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Surveillance Through Semi-Autonomous Bot

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***Abstract*—This paper consists of the design and implementation of the semi-autonomous surveillance bot. The idea presented in the paper is to monitor a surrounding or unknown area. This paper carries the different phases of realization such as the motion of the robot, obstacle avoidance, and video capturing and streaming. After the video has been captured the recorded clip is streamed to a remote server which assesses the surrounding. For the implementation of the idea, different tools were required for the execution of the precursor. For building the model, the hardware required was Raspberry Pi, infrared sensors, L293D motor driver. Raspberry Pi consisting of a Raspbian operating system running on python language for video capturing and obstacle sensing was used.**

***Index Terms*—Raspbian, Python, Pi Camera, Semi-Autonomous, LXDE**

I. Introduction

In the area of robotics, bots are being designed to perform complex tasks on their own or with very little human intervention. Nowadays, they are deployed in fields where it is difficult for human presence and human observation [1]. Any algorithm designed for a specific bot has to consider its hardware attributes. Environment mapping and obstacle recognition are the most commonly used algorithms in robotics. The observation that we acquire from a camera or sensor is called mapping while any hindrance or object detected in its path is called obstacle recognition [2].

In every situation, human presence can not interfere in a surrounding and assess the environment [3]. Sometimes we need the assistance of machines and robots. The paper proposes a semi-autonomous bot that does the work of observing an unknown surrounding and avoiding obstacles while moving forward and providing feedback to the controller. The design of the system so implemented follows a typical embedded system as depicted in Figure 1. Any field of research or surveillance requires close examination or scrutiny of their concerned object or subject [4]. Everywhere there is a need for technical observation of a particular subject. Few locations are either unexploitable or untraceable by human presence to inspect upon [2]. Manually it becomes difficult to look over that particular region which lacks objectivity in the quantitative analysis. So, to overcome this conundrum, we need an automatic approach. An automatic approach best suited for these kinds of applications is alternative or proxy surveillance, a machine that can scan the spot through its lenses and display it at the master controller on the other side [5]. The literature presents various techniques through which inspection can be performed by a designed bot [6]. One such technique as proposed in this paper is a semi-autonomous bot that can record a surrounding and stream the visuals to the other end for observing. In this research, a detailed survey was conducted to identify the research challenges, achievements, and progress in the said domain. The whole scenario of the semi-autonomous bot technique is elaborated in this paper. For the ease of access to inhuman conditions and inaccessible places, such bots can be used [7]. A camera serves the purpose of capturing

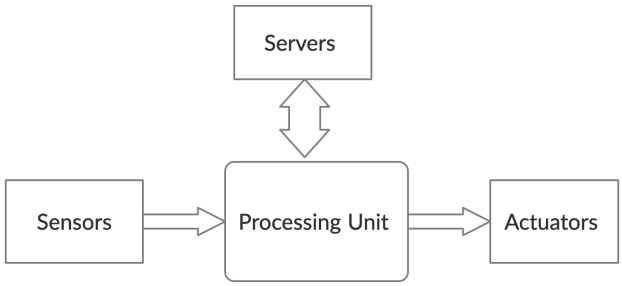

Fig. 1. A Typical Embedded System

images of the surroundings or recording the circumstances to display it on the display machine as well as any other remote display through a proper medium so the operator would need not face that harsh and critical environment [8]. The Wi-Fi property provides a wireless interface between the server and the bot. The papers reviewed expressed different ways to control and assess the surroundings using different techniques in which one of the simplest and cost-effective ones was using an IR sensor and Pi camera module in the bot. The main contributions of the paper are:

- The aim was to develop a semi-autonomous bot that can traverse an environment that is not reachable by humans, if reachable then hazardous to human life.
- For implementation, the choice of sensors is of utmost importance in cases where human life is important. The paper presents an idea of choosing the right obstacle detection sensors.
- The usefulness of pi camera is highlighted that gives a cutting-edge novelty to the implemented bot. The captured images are streamed to the remote server where it gets processed and stored for future references.

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The conventional, reliable way to control the movement of the bot through the controller is preferred through the Wi-Fi module by which the bot will be amiable to the user and will give the benefit of ease of operation even in a hostile environment. The major benefit of using an IR sensor in the paper is that it helps in stopping the motor when both the sensors get activated.

II. System Design and Implementation

The design of the proposed system follows a typical block diagram of an embedded system, based on that, the idea presented in the paper is implemented, as shown in Figure 2 and discussed in this section.

A. Softwares used

Raspbian OS:
Raspberry pi boards work with the Raspbian operating system (OS). Raspbian OS is identical to a Debian-based OS and is the official operating system of the Raspberry Pi single-board computers. It provides a modified LXDE desktop environment and numerous packages are included in it. For the implementation of the idea, Raspbian OS has been used. It provides a desktop environment that is convenient for running the applications on the board. Any python statement can be executed by using the python command terminals. The python code for the sensor, camera, and motors were done in the python IDLE which is by default available in the Raspbian OS package.

Python Command Shell:
It is a terminal where the commands are written in python to check the working of the features like camera, sensor, and motors. The .py files were initialized and run here to get the desired output. The images captured by the pi camera are processed and worked upon by executing the python commands for the same. To connect the back-end to the raspberry pi, one has to enter the command and URL of the domain to stream the camera.

B. Block Diagram

There are two IR sensors placed at the front which are used to sense the path and proceed the vehicle accordingly and avoid obstacles. The input is provided to the raspberry pi which in turn is used to move the bot forward. The output is given to the driver which controls the movement of the motor wheels. Pi camera captures the video and gives the collected data or information to the processor for further processing. The captured video is streamed to a local computer server. 5V supply is given to the raspberry pi. Python language is used for overall software coding.

C. Related Analysis

This semi-autonomous robot is used in observing an unknown surrounding or congested spot. This bot is useful in observing spots and locations where human intervention is difficult and far-fetched. Congested tubes in industries, tunnels, unexploited locations, supply pipelines are some of the areas

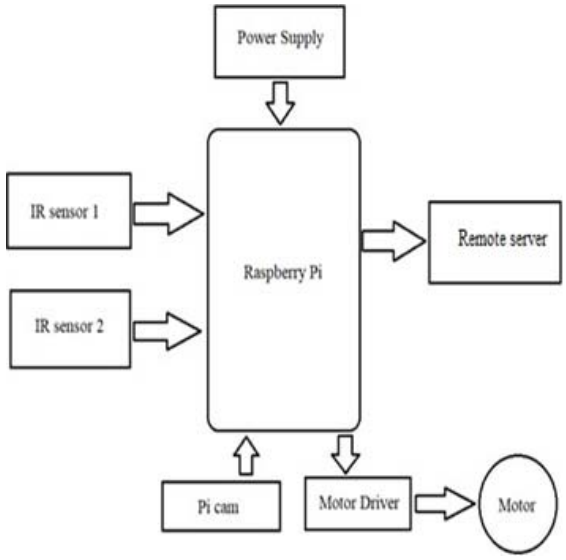

Fig. 2. Block Diagram of Proposed System

where it is difficult and dubious for humans to go. There is a requirement for a fitting alternative that has the observative and locomotive ability. An autonomous or semi-autonomous bot serves the purpose.

The proposed method is aimed at designing a locomotive bot that can keep away from the obstacles and stream the visuals to a remote location for observation. Raspberry Pi B is the processor which is responsible for processing sensed data as well as controlling the motion of the robot using python programming language installed in it. IR sensors are used to make a path by sensing and providing feedback to the motor driver and processor. Pi camera is used to capture or record images of the environment.

D. Implementation

1) Hardware: Infrared sensors are interfaced with the microprocessor Raspberry Pi. These Infrared sensors are emitting IR rays which are helping them to detect the obstacles. After detection raspberry pi takes the input and analyses it. This calculated signal will guide the motor driver. The motor driver will drive the motors according to the instructions of the processor.

2) Software: Firstly, flash the Raspbian operating system into the memory card. Using this memory card, one can boot the operating system in the raspberry pi and run it using virtual network computing (VNC) viewer. Once the IP address of the raspberry pi is searched and matched, the VNC viewer runs the terminal window. With the help of the python programming language, the program code is written and compiled. The code is written to control the working of the sensors and the motor.

III. Result

The idea of the semi-autonomous bot is to help, through the manoeuvre of bots, humans reach environments critical

to be reached. The idea can be implemented by developing an embedded system using the components like sensors for input, microcontrollers for processing, a memory to store the fetched data, and actuators for performing the actions. For implementing the bot several sensors were tried and tested of which comparison of two is discussed in this section. The trial and experimentation with the sensors are also verified through hardware implementation. The results show the implementation and outputs of the surveillance bot after doing a plethora of experimentation. The output of the Pi camera is shown in the VNC viewer window, and the detection of the obstacle was done using the IR and ultrasonic sensor, and the output window of the separately implemented ultrasonic sensor and its response in a pragmatic environment is discussed in this section.

The ultrasonic sensor HC SR-04 tested with the bot gave the distance of the bot from the obstacle. The output of the sensor is used to stop the motor for avoiding potential crashes as shown in Figure 3.

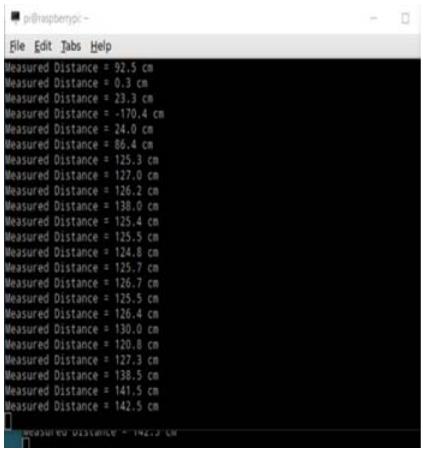

Fig. 3. Ultrasonic Sensor Output

The IR Sensor placed at the front of the bot blinks on detecting the obstacle in front of it and turns the motor off. If no obstacle is detected the vehicle traverses the terrain. The final implemented system is as shown in Figure 4.

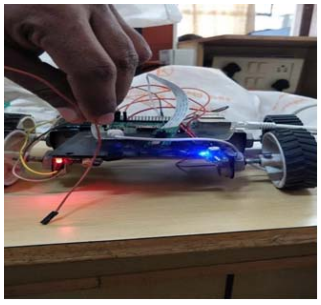

Fig. 4. Testing The Implemented System

The Pi camera placed on the front of the bot gave the image of anything placed in front of it, as shown in Figure 5.

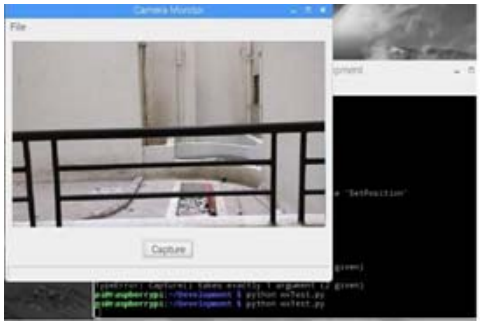

Fig. 5. Pi Camera Output

The below table compares the two sensors, IR Sensor & Ultrasonic sensor, that were tested for the implementation of the bot.

TABLE I

Sensor Comparison			
Sr. No.	**Name of Sensor**	**Range** *(cm)*	**Voltage** *(volt)*
1	Ultrasonic Sensor	1-100	5
2	IR Sensor	1-20	5

The python codes for the ultrasonic sensor and IR sensor with the motors were executed. The analysis of the precision of the two sensors suggested that the IR sensor was able to detect objects precisely and provide feedback to the motor driver to stop automatically when an obstacle in close range is detected. The movement of the bot should pause only when an obstacle in close proximity is detected and for that the IR sensor was more effective as it has a smaller range of detection which is ideal for a precise movement and surveillance. The Pi camera was installed through the python command window and the command to display captures image was executed. The camera was able to capture the view of the environment in front of it suggesting that it was fit to be used as a surveillance camera.

IV. Conclusion

The need of inspecting or observing a particular environment is of utmost importance for spotting certain obstructions in an unknown location like archaeological sites or detecting a fissure or crack in a pipeline. It can be fulfilled by the semi-autonomous robot which will stream the visuals using a Pi camera. The paper presents the idealness of the pi camera and its image captured by the robot which will stream it to a remote server or store it for processing and analysis. The converted images will be used to detect any abnormality or unknown obstacles. This robot will reduce the load on human work and emerge as an exemplary alternative for humans who find it difficult to track down or pass through small vents or caves or cross boundaries. The paper compares the idealness of the ultrasonic sensor and IR sensor to provide precise obstacle detection to a limited distance so that the motors keep working until they are in very close proximity of an obstacle.

REFERENCES

[1] S. Popesku, E. Meister, F. Schlachter and P. Levi, "Active wheel - An autonomous modular robot," 2013 6th IEEE Conference on Robotics, Automation and Mechatronics (RAM), Manila, 2013, pp. 97-102. doi: 10.1109/RAM.2013.6758566

[2] D. Avola, G. L. Foresti, L. Cinque, C. Massaroni, G. Vitale and L. Lombardi, "A multipurpose autonomous robot for target recognition in unknown environments," 2016 IEEE 14th International Conference on Industrial Informatics(INDIN),Poitiers,2016,pp.766-771.doi: 10.1109/INDIN.2016.7819262

[3] R. Jarvis, N. Ho and J. Byrne, "Autonomous Robot Navigation in Cyber and RealWorlds," 2007 International Conference on Cyberworlds (CW'07), Hannover, 2007,pp.66-73.doi: 10.1109/CW.2007.31

[4] S. Bensalem, M. Gallien, F. Ingrand, I. Kahloul and N. Thanh-Hung, "Designing autonomous robots," in IEEE Robotics & Automation Magazine, vol. 16, no. 1, pp. 67-77,March2009. doi: 10.1109/MRA.2008.931631

[5] T. Zielinska, "Control systems of autonomous robots," Proceedings of the Fourth International Workshop on Robot Motion and Control (IEEE Cat. No.04EX891),Puszczykowo,2004,pp.47-51.doi: 10.1109/ROMOCO.2004.240636

[6] J. Sequeira and I. Ribeiro, "Hybrid control of semi-autonomous robots," 2004 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (IEEE Cat.No.04CH37566),Sendai,2004,pp.1838-1844vol.2. doi: 10.1109/IROS.2004.1389664

[7] P. Benavidez et al., "Design of semi-autonomous robots for competitive robotics," World Automation Congress 2012, Puerto Vallarta, Mexico, 2012, pp. 1-6

[8] Denker and M. C. eri, "Design and implementation of a semi- autonomous mobile search and rescue robot: SALVOR," 2017 International Artificial Intelligence and Data Processing Symposium (IDAP), Malatya, 2017, pp. 1-6. doi: 10.1109/IDAP.2017.8090184