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Border surveillance robot

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ABSTRACT

Border monitoring is a complex challenge, it requires protection all day, all night and in all conditions. Border security is required to monitor the area every second and detect unusual activities, this is generally being carried out by human effort, but humans are prone to errors due to fatigue or exhaustion. Border surveillance robot comes up with a special surveillance, scanning the area continuously in real time. This monitoring greatly decreases the erroneous human monitoring. The proposed system provides a real time video footage and ensures protection from terrorists or any kind of prohibited intrusion. As enormous manpower and assets are needed at the borders which cover a large area under harsh climate and improper terrain, we designed a semi-automated border surveillance robot. This robot's main aim is to move in this harsh terrain and transmit video in real time to the base or the operator. This video feed is then used by the operator to move the robot in a desired direction. Here, we are utilizing a raspberry pi, a small size computer which will control the motions of the robot and transmits video over real time to the operator over internet with Wi-Fi network which in indeed, for sure will save and reduce the soldier lives from risk operations.

Keywords— *Raspberry pi, Arduino, Motor driver, Motors, Pi-Camera, and Raspberry pi-based operating system*

1. INTRODUCTION

1.1 Motivation

Border security provides regional monitoring, immediate warning and border patrolling management. For a long time, this has been a major problem to protect the country's boundaries against terrorists, illegal immigrants, illegal trades etc. Currently, most of the military monitoring services lack the required standard's which is not up to expectation, leading to border soldiers lives being put in constant danger. So as to decrease the soldier lives being lost and to improve the surveillance standard's there is need for a system which can effectively monitor the border with locomotion and surveillance capabilities.

1.2 Objective

With soldiers lives constantly at stake, there is a requirement for effective high-quality video transmission. The proposed model has a better video capturing. This model is capable of locomotion on various surfaces and terrains. With the advancements in technology there are better options for surveillance with on board and modular cameras, assisting in various fields especially security and secret video recording. But still they are not enough as they cannot act by themselves. The proposed model is on of a kind surveillance equipment with locomotion capability allowing for immediate action. The proposed model has two individual units perfectly interfacing with each other they are a remote-control unit (coded software) and a robotic unit. An operator can control the device from a remote position which is achieved by a raspberry pi technology along with motors for movement driven by a motor driver circuit. This robot can find its application in various fields involving surveillance.

2. LITERATURE SURVEY

1. Surveillance is major thing at places like international borders in order to stop or prevent any illegal entries into the country. It is a tough job to do as it involves a lot of risk. This paper proposes soldiers to be replaced by a robot which can do the surveillance and thereby reducing the risk drastically. It increases the efficiency and save lives at the same time. These days the systems use a

camera mounted on a locomotive robot. This robot can move to different positions. These are more adaptable compared to fixed cameras. With the advancements in internet and connectivity between devices, the videos captured by camera on robot can be monitored remotely on a computer, which is feasible by connecting the raspberry pi with internet. The Ultrasonic sensor helps the robot to detect any movement and transfers all the data through the internet immediately. The futureapplications of this surveillance robot might include facial recognition technology and may even be equipped with weapons so that it can eliminate terrorists who are trying to enter our country and create chaos.

2. The ordinary border patrol system is affected by thorough human involvement. Recent automated border patrol systems consist of new technological devices like drones, sensors devices and surveillance towers with wireless camera. However, each of these have problems like area of effect, wrong detections and line of sight constraints. BSF uses PIR sensors for human intervention at the border, a metal detector to discover any explosives or landmines and a closed-circuit TV (CCTV) for surveillance along the border. But this paper proposes robotic vehicle with an arm that can be controlled remotely with the help of Bluetooth technology. This paper proposed to use thermal infrared imaging to detect intrusions along the border, which works mainly due to the heat released from a human body. It uses L293D driver ICs to run the motor. It informs if any intruder is found and checks for explosives around the area. It then alerts the BSF about the entire situation so that they can come prepared. Using Thermal IR imaging can trigger false alarm sometimes as animals have the same property to emit heat. But of course, this can be definitely overcome in the near future.

3. In this paper the proposed model is an autonomous robot which detects trespassers using PIR motion sensor and alerts cops by SMS using GSM and clicks images of trespasser using camera on Android device and mails the image to specified e-mail id using an Android based application. This makes possible for the police to act fast and catch the intruder and also in a cost-effective manner. This robot depends on facial recognition software to detect intrusions at the border. It captures image and then verifies if the intruder is a human and alerts the security personnel. This robot can be operated using three modes. This robot uses a specifically developed android application for the controlling.

4. Robots perform better surveillance when integrated with various technologies. It mainly integrates with cameras for monitoring and sensors for detecting any change. This project is built with a ZigBee wireless sensor to detect any intruder. It is equipped with metal detector, camera, humidity and temperature detector etc for various actions. It can replace soldiers in dangerous stealth operations to detect any explosives and to kill the enemy. Even if anything goes wrong, we just loose a small amount of money rather than losing a soldier's life. It uses a variety of sensors to acquire information on everything around the area it was to monitor. Future robots can even use Artificial intelligence to make decisions on their own to eliminate intruders.

3. COMPONENTS USED

It is an autonomous surveillance robot, which is capable of locomotion. It has the capability of remote operation using a webpage hosted by the raspberry pi equipped on the robot. This webpage can be hosted on any browser given that it supports PHP scripting as the system is developed on PHP. The surveillance is executed by a Pi Camera which is interfaced to the raspberry pi. The system is designed in such a way that the Pi Camera can move on both X and Y axis using the pan and tilt mechanism achieved by two servo motors. The locomotion of the device depends on two 12V DC motors.

3.1 Raspberry pi

It is basically a portable computer and is as small as a credit card. Like any computer it can be connected to a monitor, keyboard and mouse and can be programmed in Python and scratch. It is the backbone of this project interfacing all the components and is used for hosting a webpage using PHP and Apache framework. The webpage controls all the movements of the robot and also posts the video recorded for surveillance.

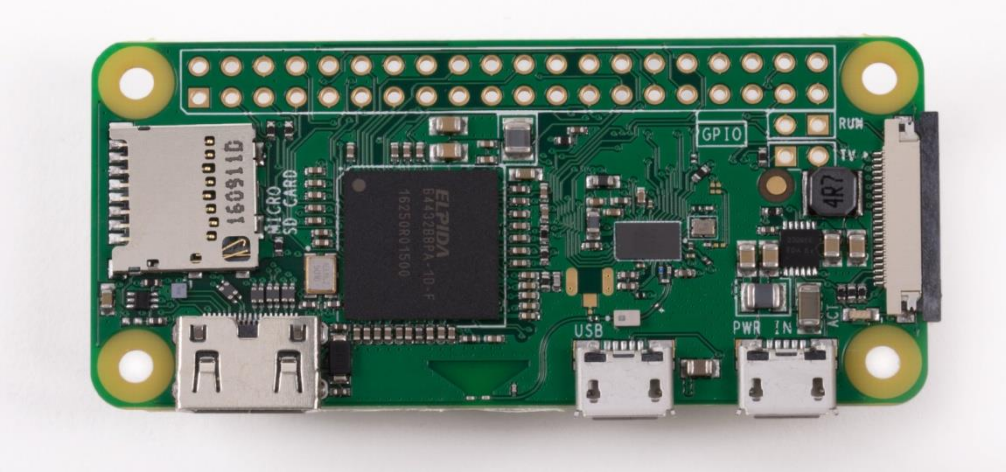

Fig. 1: Raspberry pi

3.2 Pi Camera

The Raspberry Pi Camera is a dedicated camera module for raspberry pi. It uses CSI interfacing to connect to the pi. It has a resolution of 2592x1944and supports videos of 1080p at 30fps, 720p at 60fps and 640x480p. It captures the video and sends it as serial data to raspberry pi.

Fig. 2: Pi-Camera

3.3 Arduino Uno

The Arduino Uno is a MC board developed by Arduino.cc. The board is equipped with sets of digital and analog input/output pins which can be interfaced with different expansion boards and other circuits. It has 14 Digital pins, 6 Analog pins. It is programmed in Arduino IDE via a type B USB cable. In this project it is used to controls the servo motors due to its higher resistance (compared to raspberry pi) to back currents produced by servo motors.

Fig. 3: Arduino Uno

3.4 Servo motor

A servo motor is generally a closed loop control system and uses feedback of its position to control its speed and final position using a simple potentiometer. It is used for pan and tilt mechanism to move the camera in X and Y directions.

Fig. 4: Servo Motor

3.5 Voltage Regulator (Lm2596)

The LM2596 \is a regulator capable of driving 3 A load and can control heavy loads. With input capabilities of 4.5 to 40V it can regulate to about 3.3V, 5V and 12V. In this project different devices use different input voltages. To rectify this problem we use this voltage regulator to give 5V supply to raspberry Pi and Arduino and 12V supply to motor driver.

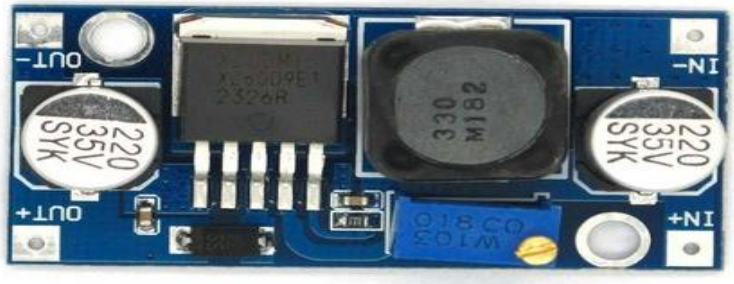

Fig. 5: Voltage Regulator

3.6 Motor driver(L298)

It is a dual H-Bridge circuit which can control the speed and direction of two motors simultaneously. It is used to drive DC motors with voltages ranging from 5 to 35V and current of 2A. It has two different blocks each for motor A and B. It is used to drive the DC motors.

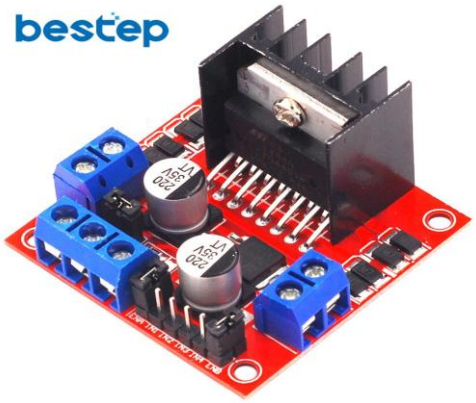

Fig. 6: Motor Driver

3.7 DC motors

A DC motor is an electronic device used to convert electrical energy into mechanical energy. It has a stator, an armature, a rotor and a commutator with brushes. The coil inside it produces a magnetic field always opposite to the magnets polarity when current passes through it allowing it to turn. It has an rpm of 300. In this project 2 DC motors are used for locomotion of the robot.

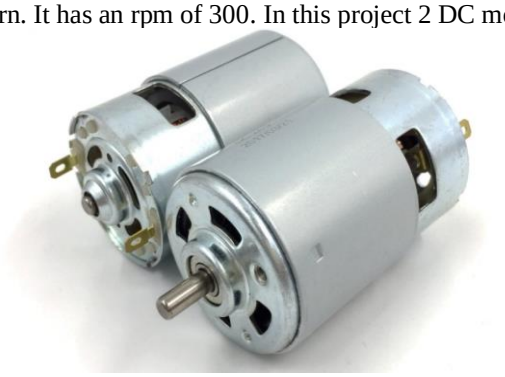

Fig. 7: DC Motor

4. DESIGN AND IMPLEMENTATION

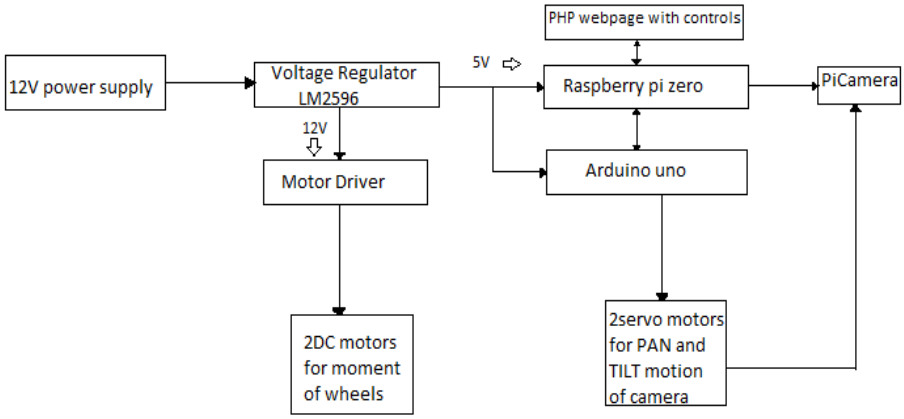

Fig. 8: Implementation design

The raspberry pi hosts a website with the help of the PHP code. This webpage has buttons to control all the moments of the device. The PHP code controls this GPIO pins of the raspberry pi using shell_exec() function. The Pi-Camera records video in real time and the webpage projects this video allowing surveillance of the area from aremote place. The raspberry pi controls the locomotion of the robot by sending high and low signals to the motor driver to which the two DC motors are connected. The forward button on the webpage moves the device in forward direction with 2 motors running forward, back button makes the motors reverse, while the left button makes the right side motor move forward and left side motor move backwards and vice-versa for right button, and the device only stops when stop button is hit. The Arduino is interfaced to raspberry pi the Arduino controls the two servo motors used for moment of the camera so as to give a better visual to the operator. The servo motors are in arranged in way to allow pan and tilt, i.e. movement of the camera in both X and Y axis. The high and low signals for the servo motor come from raspberry pi through Arduino. The servo motors moment is given with a delay of 10ns in a for loop letting it have a smooth movement and only stops on hitting the stop button or the max allowed value which is 180 degrees for pan and 100 degrees for tilt. The voltage supply comes from a 12V battery connected to a voltage regulator LM2596 giving raspberry pi and Arduino 5V each and 12v directly from the battery to motor driver L298. The webpage is opened by putting the IP address of the raspberry pi on a browser.

Whenever a button is pressed on the webpage its value is passed as a part of the URL to the raspberry pi thereby activating the appropriate GPIO pins resulting in the desired operation of the robot.

5. CONCLUSION

The border surveillance robot will become an essential asset as it can exponentially decrease the border deaths. It can save government money on labor and army personal's laborious hardships. Instant detection of infiltration will allow for a better counter measure to face the intruders head-on. The cost effectiveness of this system adds to its strengths. Suitable utilization of this system at appropriate positions can keep in check any suspicious activity at the border with efficiency and accuracy.

6. FUTURE SCOPE

In future large-scale implementation of this system is possible. With improving technology, we can introduce even more modules into this proposed system. The idea is to use a gun with the same pan and tilt mechanism to enable the system of instant action at the border. State of the art technologies like AI and advanced sensors can make this system even more efficient, accurate and time saving. But for now, the system is confined to the above proposed model and the results will be retrieved after further experiments.

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