"UNMANNED GROUND VEHICLE"

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Abstract- Some of the most prominent problems facing the world today are Terrorism and Insurgency. Governments and scientists across the globe are working day and night to bring these problems under control. Billions of dollars are spent by nations for the research of new defense systems *that* are capable of safeguarding citizens from terrorist threats.

Nowadays with major advancements in the field of vehicle automation, several dangerous and crucial counter-terroris*m* operations are being handled by sophisticated machines *that* are not only more efficient but are also responsible for saving several human lives.

The project "Unmanned Ground Vehicle" is built to undertake missions like border patrol, surveillance and active combat both as a standalone unit (automatic) as well as in coordination with human soldiers (manual). It is a prototype illustrating the ever-expanding need for sophisticated technology and precision-driven vehicles catering to the present-day needs for *the* first line of defense. A person from a remote place can comfortably control the motion of the robot wirelessly and in situations where manual control is not prudent, the vehicle is capable of reaching the pre-programmed destination on its own.

This defense system of ours has two units- one is the control unit (to control mobility) and the other is the motion tracking unit. This robot would be a remote operator would be getting a live video feed from the camera to help him manually control both the above-mentioned units of the rover. The rover is also capable of automatically tracking *the* movement of objects in its range of vision.

The rover is controlled by a human operator and live video is fed back to the base station. The turret will follow the movement of a joystick or a mouse. There is an additional ARMCON controller which helps the soldier on *the* war field to control the rover using *a* wireless modem.

Keywords- Border patrol, Insurgency, live video, Mobility, Prominent, Surveillance, Terrorism, terrorist threats, tracking unit, Vehicle automation**,** etc.

I. INTRODUCTION

Robotics have helped humans greatly in achieving everyday tasks. Robots are designed to work in any environment and perform the task on behalf of humans. They operate under real-world and real-time constraints where sensors and effectors with specific physical characteristics have to be controlled [1]. An unmanned ground vehicle (UGV) is a vehicle that operates while in contact with the ground and without an onboard human presence. UGVs can be used for many applications where it may be inconvenient, dangerous, or impossible to have a human operator present.

Unmanned mobile robots are actively being developed for both civilian and military use to perform dull, dirty, and dangerous activities. They proved to be effective in a large number of circumstances where the use of human labor is too expensive, the task is risky, or it is impractical for human capability [3]. The robustness, range, and security of the communication link between the remote base station and the UGV, obstacle avoidance must be taking into consideration. Taking the surrounding environment readings by a large number of sensors and process these data to form a clear picture to achieve the greatest benefit of UGV [6].

There is a wide variety of Tele-operated UGVs in use today. Predominantly these vehicles are used to replace humans in hazardous situations. Examples are explosives and bomb disabling vehicles. Generally, the vehicle will have a set of sensors to observe the environment, and will either autonomously make decisions about its behavior or pass the information to a human operator at a different location who will control the vehicle through teleoperation.

A UGV is a mechanical machine capable of ground locomotion. Ideally, any UGV has the objectives of perceiving the environment around it through the aid of sensors, localizing itself within this environment utilizing software algorithms, building a map of its surroundings if the map is not prior, planning its motion, and producing the motor commands necessary to follow a specific path. These commands vary significantly with the drive system employed, the wheel or leg set used for the machine and the feedback mechanism used. As such, it becomes quickly apparent that the wealth of resources and design options that could be utilized in a UGV design can be overwhelming [5].

II. SYSTEM ARCHITECTURE

A UGV can be viewed as a Mechatronics system that integrates mechanical, electrical, computer and control engineering solutions. Three main considerations affect the design of such a system. Namely, development cost and time, UGV capabilities and features, and lastly, the quality and reduction of bugs in the system as a whole [5].

The commands are sent over to the UGV remotely using wireless communication such as RC or RF, while it transfers live video feedback to the user.

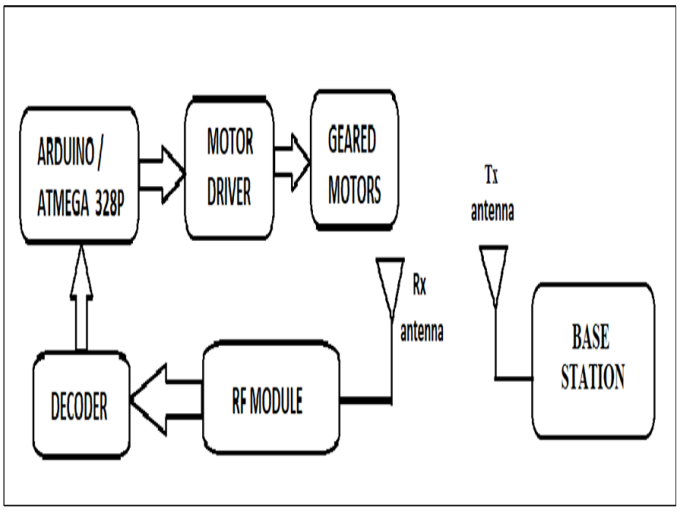

Fig 1: UGV Control System Block Diagram

The base station is a computer system located at a remote place away from the UGV which controls it using the keyboard, mouse for mode control and movement and live video feedback for monitoring the environment. And it also contains a transmitter circuit [3].

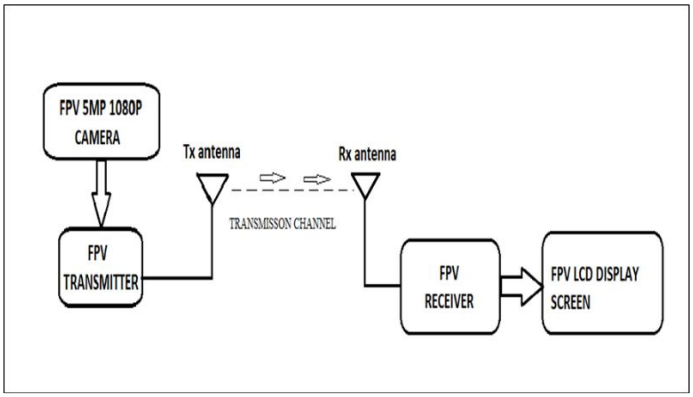

Fig 2: UGV Video Transmission and Receiver Block Diagram

The computer receives the data from UGV and displays it on a graphical user interface (GUI)/Display for the operator to understand the environment easily. This is a full-duplex communication. The operator at any time issues the command from the computer which microcontroller installed on UGV receives through the Transmitter module and after processing micro-controller issues the command to motor drivers accordingly [3].

The FPV monitor is simply a small screen used to view the live video feed from the ground. They are usually small so they can be powered by a battery and used in remote places. Some FPV monitors have integrated video receivers and digital video recorders. Since an FPV signal is commonly lost and regained sporadically, a monitor used for FPV should not change the configuration or turn off when it detects the signal that has been lost.

III. MECHANICAL DESIGN

There exists a wide range of options for UGV mechanical design for locomotion, each option comes with its pros and cons. For example, a differential drive is a simple option that utilizes a separate motor for each of the two wheels; however, for straight-line travel and exact angle rotation, a feedback system has to be applied to the motors to obtain the speed of each motor and apply the required calculations. Other mechanical designs such as the synchro and dual differential, utilize a motor for forwarding drive and another separate motor for turning. These designs have the mechanical certainty of driving in a straight line; however, they have the disadvantage of complex design and efficiency loss due to the use of gears [6].

In this research design, using six motors drive gives us a higher torque with an easier control. Furthermore, can obtain a zero turning radius, in other words in can spin 360 degrees around its neutral axis, with the application of our control algorithms. The location of the center of mass is important, as it reduces required torque and power if chosen to be close to the axis or rotation.

Fig 3: Mechanical Design

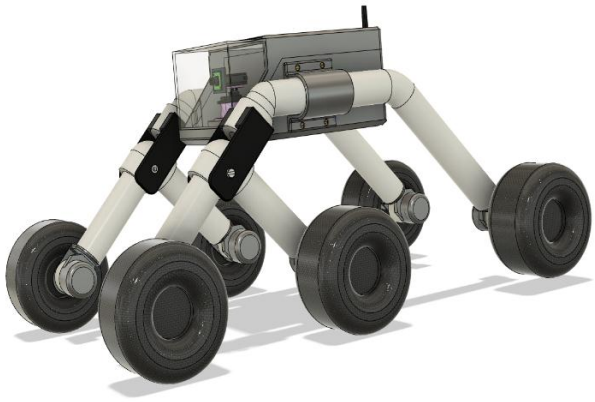

Fig 4: 3D Design

IV. CONTROL SYSTEM DESIGN

Control system design includes the basic electrical components in UGV to provide the efficiency for operation and control [6]. The main requirement for electrical design is to extend operating time, provide constant reliable voltage to motors and other electronics, condense power supply into a single unit and deep-cycle battery.

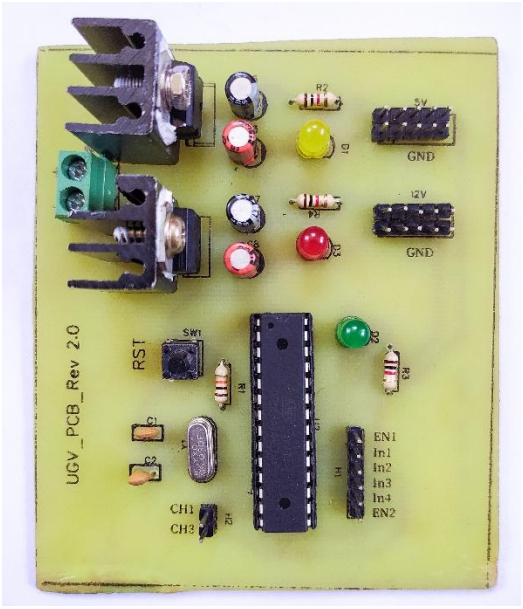

Fig 5: PCB

The PCB is designed to provide control over the UGV movements. It has an inbuilt configuration for supply power to various components. It can supply 5v to 12v as per the requirement of components.

Control system design is consisting of a control circuit and regulated power supply circuit, which supply components from the same input supply. The control circuit is made by using the ATMEGA-328 Micro-controller.

Components **Are Follows:**

A*. Arduino Microcontroller*

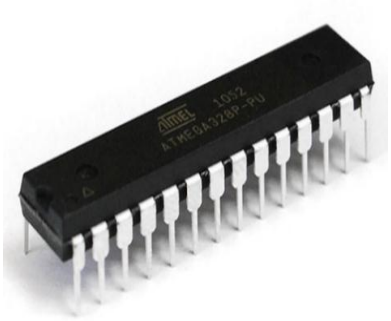

Fig 6: Arduino Uno Microcontroller (ATMEGA-328P)

"Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software." The open-source Arduino environment makes it easy to write code and upload it to the i/o board. It runs on Windows, Mac OS X, and Linux.
The environment is written in Java and based on Processing, Avr-GCC, and other open-source software.

ATmega328 is an 8-bit and 28 Pins AVR Microcontroller, manufactured by Microchip, follows RISC Architecture and has a flash type program memory of 32KB.

B*. Gear Motor*

Fig 7: DC Gear Motor

A gear motor is a specific type of electrical motor that is designed to produce high torque while maintaining a low horsepower, or low speed, motor output. Gear motors can be found in many different applications, and are probably used in many devices in home.

A. RC Transmitter & Receiver

Fig 8. RC Transmitter & Receiver

Radio control (often abbreviated to R/C or simply RC) is the use of control signals transmitted by radio to remotely control a device. Radio control is also used for control of model vehicles from a hand-held radio transmitter. Industrial, military, and scientific research organizations make use of radio-controlled vehicles as well.
RC Transmitter & Receiver Specification

- Band-Range: 2.4055 – 2.475GHz
- Charging Port: Yes
- Low Voltage Warning: Yes (at less than 9V)
- No. of Channels: 6
- Operating Voltage12V DC (1.5AA x 8 Battery)

B. *FPV Camera*

Fig 9: FPV Camera

First-person view (FPV), also known as remote-person view (RPV), or simply video piloting, is a method used to control a radio-controlled vehicle from the driver or pilot's viewpoint. Most commonly it is used to pilot a radio-controlled aircraft or another type of unmanned aerial vehicle (UAV). The vehicle is either driven or piloted remotely from a first-person perspective via an onboard camera, fed wirelessly to video FPV goggles [3][4] or a video monitor. More sophisticated setups include a pan-and-tilt gimbaled camera controlled by a gyroscope sensor in the pilot's goggles and with dual onboard cameras, enabling a true stereoscopic view.

FPV Camera Specification

- Sensor: 1/3 "CMOS
- Camera size: 28 * 24.5 * 17.5mm
- Electronic Shutter Speed: 1/50-1/100
- With lens cover, well protecting the lens
- Super lightweight, low power consumption
- Lens: 2.8mm IR coated

C. *FPV Transmitter & Receiver*

Fig 10: FPV Transmitter and Receiver

An FPV Radio Transmitter is an electronic device that uses radio signals to transmit commands wirelessly via a set radio frequency over to the Radio Receiver, which is connected to an aircraft or multirotor being remotely controlled. In other words, it's the device that translates the pilot's commands into the movement of the multirotor.

FPV Camera Transmitter Specification

- Antenna Gain: 2db
- Frequency: 5.8GHz
- Power Input: 7.4-16V
- Working Current: 220mA at 12V
- Transmitting Range: up to 5km in open ground

FPV Camera Receiver Specification

- Antenna Gain: 2db
- Antenna Impedance: 50Ω
- Video Format: NTSC/PAL auto
- Power Input: 12V.
- Working Current: 200mA max
- Weight: about 85g

V. SPEED CONTROL AND THE POWER SUPPLY

The UGV speed was controlled by an RC Transmitter and Receiver using Microcontroller. The UGV could reach the maximum speed in 4-5 seconds. The UGV uses 400 RPM DC Gear motors which gives the maximum speed suitable to be used in different fields.

The UGV has a Battery Power supply, it used a parallel battery connection to provide 12V using six 3.7V batteries each three of them were connected in series. This power source was used for the driver, Receiver, Transmitter, and controller to get the most stable power distribution over the system.

Fig 11: 2P3S Battery

VI. ADVANTAGES

- Tracked
- Teleoperated
- Replace the humans in hazardous situations
- Light Weight and Small

VII. LIMITATIONS

- It can be detected by troops
- Bandwidth problem due to Wireless Solutions
- A battery can power up the system only for a particular duration.

VIII. APPLICATIONS

- Search and Rescue
- New Explorations
- To take a dangerous mission which involves loss of human life.
- Surveillance

IX. FUTURE SCOPE

- UGVs can be used to traverse and map mine tunnels.
- Unmanned harvesting tractors can be operated around the clock making it possible to handle short windows for harvesting.
- In the warehouse management system, UGVs have multiple uses from transferring goods with autonomous forklifts and conveyors to stock scanning and taking inventory.

CONCLUSION

An Unmanned Ground Vehicle has been designed and assembled using off-the-shelf, commercial-grade components. The design of the mechanical systems followed a simple yet powerful approach where all the parts were integrated within the vehicle with the strict minimum modifications introduced

The incorporation of various technologies under one roof has given us the path to achieving goals that have never been realized in such an efficient manner in the past. These technologies bring about a relying and able machine to tackle Situations on its own and ease a human's job in the present-day scenarios.

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REFERENCES

[1] Shafer, M. Turney, F. Ruiz, J. Mabon, V. Paruchuri, Y. Sun Robotics based autonomous wheelchair navigation J Commun Comput, 13 (2016), pp. 319-328

[2] K. Dumbre, S. Ganeshkar, A. Dhekne Robotic vehicle control using internet via webpage and keyboard Int J Comput Appl, 114 (17) (2015)

[3] M. Noor, S. Zain, L. Mazalan, "Design and Developement of remote-operated multi-direction unmanned ground vehicle (UGV)" Sep 2014.

[4] Development of A Low-Cost Differential Drive Intelligent Ground Vehicle Nathir A. Rawashdeh, Laith M. Alkurdi, Hudhaifa T. Jasim German Jordanian University Department of Mathematics Engineering P.O. Box 35247, Amman 11180, Jordan (2013)

[5] M. Koval, "Vision Based Autonomous Ground Vehicle Navigation", unpublished technical report. Rutgers University, New Jersey. USA 2012.

[6] B. Abdelhafid, M. Necar, A. Mansour, E. Mostafa, "Design and Implementation of an Unmanned Ground Vehicle for Security Applications" 7th International Symposium on Mechatronics and its Application (ISMA10), Sharjah, UAE, April, 2011.

[7] J.M. Anderson, K. Nidhi, K.D. Stanley, P. Sorensen, C. Samaras, O.A. Oluwatola Autonomous vehicle technology: a guide for policy makers Rand Corporation (2011)

[8] S.S. Srinivasa, D. Ferguson, C.J. Helfrich, D. Berenson, A. Collet, R. Diankov, et al. HERB: a home exploring robotic butler Aut Robots, 28 (1) (2010), pp. 5-20 & pp. 349-370

[9] O.R. Vincent, O. Folorunso June. A descriptive algorithm for sobel image edge detection Proceedings of Informing Science & IT Education Conference (InSITE). 2009, 40 (2009), pp. 97-107

[10] S.J. Lee, D. M. Lee and J. C. Lee; "Development of Communication Framework for Unmanned Ground Vehicle", in Proceedings of the International Conference on Control Automation and Systems, Oct. 14-17, 2008, Seoul, South Korea, pp 604-607

[11] J. Ortiz, et al.; "Description and tests of a multisensorial driving interface for vehicle teleoperation", in Proceedings of the 11th International IEEE Conference on Intelligent Transportation System, October 12-15, 2008, Beijing, China, pp 616-621

[12] L. Lo Belloy et al.; "Towards a robust real-time wireless link in a land monitoring application", in Proceedings of the 11th IEEE Conference on Emerging Technologies and Factory Automation, EFTA'06, September 20-22, Prague, Czech Republic, pp 449-452.

[13] Mohd Azlan Shah Abd Rahim and Illani Mohd Nawi, "Path Planning Automated Guided Robot," Proceedings of the World Congress on Engineering and Computer Science 2008, WCECS 2008, October 22 - 24, 2008, San Francisco, USA, ISBN: 978-988-98671-0-2.

[14] J. Kramer, M. Scheutz Development environments for autonomous mobile robots: a survey Aut Robots, 22 (2) (2007), pp. 101-132

[15] Tuijl, J.G. Kornet, J. Meuleman, J. Bontsema, et al. An autonomous robot for harvesting cucumbers in greenhouses Aut Robots, 13 (3) (2002), pp. 241-258

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