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SELF CONTROLLED ROBOT FOR MILITARY PURPOSE

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ABSTRACT

Although there are many command controlled robots, the need for self-controlled robots are on rise for military purposes, which in general called as Unmanned ground vehicles (UGVs). These robots are used to augment the soldiers capability in an open terrain. In the last decade, enormous efforts is put in developing robots for war fields and extensive research is carried out in various parts of the world. This motivation helped us build a prototype self-controlled robot (called as UGV) to undertake missions like border patrol, surveillance and in active combat both as a standalone unit (automatic) as well as in co-ordination with human soldiers (manual). Likewise, command controlled mode, we use another specific mode called, self-control mode or automatic mode. In this mode, UGV is manoeuvred automatically and it capable of travelling from one point to another point without human navigation commands. It uses GPS, magnetic compass and adjust strategies based on surroundings using path planning and obstacle detection algorithms. The complete set up and working of the self-control mode UGV are described in the paper.

Keywords: Controller, GPS, Robots, Self-control mode, Unmanned ground vehicle.

I. INTRODUCTION

Recently, the demand for military robots has increased tremendously. This has created lot of opportunities for re-searchers to develop efficient robots. The need for self con-trolled robots is due to the terrorism and insurgency problems faced by the people and soldiers. Huge investments are made by nations for the research of new defense systems which are capable of safeguarding citizens from terrorist threats; one such is a unmanned ground vehicles (UGV). This motivated our group to develop prototype self-controlled unmanned ground vehicle (UGV) to undertake missions like border patrol, surveillance and in active combat both as a standalone unit (automatic) as well as in co-ordination with human soldiers (manual).

Most prominent problems today are terrorism and insurgency. Governments, researchers and scientists are working on new defense systems which are capable of safeguarding citizens from terrorist threats. Some major advancements have taken place in the field of vehicle automation. This motivated our group to work on Unmanned ground vehicle (UGV) which could serve military operations.

UGV is a vehicle that operates on open land with or without humans presence for giving navigation commands and decision making. In this paper, we have considered four different modes to control the UGV. They are

- **Command control mode:** In this mode, we have considered humans decision making and providing navigation commands based on the live video signal received from the camera mounted on the UGV.

- **Self control mode:** In this mode, we have considered self-decision making and self-navigation based on the GPS co-ordinates, magnetic compass, path planning and obstacle detection algorithms.
- **Gesture control mode:** In this mode, we have considered the hand gesture signals, where the UGV will be controlled using commands sent based on the hand movements mapped by the IMU unit.
- **Raptor control mode:** In this mode, we have considered the motion tracking system implemented through advanced image processing algorithms to locate and eliminate targets in the field vision.

An autonomous UGV is essentially an autonomous robot but is specifically a vehicle that operates on the surface of the ground. A fully autonomous robot in the real world has the ability to:

- Gain information about the environment.
- Work for extended durations without human intervention.
- Travel from point A to point B, without human navigation assistance.
- Avoid situations that are harmful to people, property or itself, unless those are part of its design specifications
- Repair itself without outside assistance.
- Detect objects of interest such as people and vehicles.

A robot may also be able to learn autonomously. Autonomous learning includes the ability to:

- Learn or gain new capabilities without outside assistance.
- Adjust strategies based on the surroundings.
- Adapt to surroundings without outside assistance.

Autonomous robots still require regular maintenance, as with all machines.

The major hardware components used are:

- ARDUINO MICROCONTROLLER
- SERVO MOTOR
- DC MOTOR
- INERTIAL MEASUREMENT UNIT (IMU)
- ZIGBEE RADIO MODEM
- 78XX IC'S
- ELECTROMAGNETIC COMPASS MODULE
- GPS RECIEVER SYSTEM
- H-BRIDGE
- LITHIUM POLYMER BATTERY
- FTDI CHIP
- WEBCAM
- 2X RELAY BOARD
- IR SENSORS
- NICKEL-CADMIUM BATTERY

II. SELF CONTROL MODE

The aim of this mode is to enable autonomous functioning of the unmanned ground vehicle without human supervision. To accomplish this operation navigation technology such as GPS, magnetic compass is used to provide the on-board system enough data to operate as a self-navigated system. Other technologies like Infra-red sensors are used in our prototype to provide functional obstacle avoiding capabilities which augment the autonomous operation.

The main tasks of the self-control mode are:

- UGV is capable of travelling from point A to point B without human navigation commands.
- Adjust strategies based on surroundings using path planning and obstacle detection algorithms.

For these tasks to be performed, both path planning and obstacle detection algorithms need to be designed carefully. The block diagram for the self-controlled mode is shown in fig 1.

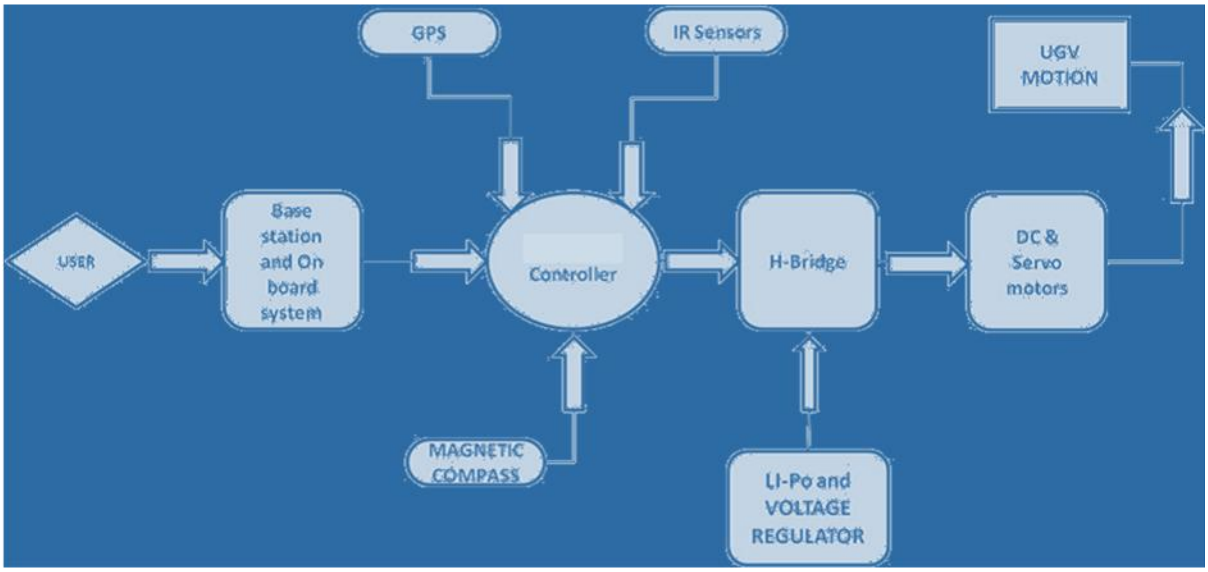

Fig 1. Block diagram for the self-control mode

The block diagram of the UGV consists of various components. They are Base station: It's a computer system located at a remote place away from the UGV which controls it using keyboard, mouse for mode control and movement and live video feedback for monitoring the environment.

Keyboard and mouse: They are used to handle the motion of the UGV and the movement of the turret for wide angle vision.

3G Internet: Communication medium for system to system interaction so as to control the UGV wirelessly.

On-board system: A computer system placed on the UGV itself which receives the commands and delivers it to the control Unit.

Camera: An image acquiring device which provides the video required for UGV vision.

Control Unit: It's the Arduino microcontroller which receives signals from the user and other sensors and performs tasks such as turret movement and UGV movement.

GPS Unit: A navigation system used in the autonomous mode for obtaining location co-ordinates.

Compass: To acquire the direction to which the UGV is facing.

IR sensors: Infrared Sensors used in the obstacle avoidance mechanism incorporated into the autonomous mode.
Servo motor: they are used to control the direction turn of the UGV and the 2 axis movement of the turret.
DC motor: These are used mainly for the UGV movement.
Li-PO Battery and voltage regulator: the power source supplying the entire UGV with voltage regulation to provide optimum power ratings.
Wireless modem: Zigbee to provide wireless data transfer for the ArmCon mode.
IMU: An inertial measurement unit which tracks the orientation of the hand used for hand Gesture control (ArmCon mode).
Ni-Cd battery: Used for powering up the Control Unit, Zigbee and the IMU.

III. ALGORITHM DESIGN FOR SELF-CONTROL MODE

The algorithm design for self-control mode is quite easy and straightforward. We mainly considered two important algorithms: path planning and obstacle detection algorithms for the UGV to navigate automatically. First, user obtains the current GPS co-ordinates and the heading reading from the compass for the UGV. Then the destination co-ordinates are acquired from the user. Angles are calculated by which the UGV orients with the desired direction using simple trigonometric functions. Calculated angle provides the UGV movement control signals. The UGV navigates itself to the desired location based on the IR sensors values which are obtained with respect to the obstacles. Path planning algorithms are used to decide the path taken.
Obstacle avoiding algorithm is also incorporated, which makes sure, the unmanned ground vehicle avoids obstacles while doing task at hand in the most efficient manner based on the IR sensors values which are obtained with respect to the obstacles. At the base station side, user obtains the GPS co-ordinates continuously from the UGV. Destination co-ordinates are given by the user itself. Based on the path planning and obstacle detection algorithm, UGV navigates automatically.

IR(L)	IR(M)	IR(R)	Operations performed
1	0	0	Right() and Up()
1	0	1	Up()
1	1	0	Right() and Up()
1	1	1	Random[Right() or Left()] and down()

Fig 2. Obstacle detection algorithm

V. APPLICATIONS OF UGV

- Before RECONNAISSANCE- Also known as Scouting, is the military term for performing a preliminary survey, especially an exploratory military survey, to gain or collect information.
- BOMB DISPOSAL- Used in defusing and deactivating Explosives as a result of which an added feature a robotic arm can be added.
- SEARCH AND RESCUE-In times of Natural calamities or man based disasters, it proves to be a reliable machine to locate people or objects with ease where it renders human effort futile.
- BORDER PATROL AND SURVEILLANCE- In times of military warfare or border encroachment, it is used to monitor alien force entering into the territory.
- ACTIVE COMBAT SITUATIONS- Widely used on the battlefield, UGVs equipped with Explosives, Weaponry and shields have proven to be handy expendables assets without the cost of human life
- STEALTH COMBAT OPERATIONS- Spying purpose without coming into the radar of the enemy is effective in war strategies.
- NEW EXPLORATIONS – Deep cave searches, underwater explorations and the currently executing Mars and outer planets exploration can be performed.
- To undertake dangerous missions which involves loss of human life.

VI. RESULTS

Successfully built an unmanned ground vehicle (UGV) capable of being controlled automatically using the GPS, magnetic compass, path planning algorithm and obstacle detection algorithm shown in figure 3.

Fig 3. Prototype Unmanned Ground Vehicle

V. CONCLUSION

A prototype UGV capable of being controlled automatically using GPS, magnetic compass, path planning and obstacle planning algorithms is built successfully. Likewise, command controlled mode, we used another specific mode called, self-control mode or automatic mode. In this mode, UGV is manoeuvred automatically and it capable of travelling from one point to another point without human navigation commands. It uses GPS, magnetic compass and adjust strategies based on surroundings using path planning and obstacle detection algorithms. The complete set up and working of the self-control mode UGV are described in the paper. Automatic robots using GPS can be used for military purposes which need to be operated outdoors. This UGV can undertake missions like border patrol, surveillance and in active combat both as a standalone unit (automatic) as well as in co-ordination with human soldiers (manual). Our future work is on developing arm controlled mode (gesture controlled) along with command control mode and automatic mode.

VI. FUTURE SCOPE

There is a role and place for both unmanned and manned systems on the future battlefield. While operating unmanned systems can prove costly, keeping people out of harm's way is priceless. The use of unmanned systems brings many benefits, but they should be seen as complementary to rather than replacements for existing manned systems. The UGVs are used in different kind of applications like military, surveillance, security service, riot control, hostage situation, police, law enforcement, border patrol, etc. They work more effectively in environmental extremes such as heat, cold, or nuclear, chemical and biological contamination. Thus, UGV can be used to augment the soldiers' capability in the field of military operations. In this paper, we present automation robot and its software architecture to efficiently control UGV in the future combat fields. In addition, we develop the UGV for autonomous moving using a variety of sensing techniques and sophisticated-designed systems. To verify the effectiveness of our proposal, we develop the automation robotic system and UGV respectively. In addition, we conduct a great many automation tests for multiple unmanned ground vehicles in the predefined combat area. The developed systems, UGV and automation system, is easy to operate and enable significant reduction in station operator workload by utilizing an intuitive graphic user interfaces for UGV navigation and allowing a single station operator to command multiple IUAR's at a time. In the consequence of the operation test, we expect that the automation system and UGV play an important role in the future military operation.

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