Automated Area Surveillance Robot (AASR)

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Abstract: *Inter-state and national security are now more at stake partially owing to the rise of the terrorism groups which constantly avoid trained military and fix their attacks on un-expecting, unarmed civilians. Now as the foes are intensively trained by major terrorism and govt. based groups they usually obtain fancy and latest technology weapons and explosives and, enter into areas they shouldn't and, carry out their attack with the element of surprise. Now mostly their attacks are carried out successfully, their success factor is based on the unawareness and their unexpected entry into the area. A human being or a soldier cannot constantly have a watch over the possible area as they may commit mistakes or may even let the foes enter unnoticed if they use camouflage techniques. Now to combat this scenario we are planning to introduce, "Automated Area Surveillance Robot". This AASR will prove to be the best in surveillance as this AASR will be equipped with the best of the sensors and will collectively process the output of these sensors to possibly detect even heavily trained infiltrators. Equipped with a 60fps camera for image processing along with IR beamers and Ultrasound sensors, its area of use is widened. It possibly can be used by companies and institutions to have a watch over their facility round the clock. It can be used by street associations to have their streets monitored. This AASR may also be of good use to the army. In groups of 8 or 10 AASRs, these can collectively have an intense security over the restricted area. Remote alarms will be set up at strategic places so as when there is an intrusion, this AASR will set off these alarms so that the people or soldiers nearby will be alerted properly. With powerful chassis and motors, this AASR can keep up to the speed of a normal human being thus tailing the intruder constantly. A continuous video feed of the events happening will be relayed to the device monitor wirelessly. Overall this AASR will prove to be the best in security and surveillance systems.*

Keywords: Robotics, AASR, Surveillance Security, Automatic Detection, Chasing, Capture

1. Introduction

Our prototype AASR is basically an electromechanical machine robot in which control and processing is done by microcomputer. The objective of this project is to design a prototype surveillance system that will require minimal installation, while offering more comprehensive monitoring of an unsecured place. It will be more complete and user friendly than most of the surveillance systems presently on the market. This robot will provide monitoring of a specified area and using various sensors track the data and under any interruptions it will automatically activate its commands. The extreme tasks that can't be performed by humans can be easily done.
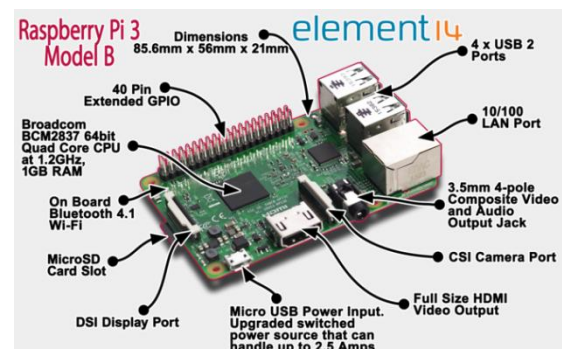
2. Need and Analysis

- The security of a specified area can be done by a CCTV camera but that requires human work and surveillance.
- The security of bank, Navy, Army, Government offices are crucial for the development of the nation.
- This robot helps increasing the security of such institutions with automatic surveillance of a given area and instant alert to security center
- The global security robots market was valued USD 1.34 Billion in 2015 is expected to reach USD 2.36 Billion by 2022, at a CAGR of 8.56% between 2016 and 2022.
- Increasing adoption of unmanned solutions by different military and defence forces is leading to the rise in demand for security robots worldwide.

Years considered for this report Base year: 2015 Estimated year: 2016 Forecast period: 2016–2022.

3. Raspberry Pi 3 Micro-Computer

This raspberry pi 3 by Raspberry Pi boasts that it has made a very cheap computer just for 20USD$. It consists of a 1.2GHZ raspberry pi 3 processor allows raspberry pi 3 to be small and powerful enough to handle any task. It consists of 4GB of High-speed Storage. It also has 1 GB of RAM. In general, raspberry pi is powered by a 5-volt source like a USB port and in general, 1100 MHz ARM, 500 MHz and overvoltage of about 6.

The Pin Headers provide a massive **amount of connectivity, making raspberry pi** a suitable platform for product development for physical computing and "internet of things" devices**.**

Also the pi3 model supports wifi and Bluetooth.

4. Automatic Navigation

The Automatic Navigation is achieved based on the area of operations. If the area of operation is outdoor, GPS would be used for automatic navigation. If the area of operation is indoor, the process becomes different. When indoor, the AASR first sends out some high beam Infra-Red rays and scans out the entire are in a 360* point of view. With the receiving output the AASR forms a matrix of the room's perimeter within itself. And the AASR starts moving around the perimeter and within the area alternatively. It also uses HC-SR04 ultrasonic range finder to detect obstacles and avoid them. In outdoor operation it uses its onboard GPS to track its location and uses the same algorithm to go around within a permissible range.
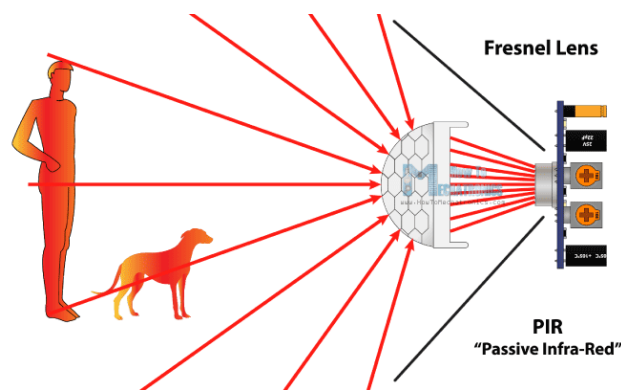
5. Auto Surveillance

This would be the most prevailing feature in the AASR. Since the project is aimed at reducing maximum human intervention an effective algorithm for Automatic Surveillance will be developed. This will coexist with Automatic Navigation systems. While the AASR is in transit, the Reflexive ID'ying feature will be ON. When there is a human presence within the AASR's range, the human is detected by the PIR sensor and it keeps track of his movement. The High intensity IR from Reflexive ID'ying scans for the 'friendly' ID on the human. If there is no ID present or if the ID is unable to be scanned, the AASR immediately raises a notification to the device controller. Now the AASR keeps following the 'suspicious' human. It uses the onboard OV5647 camera to recognize the human's face to find a 'friendly' match from the remote server. Even when that fails or if it becomes impossible, the AASR terms, the 'suspicious' person as a 'Potential Intruder'. The AASR now starts tailing the Potential Intruder at its full speed. If the device controller specifies to the AASR that the unrecognized person is a 'friendly' the AASR will stop tailing him and will return back to Surveying.
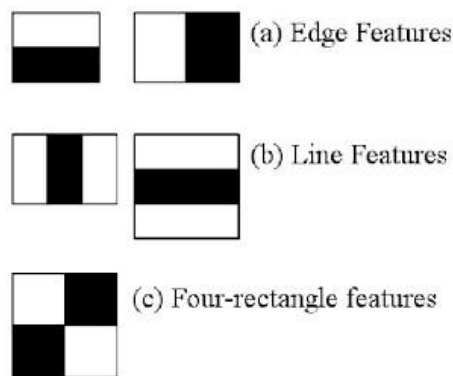
6. Human Detection

Our prototype (AASR) uses PIR sensors for the purpose of Human Detection. PIR sensors are used to detect any object that radiates heat. It can detect humans, animals and other objects. Fresnel lenses are used in PIR sensors which

increase the range of detection. It contains lenses that are partly transparent and can pick up radiations from visible light. The PIR sensor is divided into two partitions where each one is reactive to infrared. In normal state, it senses the infrared radiation radiated naturally. When a human being or any other warm blooded being passes one half detects the change in differential value of the IR. When the human goes out of range, a negative change is seen. So with the corresponding instant outputs this sensor can detect human presence and movement.
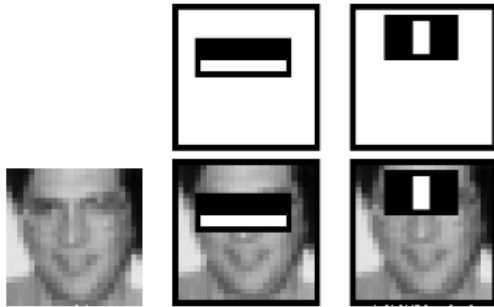

7. Face Tracking and Human Detection Using Video Processing

Face detection is an important feature of the Automated Area Surveillance Robot (AASR).When the passive infrared fails to detect the human or classify them, Face detection would be used to detect them. Face detection in AASR is achieved by the use of OV5647 camera, which is used to differentiate between an intruder and security personnel. The main function of this OV5647 camera would be to send real time video to the control unit. The secondary function is for face detection using OPENCV.

OPENCV (Open Source Computer Vision) was developed by Intel to provide a basic for coding on the computer vision related problems. There is a database of the people who are already recognized as not harmful to the specific security region and another database of people who are criminal listed and are harmful for the specific security region. These two databases are used to differentiate humans and form the core of the human detection in AASR .The procedure used to detect these humans based on their features in the database is called as Haar-cascade. Object detection using Haar-cascade is an effective methodology used to differentiate humans using their facial features. It was proposed by Viola and

Michael Jones in 2001.This algorithm required positive(images with faces) and negative images(images without faces), and these features are extracted from it using the Haar features as shown in the diagram. Using this algorithm we can differentiate the humans based on their facial features and thus Human differentiation using Face detection is achieved in AASR.

8. Reflexive Id'ying

Another crucial feature of the AASR would be Reflexive ID'ying. This is a method to differentiate the friendlies from the hostiles. This is achieved by using high intensity infra-red beams, usually found in latest TV remotes, which will have the ability to read information. The friendlies will compulsorily have to wear a customized ID card which will be rigged by a transponder which will respond to the correct frequency of the high intensity infra-red. When the human is in range, the Infra-Red will be triggered and will start sensing for the ID. When it intercepts the ID, it will read the information from the ID which will be cross matched with its remote data base. If the match is found, then the human will be identified as a friendly. All these processes will happen in a second or two at the maximum.

9. Chasing and Remote Alarming

One of the aggressive features of the AASR is its chasing capability. It is very essential in order to completely relay the hostile's live video and his location via GPS. In normal mode or surveying mode, the AASR will be moving in one third of its actual speed. With 2000rpm DC motors, its full speed can reach up to 25 Kmph. So assuming that most of the time the AASR will be in surveying mode rather than the 'alert' mode, most of its energy is saved, thus increasing the time an AASR can stay with a charge. When in alert mode, i.e. when a hostile is identified, it uses its full potential and chases the hostile at its top speed and tries to stay within a particular radius from the hostile. Thus this ensures in constant video footage and the location.

Another feature would be the remote alarming. Micro sized buzzer alarms enabled with wireless connectivity will be linked to the AASR and be placed at strategic locations around the area to be secured. Thus whenever the AASR is chasing a hostile in a place, then it would trigger the nearby alarms so the the authorities nearby will be alerted. Since the video is being relayed wirelessly using GSM module, authorities with the AASR's IP address will be immediately able to see the live video footage and location of the hostile.

10. Future Scope

- AUTOMATED AREA SURVIELLANCE ROBOT is aimed at increasing the security of banks and other sectors were information or data leak can be dangerous.
- The use of robots will not decrease or extinct the job availability for humans, AASR and man power goes hand in hand for the security of the area.
- The updates to the AASR are image processing to differentiate between the people and to identify them using their ID cards with IR sensors.
- Direct Solar Charging will be updated, so that the AASR can operate in day time without using its battery
- Lithium Polymer Batter with 10000mah will be update
- In the near future non-lethal tranquilizing shots, based attacking system will be proposed for additional security features.
- Face matching databases from various parts of the world will be added so that the hostile would be identified and be intimated to the respective authorities immediately.
- Noise cancelled motion; increased chasing speed will be added too.

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