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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.
***Index Terms*—Unmanned ground vehicle, robots, self-control mode, Arduino, GPS.**

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 pa-trol, surveillance and in active combat both as a standalone unit (automatic) as well as in co-ordination with human soldiers (manual) [1], [2], [3].

To make it clear, a vehicle that operates on ground remotely with or without humans presence for giving navigation commands and decision making is called as an unmanned ground vehicle (UGV) [4]. In this paper, we have considered self-decision making and self-navigation (au-tonomous mode) UGV based on GPS co-ordinates, magnetic compass, path planning and obstacle detection algorithms. One of our motivations for this project is the Foster-Miller TALON robot [5] and DRDO Daksh robot [6] and [7]. Foster-Miller TALON robot is a small military robot designed for missions that can travel through sand, water as well as climb stairs. Different types of TALON robots are regular (IED/EOD) TALON, special Operations TALON (SOTAL), SWORDS TALON and HAZMAT TALON [5]. On the other hand, Daksh is a remote controlled robot used in locating and destroying hazardous objects safely. It is powered electrically by a battery. The primary role is to recover improvised explosive devices (IEDs). It has a X-ray machine to locate IEDs, it has a shotgun to open locked doors, and it can scan cars for explosives. Daksh can also climb staircases, negotiate steep slopes and navigate through narrow corridors [7]. So, Foster-Miller TALON robot and DRDO Daksh mo-tivated us to develop self-control mode unmanned ground vehicle for military purposes. Our aim is to develop prototype UGV to undertake missions like border patrol and surveillance on its own (automatically and self-control). So, in this paper we explain the set up and design of the unmanned group vehicle which will be controlled by it using GPS, magnetic compass, path planning and obstacle detection algorithms. The rest of the paper is organized as follows. In Section II we explain the concept of self-control mode for operating UGV. In Section III, we explain the results. Section IV concludes our discussions in this paper.

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 figure 1.

A. Block diagram of self-control mode

The block diagram of command control mode for operating unmanned ground vehicle is shown in figure 1. The role of each blocks in the diagram are explained in detail.

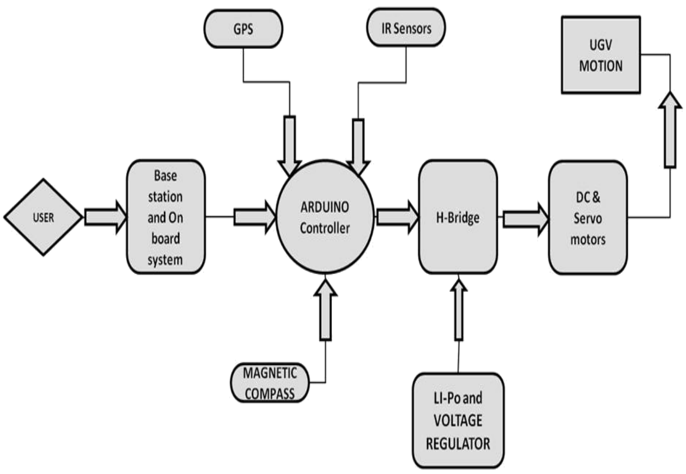

Fig. 1. Block diagram for the self-control mode.

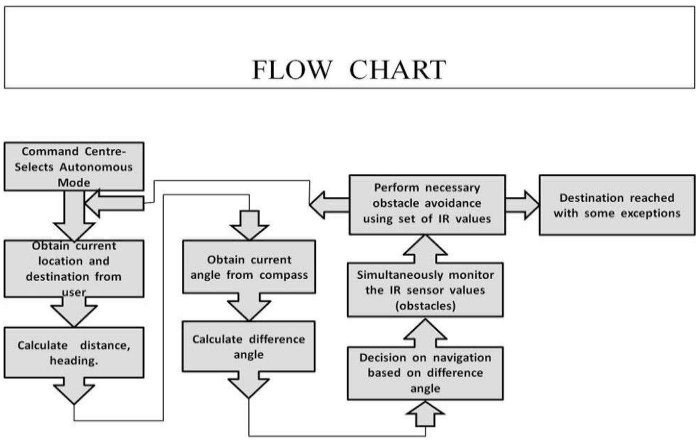

Fig. 2. Flow chart for the self-control mode.

1) Base station: Its a computer system located at a remote place away from the UGV which controls it using keyboard, mouse for mode control, movement and live video feedback for monitoring the environment.
2) Keyboard and mouse: They are used to handle the motion of the UGV and the movement of the turret for wide angle vision.
3) 3G Internet: Communication medium for system to system interaction so as to control the UGV wirelessly.
4) On-board system: A computer system placed on the UGV itself which receives the commands and delivers it to the control Unit.
5) Camera: An image acquiring device which provides the video required for UGV vision.
6) Control Unit: Its the Arduino microcontroller which receives signals from the user and other sensors and performs tasks such as turret movement and UGV move-ment.
7) GPS Unit: A navigation system used in the autonomous mode for obtaining location co-ordinates.
8) Compass: To acquire the direction to which the UGV is facing.
9) IR sensors: Infra-red Sensors used in the obstacle avoidance mechanism incorporated into the autonomous mode.
10) Servo motor: they are used to control the direction turn of the UGV and the 2 axis movement of the turret.
11) DC motor: These are used mainly for the UGV move-ment.
12) Li-PO Battery and voltage regulator: the power source supplying the entire UGV with voltage regulation to provide optimum power ratings.
13) Wireless modem: Zigbee to provide wireless data transfer for auto mode.
14) IMU: An inertial measurement unit which tracks the orientation of the hand used for hand Gesture control (ArmCon mode).
15) Ni-Cd battery: Used for powering up the Control Unit, Zigbee and the IMU.

The hardware components used in the unmanned ground vehicle are:

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

B. 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. The obstacle detection algorithm work based on the figures shown in figure 3 and figure 4. The flow chart of self-control mode for operating unmanned ground vehicle is shown in figure 2.

IR(L)	IR(M)	IR(R)	Operations performed
0	0	0	(No obstacles)
0	0	1	Left() and Up()
0	1	0	Random[Right() or Left()] and Up()
0	1	1	Left() and Up()

Fig. 3. Obstacle detection algorithm codes for left side '0'.

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. 4. Obstacle detection algorithm codes for left side '1'.

III. RESULTS

We 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 5. New technologies like Zigbee and Arduino have been implemented. The working of the UGV was demonstrated at the RGIT workshop, Bangalore (in June 2011) and successfully passed the test.

IV. CONCLUSION AND FUTURE WORKS

We successfully built a prototype UGV capable of being controlled automatically using GPS, magnetic compass, path planning and obstacle planning algorithms. 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. We strongly feel, 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.

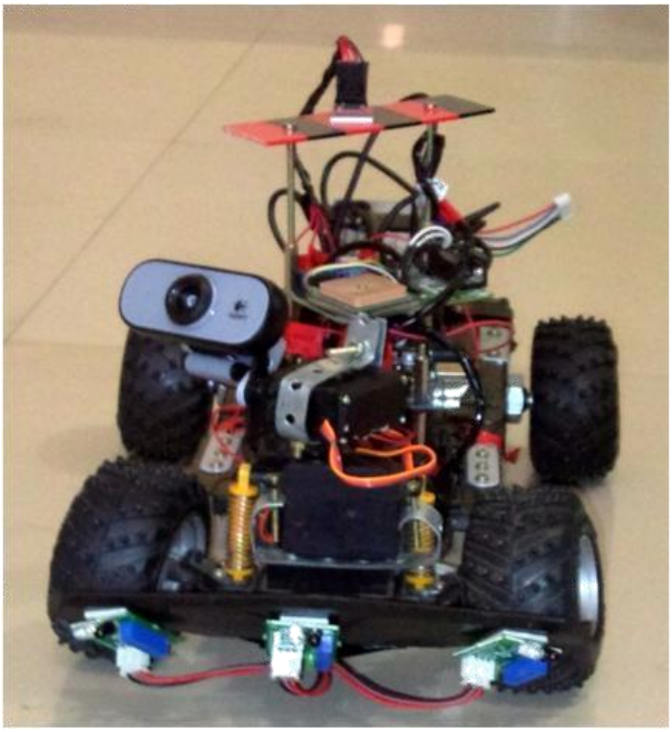

Fig. 5. Prototype Unmanned Ground Vehicle

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