International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 4 Issue 9, September – 2020, Pages: 103-108

Design and Implementation of an IP Camera Tracking Robotic System using Raspberry Pi 3B

Enerst Edozie

Department of Electrical, Telecommunication and Computer Engineering, Kampala International University, Uganda
enerst.edozie@kiu.ac.ug

Abstract: *Security systems are increasing everyday to protect life and valuable resources, many advanced method of providing security have been developed and are in use in the last few decades. In security risk areas, people often install different kinds of security systems such as flashing lights and alarms which are triggered by sensors, closed-circuit televisions (CCTV) etc. There are various types of sensors being used is these security systems. As the technologies expand rapidly, security systems have forward from alarms to Internet of Things (IoT) which includes IP cameras and even computers. Now many organizations are continually reevaluating and enhancing their video surveillance to provide optimal daily security and operational efficiency. Internet of Things (IOT) is an upcoming technology that makes use of Internet to control/monitor physical devices connected to the Internet. The basic premise is to have smart sensors collaborate directly without human involvement to deliver a new class of applications. There are different kinds of sensors such as infrared sensor, microwave sensor, radio frequency and ultrasonic sensor. However, this project uses ultrasonic sensor to detect moving objects and track them. Due to high state of insecurity being experienced in the entire world the need to keep the occupants of the area aware of any intrusion into their premises will be achieved in this project. This paper aim to design an Embedded Real-Time and a low cost IoT camera tracking robotic system based on Raspberry Pi and ultrasonic sensor for intruder observation that reinforces surveillance technology to provide essential security to homes, offices and associated control. Ultrasonic sensor sense the presence of an intruder & Controller reads the signal from the sensor, if intruder is detected, it turns on the servo motor which help in tracking the intruder's movement. At the same time the live stream video of the intruder can be monitored, and also the IP camera control system will send an image and video of the intruder via Gmail to the user. The designed system has been proven to be a reasonable advancement in access control and security system technology.*

Keywords: Raspberry Pi, IOT, Ultrasonic sensor, Tracking Robot, IP Camera, Gmail notification, Security, Servo motor.

1. INTRODUCTION

With the development of human civilization and technologies, human life has changed a lot in the past few decades. One of the technologies that has progressed is robot systems. Intelligent robots are now used in daily life 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 a variety of needs. The development of robot systems combines the theoretical expertise of various professionals. Many students have few opportunities to have hands-on experience on the robotics design. On the other hand, it is well known that students' active involvement in a subject, while they are also learning its theoretical aspects, plays an important role in concept assimilation and in mastering the acquired concepts. Robotics requires long and expensive processes to complete a realistic design and safe usage of it. From these reasons, a few companies have developed and commercialized small robotics devices, or robotic kits, that let students apply their knowledge safely. In this project, ultrasonic sensor is used. Ultrasonic sensor is a device that able to measure the distance to an obstacle by using sound waves. The sound wave is travelled out at a specific frequency and returned when its sense a thing to measure distance in real time. It has its faults and this could be an issue for the sensor to recognize an object because the sensor works based on specular basis which mean it is not a narrow range scanning angle. Hence, a precision and accuracy work need to be implemented in order to track an object. The ultrasonic sensor is low cost device that able to operate in any environment with low visibility where vision or laser systems are not really efficient. The ultrasonic sensor is able to measure distance from itself to the certain object by using pulse-echo in real time. Unlike other sensors, ultrasonic sensor provides data about object existence in front of the sensor. Any object that comes within the range of the sensor must be followed/tracked. The rotation angle of servo motor and distance values of ultrasonic sensor is used for tracking an object in real-time. Object detection distance widens using ultrasonic sensors and object movement of robot is controlled by angle of servo motor and distance of ultrasonic sensors. The IP camera is used for capturing, live video streaming and triggering the Email notification. This project can be used in high security risk areas for monitoring intruder's presence and to reduce the number of crimes. The area which has been specified as the coverage for the object tracking system is within the range of 3.7 meters. This is the maximum range that tracking system can work efficiently. For more than 3.7 meters, the efficiency will reduce gradually. However, the range can always be expanded up to 8 meters with some modification to the transmitter and receiver circuits.

2. OBJECTIVES

The main objective of this research paper is to design and implement a low cost and user friendly security tracking system that includes features such as motion detection, image processing, tracking robotic system, and emailing notification system. The system is to be based on Raspberry Pi.

- To come out with a working prototype of a IP camera tracking robotic system using Raspberry Pi
- To detect and track moving object in the range of 3.7 meters in radius using ultrasonic sensor
- To expand the ultrasonic technology in security system
- To design and implement a security tracking system with an email notification system that alert the user if an intruder entered in the restricted area.

3. SYSTEM DESCRIPTION

This project uses the Raspberry Pi 3B+ board as the main controller for the whole circuitry. There will be 2 ultrasonic sensors that will serve as the input and triggering device for the servo motor and IP Camera for live video streaming, snap shots and triggering the email notification. The IP camera is attached to the servo motor. This robotic tracking system can be used in high security risk areas for monitoring human presence and to reduce the number of crimes. Once something is in front of the sensors, (assuming that there is a person or a moving object in front) the sensors will send the data to the Raspberry Pi board stating that there is something near it, thus activating the servo motor to start moving and face the source of the movement. At the same time the live stream video of the intruder can be monitored using smart phones or laptop computers via IP address of the system, and also the IP camera control system will send an image and video of the intruder via Gmail to the user. The power supply provides the voltage and current required for effective performance of the system. This supply is tapped from the 12V DC power source and then regulated before being fed to the system.

4. SYSTEM COMPONENTS

4.1 Hardware components

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4 GHz, dual-band 2.4 GHz and 5 GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT. The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the Raspberry Pi 2 Model B and the Raspberry Pi 3 Model B.

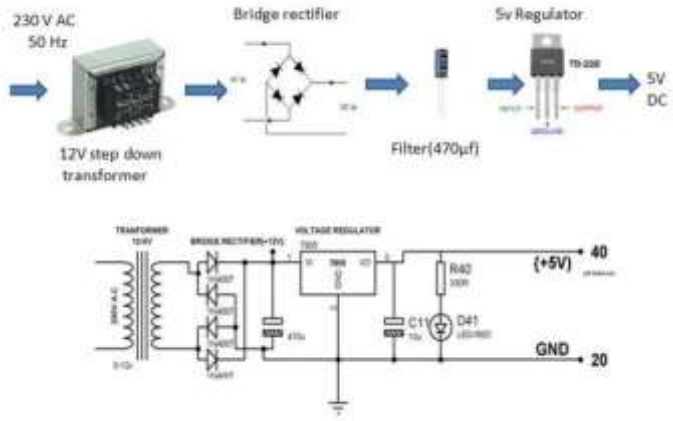
4.2 Ultrasonic sensor

It is a type of device that can measure the distance to an object by the use of sound waves. It measures the distance by sending sound waves at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being produced and the sound wave bouncing back, it is able to compute the distance between the sonar sensor and the object.

4.3 Servo motor

The **servo motor** is most commonly used for high technology devices in the industrial application like automation technology. It is a self-contained electrical device that rotate parts of a machine with high efficiency and great precision. The output shaft of this motor can be moved to a particular angle. Servo motors are mainly used in home electronics, toys, cars, airplanes, etc.

4.4 Power supply unit



4.5 Software Components

4.6 Raspbian

Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. An operating system is the set of basic programs and utilities that make your Raspberry Pi run. However, Raspbian provides more than a pure OS: it comes with over 35,000 packages, pre-compiled software bundled in a nice format for easy installation on your Raspberry Pi.

4.7 Python

Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.

5. FLOW CHART

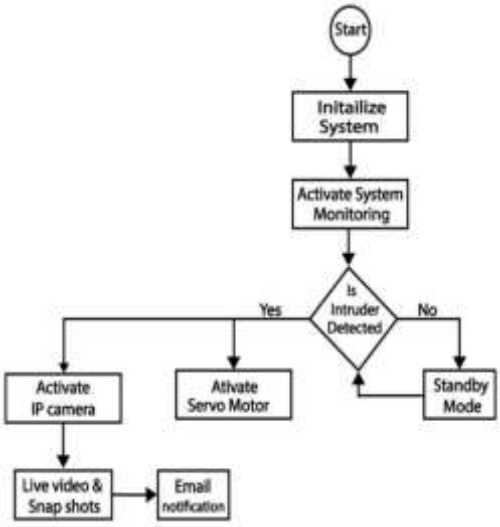


Fig1. The flow chart of the system

6. BLOCK DIAGRAM

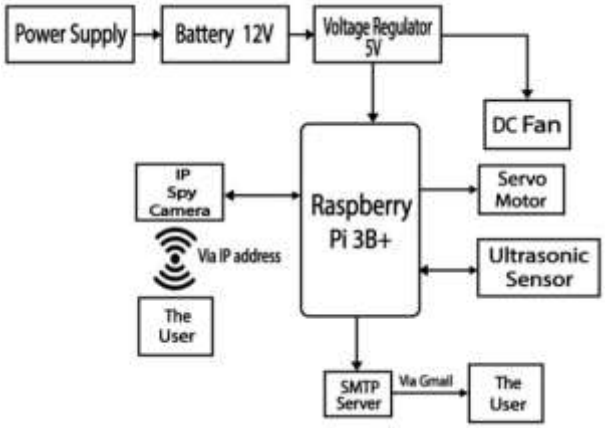


Fig2. The block diagram of the system

7. CIRCUIT DIAGRAM

8. SYSTEM OVERVIEW

Fig3. The circuit diagram of the system

Fig4. The entire view of the system

9. RESULT

The following are the results achieved from this work:
The ultrasonic sensor scan for intrusion movement around the area. On detection of motion, the ultrasonic sensor sends a signal to the Raspberry pi which triggers the servo motor, and the camera captures the image and video of the intruder and sends a Gmail notification to the user with that image and video attached to it. The system provides not only clearer view but it detects the person's movement from the beginning he/she enters the compound and tracks the movement of the person. This system can monitor the entrance, and tracks the movement to provide wider view of the place.

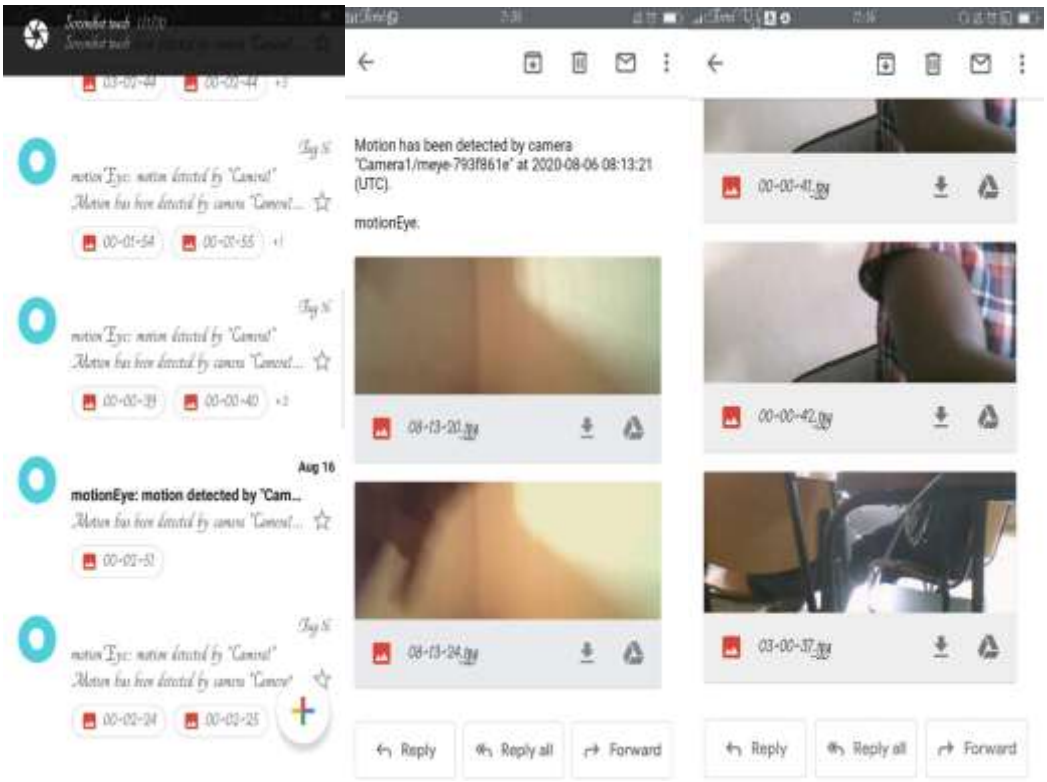


Fig5. The results of the system

10. CONCLUSION

A successful implementation of a robotic tracking system is illustrated in this research. This project uses ultrasonic sensors to detect and track moving object, it uses servo motor to rotate the camera and it uses IP camera to capture the intruder images and video. The difference in voltage received by the receivers will give signals to the Raspberry Pi to instruct the servo motor to rotate according to the difference voltage sensed by the receivers. Once the voltage difference is very small, the servo motor will stop rotating to give indication that the moving object is now stationary. The system informs the user of any intrusion in the area via Gmail no matter where the person is, except if the person is in the region where there is no network coverage at the time of intrusion. This system is affordable and easily operated, so that anyone can make use of it. All the devices communicate well, especially, the Ultrasonic Sensor communicates well with the Raspberry Pi, the IP camera communicates well with the raspberry Pi, which also communicates well with the SMTP server and Gmail notification sent successfully. It can be concluded here that the system has been successfully implemented and the aim is achieved without any deviations.

11. References

[1] Ultrasonic signal detection device-Munira Mohamed- Universiti Teknologi PETRONAS - 2002.

[2] Liang,X.;Wang,H.;Chen,W.;Guo,D.;Liu,T.AdaptiveImage-BasedTrajectoryTrackingControlofWheeled Mobile Robots with an Uncalibrated Fixed Camera. IEEETrans. ControlSyst. Technol. 2015, 23, 2266–2282.

[3] Juang, J.G.; Hsu, K.J.; Lin, C.M. A Wheeled Mobile Robot Path-Tracking System Based on Image Processing and Adaptive CMAC. J. Mar. Sci. Technol. 2014, 22, 331–340.

[4] Enerst Edozie, Wantimba Janat, Zaina Kalyankolo, Ibrahim Adabara, Dr. Kelechi John Ukagwu, "Design and Analysis of a Lab IP Spy Camera and Alarm System using Raspberry Pi and ATMEGA328P" ISSN: 2643-9026 Vol. 4, Issue 5, May – 2020, Pages: 16-20

[5] Chung-Hao Chen, et al., "Tracking a moving object with obstacle avoidance", Industrial Robot: An International Journal, Vol.33, pp. 460–468, 2006.

[6] Aji Joy1, Ajith P Somaraj2, Amal Joe2, Muhammed Shafi2, Nidheesh T M2, "Ball Tracking Robot Using Image Processing and Range Detection", Int. Journal of Innovative Research in Computer and Communication Engineering, Vol.2, pp.3571-3576, 2014

[7] F. C. Mahima and A. Prof. Gharge, "Design and Develop Real Time Video Surveillance System Based on Embedded Web Server Raspberry PI B+ Board. International Journal of Advance Engineering and Research Development (Ijaerd), NCRRET.," pp. 1– 4, 2015

[8] Kyunghoon Kim, Soonil Bae, and Kwanghak Huh "Intelligent Surveillance and Security Robot Systems", Advanced Robotics and its Social Impacts (ARSO), IEEE, 2010.

[9] Saurabh Vinayak Lawate and M. S. Ali. "Electronic Eye for Security System" International Journal of Electronic and Electrical Engineering. ISSN 0974-2174 Volume 7, Number 9 (2014), pp. 961-970

[10] J. H. Lee, T. Tsubouchi, K. Yamamoto, and S. Egawa, "People Tracking Using a Robot in Motion with Laser Range Finder," in 2006 IEEE/RSJ International Conference on Intelligent Robots and Systems, 2006, pp. 2936–2942

[11] Kawarazaki and Noriyuki 2015 Development of Human Following Mobile Robot System using Laser Range Scanner Procedia Computer Science 76 455-460

[12] Ismail R, Omar Z and Suaibun S 2016 Obstacle-avoiding robot with IR and PIR motion sensors IOP Conf. Series: Materials Science and Engineering 152 1-6

[13] Akshay C 2017 Follower Robotic Cart using Ultrasonic Sensor International Journal of Engineering Science and Computing 7(3) 5794-5797

[14] Jung S, Kim J and Kim S 2009 Simultaneous localization and mapping of a wheel-based autonomous vehicle with ultrasonic sensors Artificial Life Robotics (ISAROB 2009) 14(2) 186-190

[16] Purvi A 2017 Human Follower Robot Using Kinect International Research Journal of Engineering of Technology (IRJET) 4 1635-1637