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GESTURE CONTROLLED ROBOT FOR MILITARY PURPOSE

Mithileysh Sathiyanarayanan[1], *IEEE Student Member*, Syed Azharuddin[2]
Santhosh Kumar[3], Gibran Khan[4]
Electronics and Communication Engineering Department
Rajiv Gandhi Institute of Technology, Bangalore, India

Abstract: In spite of the fact that there are numerous controlled robots using commands from user or self-controlled that uses GPS and sensors, the requirement for gesture controlled robots are on ascent for military purposes, which is called as Unmanned ground vehicles (UGVs). These robots are utilized to increase the warrior's capacity in an open territory. In the last few years, tremendous research is going on in various parts of the world to develop robots for military purposes. This inspiration helped us fabricate a prototype gesture controlled robot (called as UGV) to embrace missions like border patrol, reconnaissance and in dynamic battle both as a standalone unit (automatic) and as well as in co-ordination with human soldiers (manual). Like, command controlled mode and self-controlled mode, we use another specific mode called, gesture control mode or hand wave mode. In this mode, UGV is manoeuvred using commands sent based on hand movements mapped by the IMU unit and the UGV is capable of travelling from one point to another point. The complete set up and working of the gesture control mode UGV are described in the paper.

Index Terms: Unmanned ground vehicle, robots, gesture con-trol mode, Arduino, GPS.

I. INTRODUCTION

As of late, the demand for the military robots has expanded massively. In this manner, opportunities for many soldiers to operate the robots to fight against the enemies have emerged and the needs for different controlling robots are on the rise. One such is a gesture controlled robot.

What do you mean by gesture controlled? In general, gesture means movement of hand (specifically fingers and arms) or face which conveys some information. Gestures can be classified into static gestures (using hand shapes) and dynamic gestures (using hand movements) [1] and [2]. Gesture recognition needs a good interpretation of the hand movement to effectively execute the commands [3]. There are two approaches: Data Gloves Approach and Vision based approach [4]. In this project, we will be using the former. In real world systems, communication can exist between humans and computer based systems including robots. Hand gesture is one of the imperative methods of communication for people to control the systems, which we call gesture controlled. There are active research being carried out in hand gesture recognition systems because of its applications for interactive human-machine interface and virtual environments. Why gesture controlled robots in military field? Gesture controlled robots can be used when there is a terrorist attack or insurgency problems faced by the people and sol-diers. The gesture control mode helps the soldier on war field to control the robot using wireless modem. Ultimately, the robot will be controlled by hand gestures which are tracked by the IMU (Inertial Measurement Unit).

We initially developed prototype command controlled robot, later we realised the importance of making a robot a autonomous, so we developed a prototype self-controlled robot. While thinking of robots being more effectively used, we came up with the idea of gesture controlled robots. To make it clear, a vehicle that operates on ground remotely with or without humans presence (also gesture controlled) for giving navigation commands and decision making is called as an unmanned ground vehicle (UGV) [5]. In this paper, 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. In situations which do not permit the UGV to be operated with base station assistance (manual and auto control) an alternative to tackle such problem is to provide another mode of control over the UGV, which we call it as gesture control mode. The aim of this mode is to remedy such situations. Here instead of sticking on to conventional input technologies, hand gestures are used to maneuver the robot and the com-mands which are acquired using inertial measurement unit are transferred wirelessly using zigbee technology. One of our inspiration for the robotics project is the Foster-Miller TALON robot [6] and DRDO Daksh robot [7] and [8]. They are used in military applications which can travel on flat and hard surfaces, also on sand and water. Since we developed prototype command controlled robot and self-controlled robot, this itself was a motivation to develop prototype gesture controlled robot to undertake missions like border patrol and surveillance. In this paper we explain the set up and design of the unmanned group vehicle which will be controlled by hand gestures. The rest of the paper is organized as follows. In Section II we explain the concept of gesture control mode for operating UGV. In Section III, we explain the results. Section IV concludes our discussions in this paper.

II. GESTURE CONTROL MODE

The aim of this mode is to enable gesture functioning of the unmanned ground vehicle without base station assistance. To accomplish this operation, hand gesture commands need to be acquired using inertial measurement unit and then be transferred wirelessly using zigbee technology.

The main tasks of the gesture control mode are:

Gesture control mode is implemented when situations do not permit the UGV to be operated with base station assistance (manual and auto control). UGV is capable of travelling from

one point to another using hand gestures commands from humans. Hand gesture commands are acquired using inertial mea-surement unit and transferred wirelessly using zigbee technology. For these tasks to be performed, hand gesture commands need to be acquired completely using inertial measurement unit and transferred wirelessly using zigbee technology. The block diagram for the gesture controlled mode is shown in figure 1.

A. Block diagram of gesture control mode

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

- *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.
- *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:* Infra-red 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 move-ment.
- *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 trans-fer for auto 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.

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 gesture control mode

The algorithm design for gesture 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.

(a) ARMCON SIDE (Arm Controller Side)

- First, user provides pitch and roll values based on the inclination along x and y axis i.e. it senses the tilt motion of the Board. We have assumed a range of 30 degrees along both the positive and negative directions. Values are serially monitored and transmitted by arduino and zigbee respectively.

(b) UGV SIDE (Robot Side)

- UGV monitors serial input for the received characters and makes the subsequent decisions. The following functions are executed in response to the character sent [up (), down (), left (), right (), halt ()]. We have provided Clockwise and anticlockwise pin assignment for forward and reverse movement of the UGV.
- Dedicated PWM signal pin for 80 - 120 degrees range of servo turn is maintained and H - Bridge Enable control is being utilized for braking.

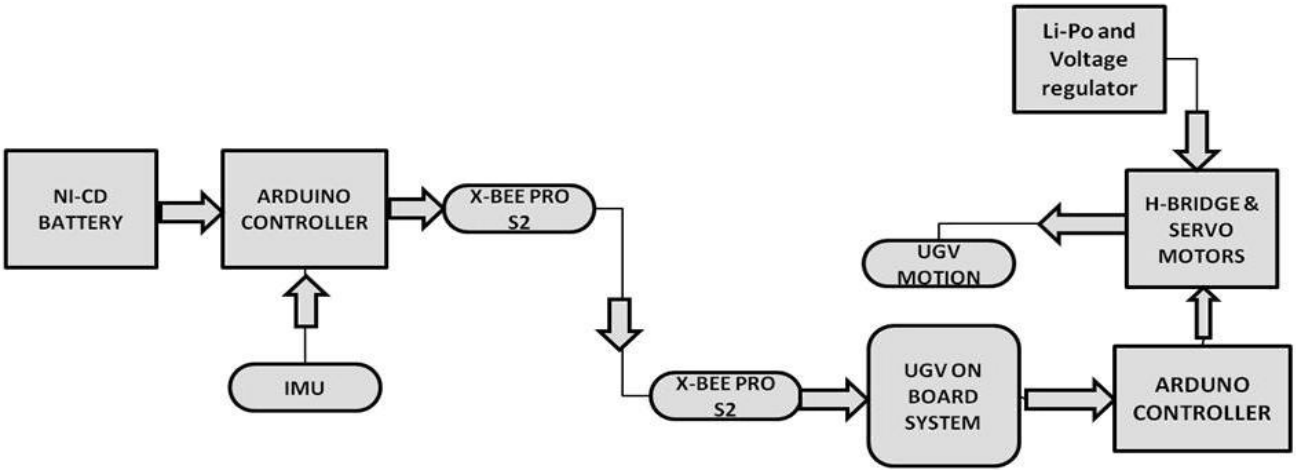

Fig. 1. Block diagram for the gesture control mode.

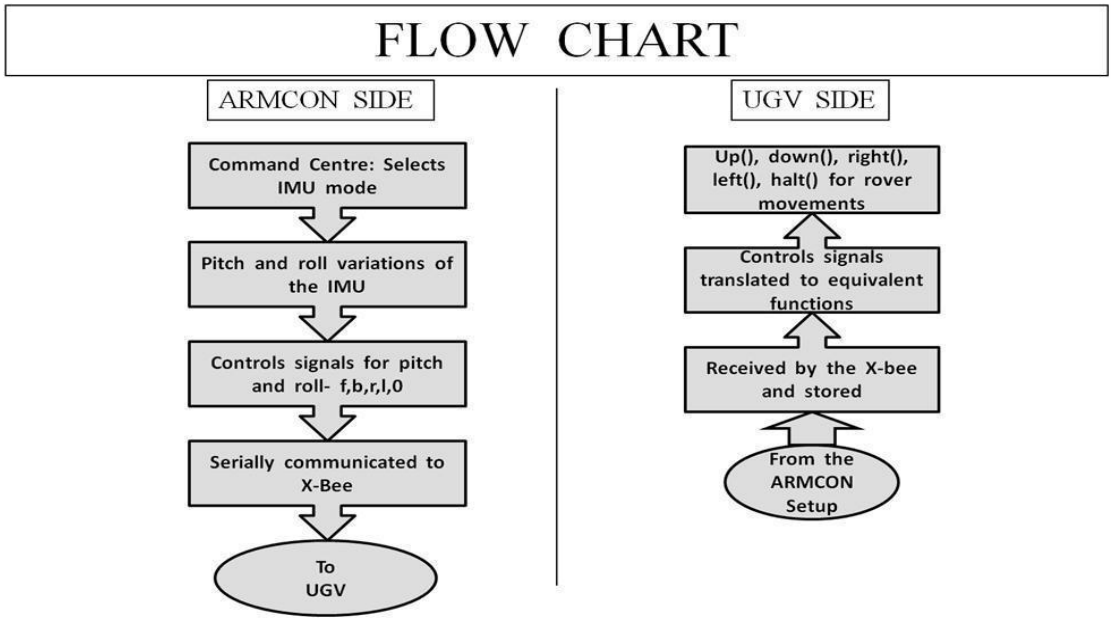

Fig. 2. Flow chart for the gesture control mode.

At the UGV side, from user, UGV obtains the complete infor-mation to move along which direction. So basically, navigation signals are controlled by the user using hand gestures. The gesture control algorithm work is based on the figure shown in figure 3. The flow chart of gesture control mode for operating unmanned ground vehicle is shown in figure 2.

III. RESULTS

We successfully built an unmanned ground vehicle (UGV) capable of being controlled using hand gestures as 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 success-fully passed the test.

Range	Character sent	Objective
Pitch > 30	F	Forward
Pitch < -30	B	Reverse
Roll > 30	R	Right
Roll < -30	L	Left
-30<= pitch >=30 -30<= roll >=30	0	Stop

Fig. 3. Gesture control algorithm

IV. CONCLUSION AND FUTURE WORKS

We successfully built a prototype UGV capable of being controlled using hand gestures. Likewise, command controlled

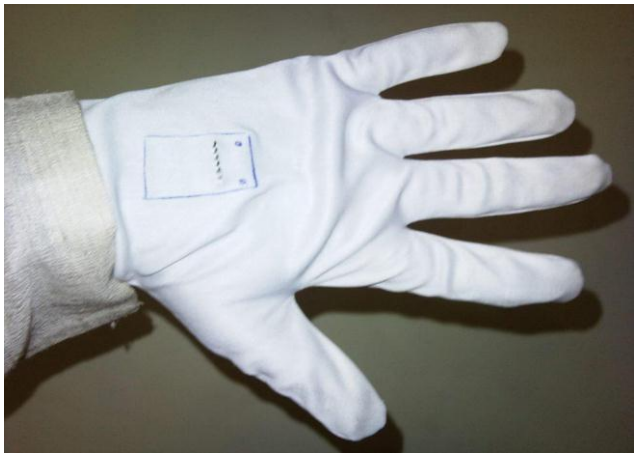

Fig. 4. Gloves to control Unmanned Ground Vehicle

Fig. 5. Prototype Unmanned Ground Vehicle

mode and self-controlled mode, we used another specific mode called, gesture control mode (ARMCON mode). In this mode, In this mode, UGV is manoeuvred using commands sent based on hand movements mapped by the IMU unit and the UGV is capable of travelling from one point to another point. The complete set up and working of the gesture control mode UGV are described in the paper. Similar to command controlled and self-controlled UGV, This gesture controlled UGV can also 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 all the three modes simultaneously in the UGV for military application (command control mode, self-control mode and gesture controlled mode).

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