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SELF CONTROLLED ROBOT FOR MILITARY PURPOSE USING PIC MICROCONTROLLER

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ABSTRACT

Self-controlled robots are those which can direct themselves without any human commands. Even though there are many command controlled robots, there is an increase in demand for the self-controlled robots for the military purposes, which in general called as Unmanned ground vehicles (UGVs). These robots are used to augment the soldier's capability in an open terrain. In the last few decades, enormous efforts has been made for developing robots for war fields and extensive research is carried out in various parts of the world. This leads to build a self-controlled robot called as UGV using PIC microcontroller. PIC microcontroller is thus used because of its low cost and high clock speed. In the self-controlled mode, UGV is maneuvered 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: PIC microcontroller, Unmanned ground vehicle, robots, self-control mode, IR sensors, GPS.

INTRODUCTION

Now-a-days, 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 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)[1][2][3]. To make it clear, a vehicle that operates on ground remotely with or without human's presence for giving navigation commands and decision making is called as an unmanned ground vehicle (UGV) [4]. In this paper, I have considered self-decision making and self-navigation (autonomous mode) UGV

based on GPS co-ordinates, magnetic compass, path planning and obstacle detection algorithms. One of the motivations for this paper is the Foster-Miller TALON robot [5] and DRDO Daksh robot [6] & [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 motivated to develop self-control mode unmanned

ground vehicle for military purposes using PIC microcontroller. The 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 explained 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.

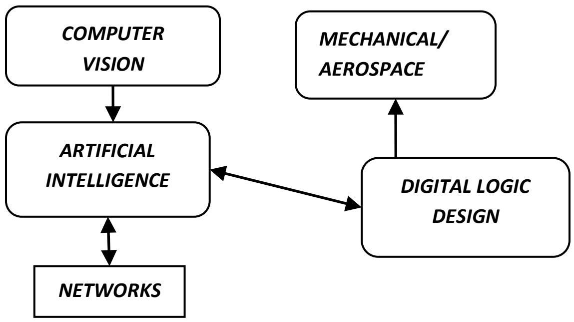

Fig1: UGV (Unmanned Ground Vehicle)

DESIGN METHODOLOGY

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 2.

A. Block diagram of self-control mode

The block diagram of command control mode for operating unmanned ground vehicle is shown in figure 2 and the flow chart is shown in figure 3. The role of each blocks in the diagram are explained in detail below. It consists of various components such as H-bridge, PIC microcontroller, voltage regulator, DC and servo motors,

GPS, magnetic compass, Unmanned Ground Vehicle (UGV), Three IR sensors one at the center and the other two sensors one at the left and the other at the right of the Unmanned Ground Vehicle.

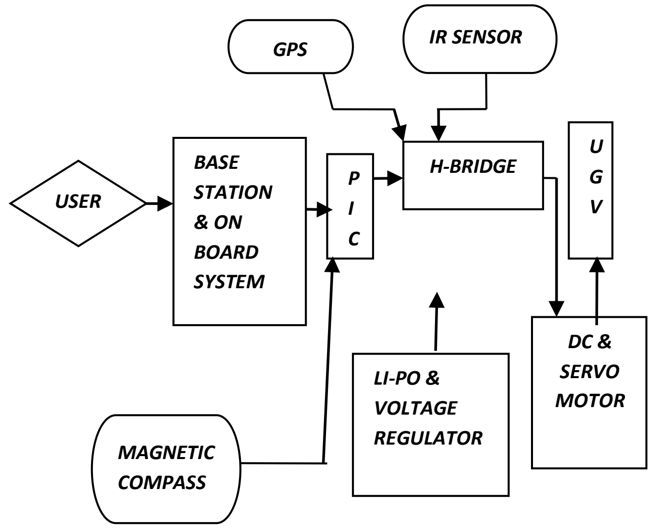

Fig 2: Block diagram for the self-control mode.

The various hardware components thus used in the unmanned ground vehicle are as follows:

1. Base station
2. Keyboard and mouse
3. 3G Internet
4. On-board system
5. PIC microcontroller (16F877A)
6. Camera
7. Control Unit
8. GPS Unit
9. Electro Magnetic Compass

1) **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, movement and live video feedback for monitoring the environment.

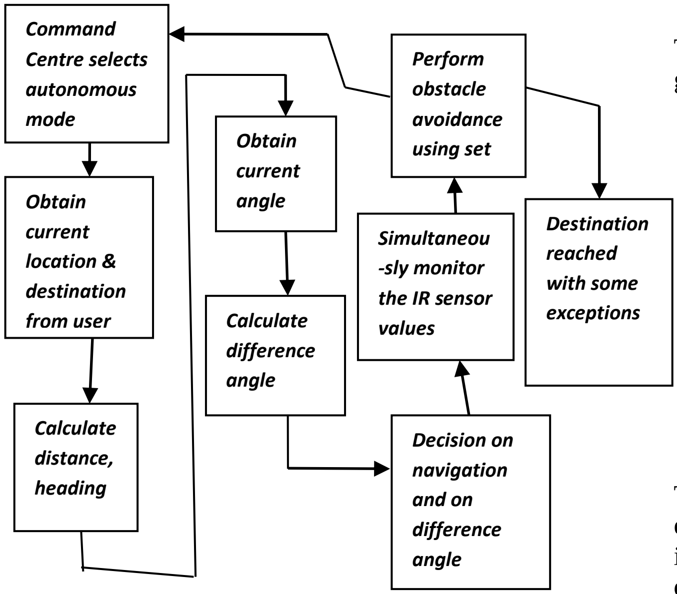

Fig.3: Flow chart for the self-control mode

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) **PIC (16F877A):** It is a RISC (Reduced Instruction Set Computer) design. Its code is extremely efficient, allowing the PIC to run with typically less program memory than its larger competitors.
6) **Camera:** An image acquiring device which provides the video required for UGV vision.
7) **Control Unit:** It's the PIC microcontroller which receives signals from the user and other sensors and performs tasks such as turret movement and UGV movement.
8) **GPS Unit:** A navigation system used in the autonomous mode for obtaining location co-ordinates.
9) **Compass:** To acquire the direction to which the UGV is facing.
10) **IR sensors:** Infra-red Sensors used in the obstacle avoidance mechanism incorporated into the autonomous mode.
11) **Servo motor:** they are used to control the direction turn of the UGV and the 2 axis movement of the turret.
12) **DC motor:** These are used mainly for the UGV movement.

The hardware components used in the unmanned ground vehicle (UGV) are:

- SERVO & DC MOTOR
- ELECTROMAGNETIC COMPASS
- MODULE GPS SYSTEM
- H-BRIDGE
- LITHIUM POLYMER BATTERY
- WEBCAM
- IR SENSORS
- NICKEL-CADMIUM BATTERY
- PIC MICROCONTROLLER

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.

Table.1: Obstacle detection code for left side "0".

IR(L)	IR(C)	IR(R)	OPERATIONS PERFORMED
0	0	0	No obstacle
0	0	1	Left() & right()
0	1	0	Random[Left() or right()] & up()
0	1	1	Left() & up()

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.

Table.2: Obstacle detection code for left side "1".

IR(L)	IR(C)	IR(R)	OPERATIONS PERFORMED
1	0	0	Right() & up()
1	0	1	Up()
1	1	0	Right() & up()
1	1	1	Random[Left() or right()] & down()

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 table 1 and table 2. The flow chart of self-control mode for operating unmanned ground vehicle is shown in figure2& 3.

SOFTWARE DESIGN OF THE SYSTEM

- It is a RISC (Reduced Instruction Set Computer) design
- Only thirty seven instructions to remember
- Its code is extremely efficient, allowing the PIC to run with typically less. Program memory than it's larger Competitors.
- It is low cost, high clock speed.

The software is developed in modules and integrated for over all implementation of the system.

Fig.4: PIC16F877A

A. Internal peripherals of PIC microcontroller

The internal peripheral of PIC microcontroller (16F877A) is shown in the figure.6 below. It consists of EEPROM, USART, MSSP, timers, oscillators, analog comparator, PSP, CCP, RAM, program memory and various other peripherals.

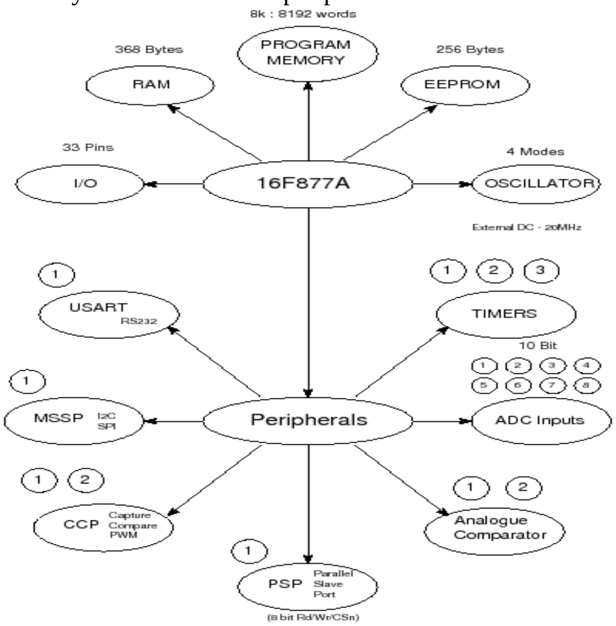

Fig.5: Internal peripheral algorithm of PIC

OBSTACLE DETECTION ALGORITHM

When these robots detect any obstacles in its path it would change its direction to avoid collision. Here, used the PIC controller interfaced it with the LCD display and 3-IR sensors to detect obstacles in the front, right and left directions. The LCD display indicates the distance of the robot from the obstacle when the robot is in the range of 10cm to 80cm and it also displays the direction in which the robot will turn when it sees an obstacle.

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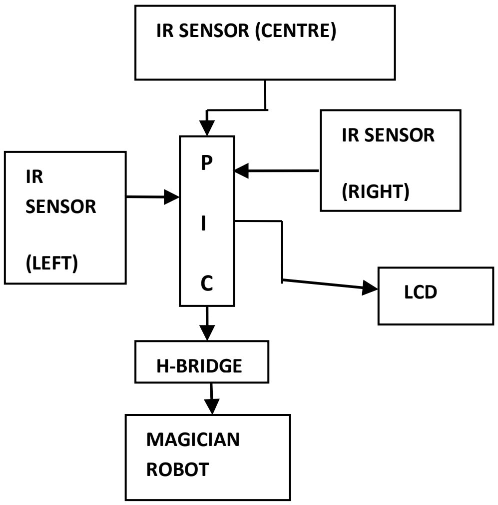

Fig.6: Obstacle detection algorithm

SIMULATION RESULTS

As the PIC microcontroller is used as the central processing unit of the system, we can write the program for the IC in embedded C programming language. The various software tools for development are:

1. MP lab IDE v8.36
2. Proteus simulation software

The software is developed in modules and integrated for over all implementation of the system.

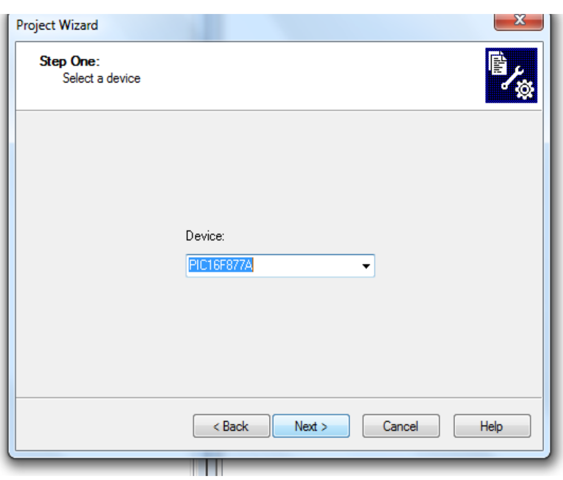

Fig.7: Select PIC configuration

The output of self-controlled robot for military purpose using PIC microcontroller is thus simulated with the help of MP lab IDE v8.36 and Proteus simulation software. In figure 8 the required version (16F877A) of PIC microcontroller is selected. A new folder is thus created in the required location and thus the created file is browsed and the file path is selected and saved. In figure 9, the proteus design suite 8.1 is thus used to simulate the output.

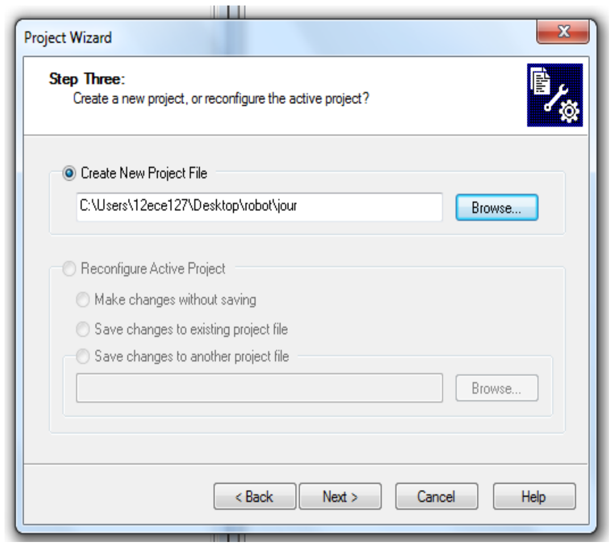

Fig.8: Browse and save the file.

Fig.9: Proteus design suite 8.1

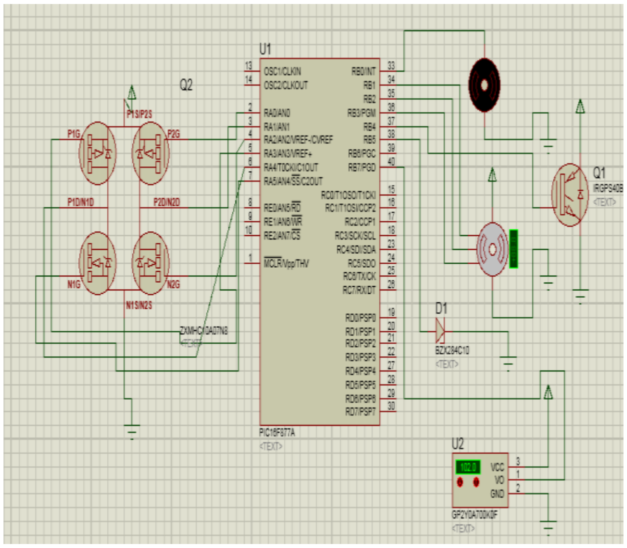

Fig.10: Simulation result

In figure 10 the required components are thus assembled and the simulation is done.

RESULTS

Thus successfully built an unmanned ground vehicle (UGV) capable of being controlled automatically using the GPS, electromagnetic compass, path planning algorithm and obstacle detection algorithm shown in the above figures .

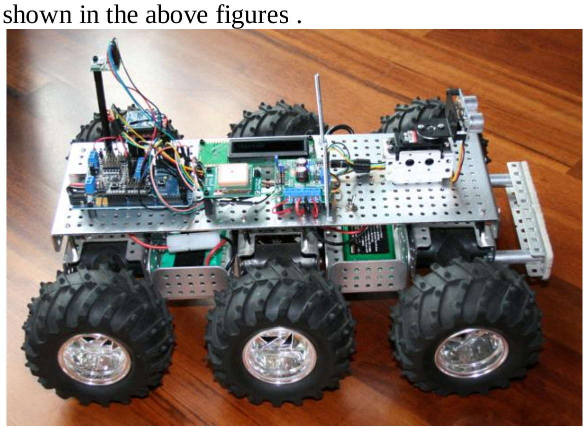

Fig. 11. Prototype Unmanned Ground Vehicle

CONCLUSION AND FUTURE WORKS

A prototype UGV that is capable of being controlled automatically using GPS, magnetic compass, path planning and obstacle planning algorithms is thus successfully build. Likewise, command controlled mode,

I used another specific mode called, self-control mode or automatic mode. In this mode, UGV is maneuvered automatically and it capable of travelling from one point to another point without human navigation commands. I 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). **.** PIC microcontroller is thus used because of its low cost and high clock speed. In the self-controlled mode. The future work is on developing ARM controlled mode with gesture recognition robot controlled.

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