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Design of Unmanned Ground Vehicle for Border Surveillance

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Abstract - *The unmanned ground vehicle framework is a multipurpose stage for assortments of utilizations, for example, Museum, Bank observation and so forth., particularly reconnaissance of such territories that are regularly extremely hard to get to or risky areas. The fundamental goal of this paper is to make an unmanned ground vehicle (UGV) for observation through cameras and to scan for land mines and Improvised unstable gadget (IED) and to recoup the data about the general condition. The unmanned ground vehicle can be utilized for independent activity, catastrophic event reliefs, military applications, and so forth. The UGV that has been structured is equipped for manual activity up to a scope of 2 kms. The plan uses an Ardupilot Version 2.8 flight controller, which has an inbuilt micro controller. The GPS and the inertial estimation sensor unit are interfaced to Ardupilot. During the activity, the video got from the portable camera can be seen utilizing the web application. The video got from the UGV is handled utilizing OpenCV programming to recognize people and to distinguish objects. The unmanned ground vehicle can use in any condition and can handle any landscape without involving the mission.*

Key Words: ***Audupilot, Border Surveillance, Camera Interfacing, GPS, Radio transmitter, Unmanned Ground Vehicle.***

1. INTRODUCTION

There is always an important concern about the border patrol systems for the purpose of the national security [1]. The long stretches of any national borders are to be protected throughout which requires huge human participation for patrolling the locations/places. Most of the border patrol system involves border troops and security checkpoints. All vehicle traffic is needed to stop at security checkpoints which are set up on the international borders to detect and capture drug activities, illegitimate intruders and other illegal activities. The border security forces watch and maintains control in a specific segment of the national borders. The military troops watch the border as per the predetermined route and also time interval.

With the current ordinary fringe security watch frameworks, an enormous human inclusion is required for all the zones, if just manual watching is thought of[2]. So as to lessen the human inclusion to the total surveillance and so as to have supplemented contribution of people and the machine.

Based on watching frameworks, numerous various reconnaissance advances are being created. So as to address the existing difficulties and to add the framework intercession for security purposes, another Unmanned Ground Vehicle (UGV) is presented whose activity depends on remote sensor systems. This UGV can recognize the fringe interruption with least human investments. This work is affected by the errand that was given by the DRDO as a serious undertaking.

Outskirt safety efforts are fringe control arrangements received by any nation or gathering of nations to battle against unapproved exchange or travel over its fringes, to confine illicit movement, battle transnational wrongdoing and to maintain a strategic distance from lawbreakers from voyaging. The propelled philosophy for reconnaissance in remote and fringe regions utilizing multi functional mechanical autonomy dependent on remote sensors network which is utilized in barrier and military applications.

UGV uses a PIR sensor for human discovery and a metal locator for metal recognition. Likewise, a remote camera can be utilized which can screen the outskirt ceaselessly. The proposed mechanical vehicle can substitute the solider at fringe regions to give reconnaissance. The Unmanned Ground Vehicle (UGV) automated vehicle functions as a physically controlled vehicle utilizing the radio recurrence interface. This multi-sensory robot is utilized to recognize the nearness of the foe, catch it in camera and give the live gushing to the approved individual. Observation is the significant job while chipping away at the outskirt zone, which should be possible better with the utilization of robots.

2. LITERATURE SURVEY

Different research works are continuing for the frameworks that can be totally executed with no human mediation, with the help of innovative advancements occurring in the field of mechanical autonomy and the sensors. In [3], the creators have proposed a plan by utilizing Ardupilot 2.8 for the usage of the Autonomous quad copter framework for reconnaissance; this framework joins Arducopter firmware to control the activities of the quad copter Autonomous. In [4], the creators have planned an unmanned ground vehicle with the poise capacity. Be that as it may, the interest for manual control of UGV is ascending with new advancements being actualized in each new plan. Our UGV can be physically worked up with a scope of 2km, however, with the utilization of repeater stations it very well may be expanded. Further, in paper [5], the creators have stressed on the materialistic property of EMI protecting and concealment materials according to MIL-STD-285, 83528 and 220. According to the proposed work Aluminum adhesive tape can furnish viable protecting of 45db with the thickness of the tape being 0.3 mils. In paper [6], the plan is finished utilizing APM 2.6 controller, which drives the quad copter utilizing on-board magnetometer sensors. The inbuilt compass required for the area following isn't exactly for our application. With the data of many existing frameworks, the difficulties in the structure and to defeat a considerable lot of the disadvantages, a proficient model module of Unmanned Ground Vehicle has been created which can successfully carry out the responsibility of outskirt patrolling.

3. UNMANNED GROUND VEHICLE BODY DESIGN

The UGV body is made up of 25 gauge aluminum sheet as per the CAD design shown in fig. 1. The material selection plays an important role and affects different parameters like shielding properties and UGV weight. The Aluminium sheet has several cuttings for the fan, charging port, sensors, switches and antennas. The UGV body comprises of two structures, one is the Rover body which houses the UGV control system, battery bank, power conversion system and many more auxiliary components. The other part consists of the top cover which holds the GPS module and covers the Rover body. The entire UGV is grounded at different places to provide multi-level shielding [7] from interference from the outer environment. Fig. 2 represents the adhesive aluminum tape used in the EMI shielding and the development of the CAD design.

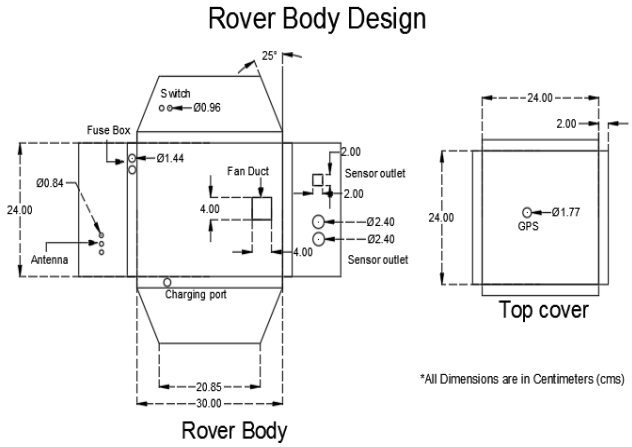

Fig. 1. AutoCAD development of UGV Body

4. COMPONENT SPECIFICATIONS

4.1HARDWARE

The important hardware components required for the prototype module of UGV are as mentioned below:

1. Ardupilot

The Ardupilot 2.8 is used to control the UGV movement. UGV movement is controlled by using the radio controller.

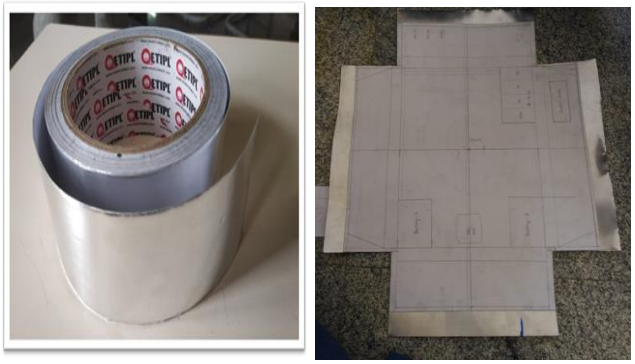

Fig. 2. Adhesive aluminium tape and Casing of UGV prototype using Aluminium sheet metal

Ardupilot also includes the accelerometer, gyro meter. The micro controller is a vital part of UGV. It is in charge of all actions an unmanned ground vehicle can perform from tasks assigned during missions and as well as camera and control sensors.

2. Motor Driver

The brushed motors work on direct supply of DC power, but speed to be controlled by PWM signals. That is where the motor drives come into play. The motor driver generates a modulated signal that controls the speed of the motor. The motor driver circuit can provide sufficient currents for all the purposes which the motor requires as the driver circuit can draw a lot of power.

3. GPS Module

To traverse the position of the UGV, GPS is interfaced. It has an accuracy of 2 m range of all 360 degrees. The Neo 7M GPS m can be used with built-in digital compass for better accuracy and precision.

4. Telemetry

The telemetry system is used to get the on-board sensor data of the APM 2.8, the telemetry module can also transmit the details regarding voltage level and current draw from the power module which is connected to the APM 2.8. The telemetry system can also transmit gyroscope information and GPS location.

5. Motors

High torque, 100rpm motors are used to cover the distance that an average solider can cover during border patrol. The high torque produced by the motor is used to overcome difficult terrains during the mission.

6. Battery

Two 7.4V Li-ion battery is connected in series to obtain 14.8V, which is fed to power convertor to obtain various voltages to meet different system requirements.

7. Camera

An HD 1200TVL camera which has a Sony SUPER HAD II sensor gives better clarity in the field of view. The powerful camera can also work in night vision mode with the help of an IR LED lighting system.

8. Video Transmitter

A powerful video transmitter is used with a range of 5KM with 48 active channels with an automatic frequency hopping feature. The video transmits has very little latency and can provide undistorted video up to 3KM range.

4.2 SOFTWARE

1. Open CV

The open CV software is open-source Image processing software. The video obtained from the UGV is processed using Open CV for object and human detection[8]. There are many classifiers which are used in image processing. We make use of the Haar cascade classifier to detect the object and human/animals or moving objects.Fig 3 represents the face detection done using the above mentioned classifier.

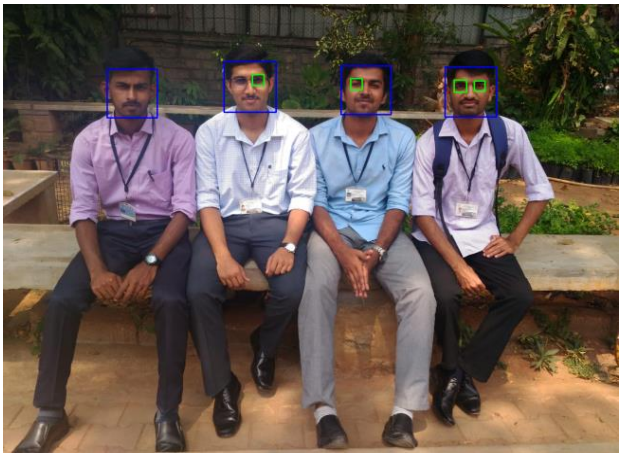

Fig.3. Face detection using Open CV

2. AutoCAD

AutoCAD is powerful software to design different models of different domains. We have designed the UGV body in a 2D format. The design tools available in AutoCAD software make it easy to design the most complicated structures easily.

3. Arduino IDE

The different sensors are interfaced with Arduino Mega and the data is obtained using a wireless transmitter.
The use of Arduino IDE helps us to interface sensors using different protocols like I2C, ICSP, and SPI.

5. BLOCK DIAGRAM OF UGV SYSTEM

The block diagram representation of the UGV is shown in the figure 4 .

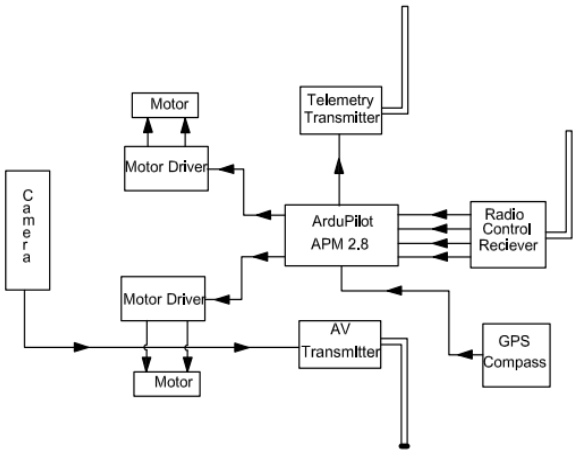

Fig. 4. Block Diagram of UGV

5.1 PULSE INDUCTION BASED METAL DETECTOR

Arduino Mega has an oscillator that runs at 16MHz. Dynamic changes in voltage are contrasted with the adjustment in voltage drop after some time at a fixed reference voltage. Positive curve is utilized by means of the comparator to identify the purpose of time where the decay voltage "crosses" a reference voltage. In the event of metal item close to the loop, the decay curve changes, and the point of time crossing the reference. Along these lines, this adjustment in voltage can be utilized to identify the nearness of the metal close to the curl. The pulse Induction based Metal indicator is appeared in fig. 5.

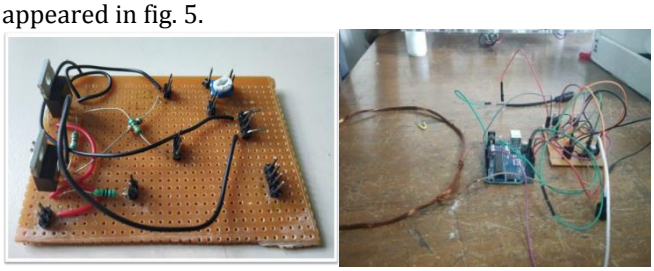

Fig. 5. Pulse Induction based Metal detector circuit
The assembled circuit is placed inside the aluminium casing which is shown in the fig.4.

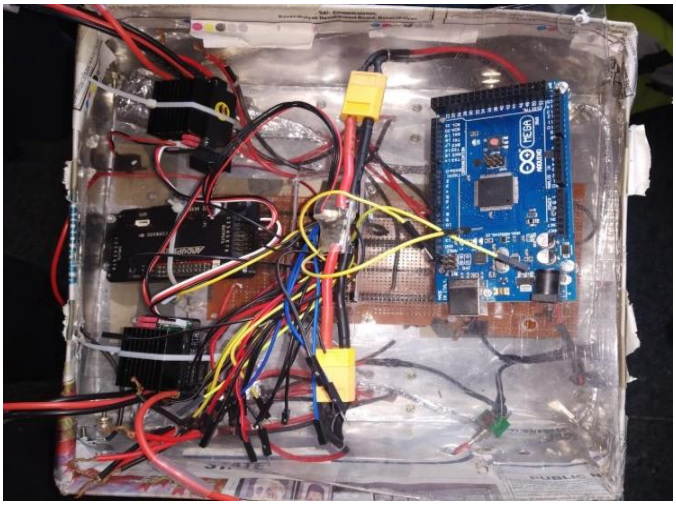

Fig. 6. Assembly of the circuitry in the Aluminium casing

The Unmanned Ground Vehicle system consists of Ardupilot 2.8 which is the brain of the rover. The Ardupilot 2.8 runs the ArduRover firmware version to control different on-board sensors. The Ardupilot 2.8 is interfaced with the power module to measure the power consumption of the unmanned ground vehicle. It is also interfaced with GPS for accurate location tracking during missions and also connected with the telemetry module to transmit the on-board sensor data such as barometric pressure, magnetometric measurements, gyro values the ground station. The remote-controlled receiver is interfaced with APM 2.8 to obtain the commands from the remote control transmitter for manual operation. The output channel 1 and 3 on the APM output is connected to the motor driver to facilitate forward/backward and right/left through skid steering mechanism. Fig.6 represents the assembled ardupilot system which is placed in the aluminium housing.

6. MODE OF OPERATION

The Unmanned ground vehicle is operated manually using a 6 channel remote controller. The channel 1 is configured for forward and backward movements, where as channel 2 is used for right and left movements. The other channels are configured for different operations like a two-position switch and are used to mark the location of the UGV in a deployed mission. The manual operation can only be possible when the rover is within the range of the remote-controlled transmitter. For increased range, repeater stations can be used to operate the UGV over a large area. Fig 8 represents the 6 channel remote controller through which the unmanned ground vehicle is controlled manually.Fig 7 represents the prototype of unmanned ground vehicle which can be deployed for manual operations on any given terrain.

Fig 7. Prototype of UGV

Fig 8. Radio controlled Transmitter

7. RESULT AND DISCUSSION

The unmanned ground vehicle framework was designed using AutoCAD software and is prototyped using aluminum sheet. The control system was implemented using ardupilot 2.8 module with arduRover firmware. The channels 1 and 2 on the radio controlled transmitter were mapped to forward/backward and right/left movement respectively.The unmanned ground vehicle can be operated up to a range of 2KM (Line of sight) without any interference. Skid steer mode of operation is implemented for the UGV maneuverability. Powerful Pulse induction based metal detector is used to detect land mines or any metal debris up to a distance of 10 to 12 cm from the ground surface. The processed video using Open CV can detect faces and can tract eye movements. Fig 8 represents the outcome of the image processed using Haar cascade classifier. Thus, we can conclude that UGV architectures can be robust systems for border surveillance with the inclusions of sensor networks and long range communication systems.

8. CONCLUSION

The project proposed is used to demonstrate the system integration and manual function of the unmanned ground vehicle. The sensors that are being used to collect various data from the surrounding and transmit it to the ground station, which enables the computer to log the data for further use. The use of this rover in the borders is more efficient than human patrolling and can work in a given environmental condition. Thus, the safety in the borders is increased and the intrusion of any weapons and human infiltration can be easily detected.

9. FUTURE SCOPE

The Unmanned Ground Vehicle (UGV) has a ton of chances for additional innovative work. The self-sufficient method of activity can be coordinated with the assistance of strategic programming. The waypoint following capacity and mission-basic waypoints can be telemetered to the ground station with the assistance of the telemetry framework. With the development of sensor innovation, Wireless Sensor Network can be actualized with lower cost and expanded exactness with precision. With the assistance of Artificial Intelligence and Machine learning, models can be prepared to perceive soilders on the vector-based facial recognition calculations. Along these lines, Unmanned Ground Vehicles assume a significant job in the military administrations by furnishing the Department of Defense with the most progressive control framework modelers and mobility capacities.

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