

A SURVEY ON CAMOUFLAGE SURVEILLANCE ROBOTS

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Abstract - This project talks about the design construction and fabrication of multipurpose spy surveillance robot. It is used either for the purpose of surveillance in Military or for General surveillance. It can also be used under hostile situations such as disaster management and for spying. The bot uses the property of camouflage to remain stealth from the nemesis. Through spider like quadruped movement and protective exoskeleton, the bot can adapt to any habitat and send information about that environment through Wi-Fi communication. The real time object classification is done using the techniques of image processing and deep learning. A living body detection behind the wall helps not only during spying but also to search victims trapped under debris during earthquakes or landslides.

Key Words: surveillance, camouflage, quadruped, Wi-Fi, spying, object classification

1. INTRODUCTION

A Robot is a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer. Modern robots are usually guided by a computer program or electronic circuitry. Military organizations use robots in hazardous and risk prone areas to perform various tasks which cannot be performed effectively by men in the Army. These Army robots are configured with only a camera and few sensors. They are heavy duty bots with confined locomotion. The main objective of this project is to build a Spy bot which not only spies but also has the feature of camouflaging. The Bots present today use wheels for locomotion which constricts their locomotion. The use of short range communication such as Bluetooth or ZigBee will not help to control the bot in remote areas. The video streaming should be in real time without any lag or loss in data. There should be no threat to the bot by any intruders. The bot should also lay low from the enemy's eyes. Other than Military purpose, the Bot should be suitable for general surveillance as well.

2. LITERATURE SURVEY

In [1] an Army spy Bot for Military surveillance is built, which runs on brushed DC motors for wheels, using a PIC 16F877 microcontroller. The remote controller circuit uses a RF module. The Robot uses a CCD camera for spying which works under 12V producing picture resolution of about 1024x800. Remote of the camera is capable of sending live

sound and visual recording to a PC or a TV through a tuner card to the station of remote controller.

However, the CCD camera would cost more and when the camera interacts with the limit switch it will stop moving. Further the camera won't work with U-turn proficiency when it contacts with the limit switch. Drawback of this camera is that it has no USB port and data transmission and receiving gets difficult and there would be loss data during transmission. The system is solely based on Spying and the vehicle's locomotion is restricted.

So the idea is to go with a better camera, an IR cut camera which works well under daylight and night with wide variety of resolutions from 640x480p to 1080p at just 3.3 V onboard power supply through USB

In [2] an Army bot is integrated with Metal detection sensor and Gas Sensor (MQ-2). Metal detection is further used for Landmine detection. The idea here is to make use of the concepts of IoT for obtaining the value of sensors. The Bot has four wheels for locomotion. The Robot lacks capabilities like spying, surveillance and camouflaging.

But, the idea of utilizing various sensors is a prominent one. With the addition of other sensors like CO₂ sensor to detect human respiration and PIR sensor for moving object detection, we would be able use the Robot for Disaster Management as well. This can be improved by building a User interface Mobile/Web application and by applying the concepts of IoT not only to display the sensor values but also for object classification.

In [3] the proposed system is for surveillance, inventory tracking, theft deterrence, threat perception and detection etc. The system uses Machine Learning/Deep Learning techniques to perform real world applications. The goal here is to try to automate most of the tasks, which can be error prone otherwise due to human errors and fatigue. The concept of DL's CNN is used for object classification and real time alerts are sent to mobile.

The problem here is that, it gets difficult to find appropriate filters in order to come with max efficiency. It would require an ample amount of time to work on data. The alternative here is to make use of readily available Object Classifiers like COCO or Tensor flow or IBM Watson IoT platform which can be implemented in real time while streaming the data as video.

In [4] the paper is about implementing the technique of camouflaging in army bots near border security using an LED matrix, Bluetooth module and a color sensor for camouflaging. The model is integrated with DC motors and LCD display and works under 5 to 12 V and run by a Microcontroller.

It is a bulkier model with minimal applications. The LED matrix is rigid and appears more like a screen. The Robot might have less efficient camouflaging as the sensor detects color with a miniature window size. The take away here is to come up with a better way to detect color and improve the efficiency of camouflaging and to adapt LED strip display for system flexibility.

In [5] the authors have proposed implementation of image processing for color detection in MATLAB using color based threshold algorithm and blob detection algorithm to process the current background. The entire system is broken down into Robot side and PC side functions using ZigBee for wireless transmission.

The thing that should be noted down here is that it would require much backend processing to execute this task as the data is solely based on image frame captured by a camera. It becomes difficult to figure out the background proficiently as the system works on a mere Algorithm. There would be immense lag in transmission and receiving of data as the system is divided into Robot end and PC end. The goal is to implement an onboard technology that can detect the color and apply the technique of camouflage without much processing.

In [6] TCS3200 color sensor module is used for color detection which gives output based on the amount of ratio of reflected color in RGB scale which gives easy estimation of background color with minimum power supply. The sensor has an array of 8x8 photodiodes and receives a square wave instead of an analog wave based on the light intensity with a typical output frequency ranging from 2Hz – 500KHz. The sensor is capable of on-chip selection of frequency scaling. It comprises of a photodiode filter type. The sensor is easily compatible with development boards.

Using these sensors at different peripherals of a Camouflage Bot would increase the efficiency of color detection. This paper serves as an inspiration to make use of TCS3200 for the purpose of surrounding color detection and camouflaging.

In [7] the authors of *Massachusetts Institute of Technology* propose an Antenna system capable of tracking 3D position of a person's limb and body parts without placing any markers. The proposed system Uses Wireless RF signals that can traverse walls and reflect off the human body, allowing for the detection of human motion through walls. Lens less image sensing is performed based on the time-of-flight of the

object's reflections bouncing off the corner. Skeletal Stitching of images is done by implementing Deep Learning and Reconstruction Algorithms. The hardware used here are hardware such as an FMCW chirp generator with bandwidth varying from 5.46 GHz to 7.24 GHz every 2.5 ms. The antenna array consists of 16 receive antennas and 4 transmit antennas. It would require multiple snapshots and frames to properly segment and analyze. Here the system would be executing high end software programming, processing and compensating huge amount of data. So the goal is to find out a simpler way for Human detection behind the walls which can be integrated to The Spy Bot.

In [8] the paper talks about a Sense through wall human detection using P220 UWB (Ultra-Wide Band) sensor which detects humans behind the wall on the basis of movement of body parts or breathing or Heart-beat. The model has a Central frequency of 2.3 GHz and a bandwidth of 4.3GHz The returned UWB radar signal will have multipath components when scattered from a human, while a single path component is observed when reflected from a plane reflecting target like metal sheet. Using this methodology it is possible to detect human through a distance up to 7-8 feet through a 4-cm wood door and a 12-cm brick wall. However, it would require much backend processing as the received signal would return in form $M \times N$ matrix which needs to be treated and transformed and subjected to reduction of clutters using SVD.

In [9] the paper gives a description on RCWL-0516 which is a microwave sensor that uses Doppler technology in the 3.2GHz range to detect the motion of nearby moving objects. The onboard signal processing chip uses the difference between the emitted frequency and the reflected frequency to notify whether there is motion surrounding the module or not. To detect motion both in open air and through walls and compatible with Arduino board. The onboard signal processing chip handles the frequency shifting and notifies the user (via TTL) when a threshold has been crossed, indicating motion. This can be easily implemented under 3.7V (Lipo battery) and cost only around about \$5.00. This serves as a motivation to utilize such sensor for The Spy Bot as this would help in rescuing people during natural calamities.

In [10] the proposed Robot is an Arduino based IR remote controlled Robot. The Arduino is connected with IR remote control series through which the movement of the robot is controlled. The Driver IC makes the gear motors work to rotate in required direction (wheel-based locomotion). Surveillance is done using a mobile camera and images are taken at regular intervals and sent through Bluetooth module. The Robot is suitable for short range communication and surveillance. Having a GPS module is an added advantage. But due to the use of Bluetooth there is immense lag and loss in data transmission and receiving. There is another complexity where the raw images has to be

processed later. The challenge is in finding the best alternative for communication i.e., WiFi. The adaptable way is to live video stream using the combination of internet WiFi and IP for remote access to view the entire stream seamlessly in the backend along with live object classification.

In [11] the model is an e- Surveillance Robot where Raspberry Pi is used as the development board. PIR sensor is used for living body detection to detect motion in the surrounding. A web application is built for video monitoring. The model uses ARM based processors which help in real time visualization. MAX232IC is used for communication between PIC6F877 and Pi. As the video is streamed through the internet, there lag in communication. There are more chance of data being tracked or lost during transmission. Because of the inefficient exoskeleton, the Robot is prone to damage by foreign objects. The paper provides an inspiration to adapt R-Pi for the proposed system as it supports the task of efficient video streaming. The goal is to develop an efficient exoskeleton to protect the components and The Bot, attached with LED strip for camouflaging property.

In [12] the paper deals with an Arduino Quadruped Robot where Arduino IDE is used for coding and Servos are used for locomotion. The shafts are connected to lightweight 3D structure which act as limbs of the Bot. The paper explains various algorithms used to perform various static and dynamical gaits. The Bot is integrated with ultrasonic sensor and Bluetooth sensor for remote control through mobile App. This is basically an Animal mocking Quadruped robot which is cost efficient and simple to build. It is capable of walking over wide range of terrains. The principle behind this is Inverse Kinematics which causes the movement of limbs with each limb having upto 3 DOF. The model of a spider bot such as this would suffice the need for flexible robot movement. This would boost surveillance as the Bot could easily creep and crawl even in remote areas.

3. PROPOSED METHODOLOGY

The basic methodology used in this project includes real time object classification, camouflaging using Color Detection sensor, behind the wall human detection using Doppler technology and adaption of Inverse Kinematics for locomotion. The Bot contains additional sensors like PIR, Metal detection, Gas-Flammable and CO₂ Sensor whose values are monitored using a web/mobile application through IoT. The IR cut camera used, has both day and night vision and the video captured through this is streamed in the backend using remote access through Wi-Fi and IP technology. A robot such as this can creep and crawl in most of terrains and perform hazardous tasks which could be fatal to soldiers or humans in general. This robot is comparatively economic and physically lighter than most of the present available surveillance bots which makes it more efficient.

4. CONCLUSIONS

The Spy Bot is comparatively light weight and is integrated with various gizmos to execute multi tasks. The Robot system is equipped with Quadruped for locomotion which makes it capable of moving on most of the terrains. The Spy Bot uses Wi-Fi for streaming the spied video in real time so the loss in receiving the capture is minimized. The Bot's Movement is controlled by a Mobile/Web Application by adapting the principles of IoT. For proficient long range communication this is also integrated with Wi-Fi. Camouflaging property is inspired by the biological feature of a Chameleon.

The Bot can enter the enemy territory, gain the information about the location, detect and process the objects present in the frame, all this while in a camouflaged stealth mode avoiding getting caught by a human eye. Also this Bot is capable of detecting Human Being behind the wall which is an added advantage. The Spy Bot basically works as a walking CCTV. Other than Military Surveillance, the Spy Bot can be utilized for even general surveillance in hotels, malls, jewelry shops, or any places which faces the threat of intruders or terrorists.

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