org/