

Unmanned Ground Vehicle

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Abstract: An autonomous UGV is essentially an autonomous UGV that operates without the need for a human controller. The vehicle uses its sensors to develop some limited understanding of the environment, which is then used by control algorithms to determine the next action to take in the context of a human provided mission goal. This fully eliminates the need for any human to watch over the menial tasks that the UGV is completing.

Existing systems do not include the environmental information assessment, object identification, self protection against high temperature and the implementation with most advanced hardware and related software algorithm.

This project presents the development of an unmanned ground vehicle with the facility of measurement of humidity, temperature and illumination, video and audio clips to get the information of the environment through which UGV navigates. The project also discusses the real time embedded implementation of this obstacle mapping system on a small Unmanned Ground Vehicle (UGV) to support real time obstacle avoidance, object identification by image processing and proposes self protection against high temperature. These activities are a part of a larger effort to establish a theoretical foundation for autonomous and cooperative multi-UxV guidance solutions in adversarial environments.

Keywords: PTEM, ZIGBEE, Simulation, Navigation, Frame, GNC,UGV,CAN

I INTRODUCTION

An unmanned ground vehicle (UGV) is a vehicle that operates while in contact with the ground and without an onboard human presence. 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.

Real Time obstacle avoidance and navigation are key fields of the project in the area of autonomous vehicles. The primary requirements of autonomy are to detect or sense changes and react to them without human

intervention in a safe and efficient manner. The objective of this project is to develop and implement a UGV control system utilizing embedded micro-controllers. This control system enables the UGV to autonomously navigate towards the specified waypoints while avoiding obstacles discovered in its path.

II BLOCK DIAGRAM AND DESCRIPTION OF UGV

Block Diagram consists of Power supply, LPC 2148 Microcontroller Circuit Board, AT89C51 Microcontroller Circuit Board, Electronic Compass Unit, Ultrasound Scanner Unit, Relay Driver & Relay Board, DC Motor Unit, ZigBee Unit, Temperature, Humidity, Illumination Sensors, etc.

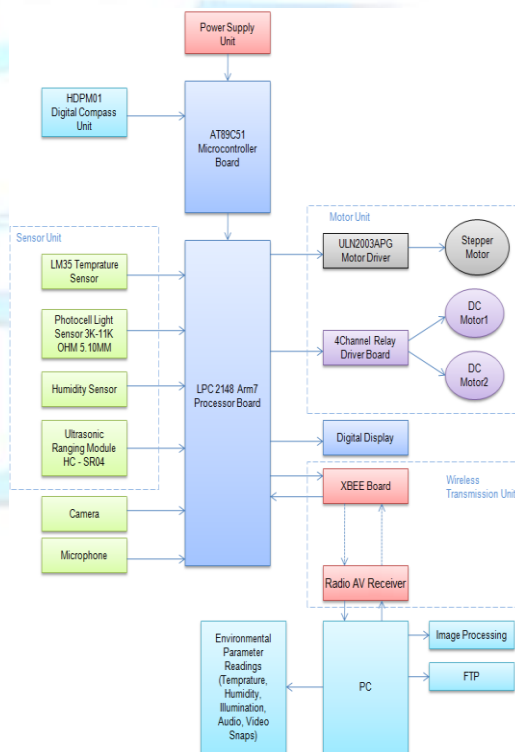


Fig 2.1 Block Diagram

This block diagram includes following circuit blocks with description.

- Power Supply:- This is 12V power supply with 1.5A current rating. This gives supply to all circuit boards either 12V directly or 5V through voltage regulator IC 7805.
- Ultrasound Scanner Unit:- This unit consists of transmitter and receiver transducer so that pulses are transmitted and echoes are received after reflection from the obstacle discovered in the path.
- Microphone:- It converts audio information into corresponding electrical signal and feeds to the Arm7 microcontroller LPC 2148.
- Camera:- It picks up the images of the environment through which UGV travels and feeds them to Arm7 microcontroller.
- Temperature, Humidity and Illumination Sensors:- These sensors detect and convert original temperature, humidity and illumination information across the UGV into corresponding electrical signal and feeds to the microcontroller.
- DC Motor Unit:- It consists of two 12 V DC motors to drive the two back wheels. Direction of these motors' rotation is determined by the ON-OFF 12V / 5V supply voltage received through relay which is controlled by control signals received from motor driver unit.
- Audio / Video clips and text file:- With the help of Zigbee module communication received audio and video messages are converted into suitable form so that they are stored in the folder and text file at control room.
- Electronics compass unit :- This detects the direction of navigation of UGV continuously and gives the corresponding information to the AT 89c51 microcontroller.
- 89c51 microcontroller unit:- This receives the output of electronics compass unit representing the current navigation direction of UGV which is further utilized by this microcontroller to keep the track of already assigned direction.
- ARM 7 Microcontroller unit :- This receives the outputs of ultrasound scanner unit which is further processed to calculate the presence of obstacle and its width, the distance from UGV and to avoid the obstacle while navigation. This also receives the signal representing temperature, humidity and illumination information of the UGV surrounding and processes them to transmit towards control room with the help of wireless communication for further analysis.
- Zig Bee Module:- ZigBee is a specification for a suite of high level communication protocols used to create personal area networks built from small, low-power digital radios. ZigBee is based

on an IEEE 802.15 standard. Though low-powered, ZigBee devices often transmit data over longer distances by passing data through intermediate devices to reach more distant ones, creating a mesh network; i.e., a network with no centralized control or high-power transmitter/receiver able to reach all of the networked devices. The decentralized nature of such wireless ad-hoc networks make them suitable for applications where a central node can't be relied upon.

III Hardware Requirements

- LPC2148 ARM7TDMI microcontroller Development
- AT89C51 microcontroller Development Board
- ZigBee Unit
- Ultrasonic Ranging Module HC - SR04
- HDPM 01 Electronic Compass
- 4 Channel Relay Board
- LM35 Temperature Sensor
- Photo Light Sensor 3K-11K OHM , 5.10 mm
- Camera
- ULN2003APG Motor Driver
- 5V Voltage Regulator IC7805

IV Software Platform

Algorithm

1. Start UGV
2. Initialize all the circuit boards.
3. Check for obstacle discovered
4. Is obstacle found?
5. If YES go to step 6, if no go to step 12.
6. Activate obstacle avoiding DC motor Drive
7. Read electronic compass data.
8. Check for deviation in direction set.
9. Is deviation in direction?
10. If yes go to step 11, if no go to step 12.
11. Activate deviation in connecting DC motor drive.
12. Measure and store illumination data.
13. Measure and store humidity data.
14. Measure and store temperature data.
15. Check present temperature status.
16. Is present temperature greater than set temperature?
17. If YES go to step 18, if NO go to step 19.
18. Switch off UGV and go to step 14.
19. Transmit the resulting environmental data and go to step 3.

Flowchart

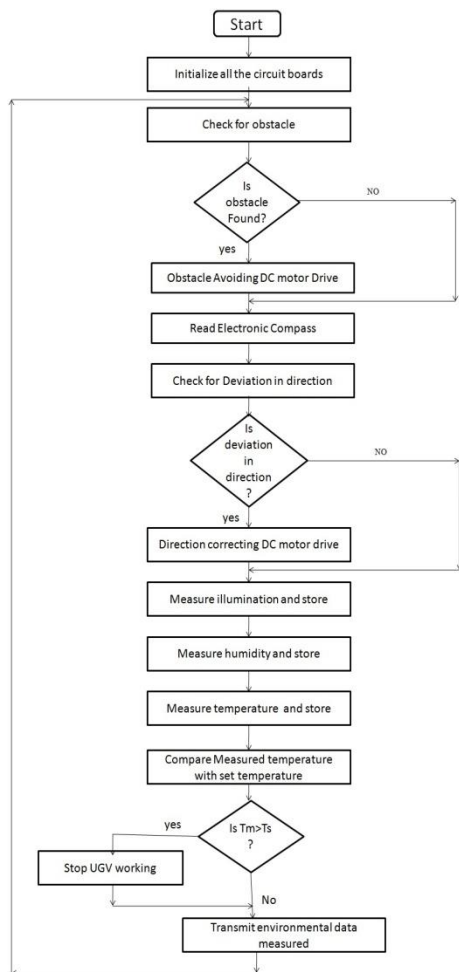


Fig. 4.1

Software Testing

Following software modules have been tested and found successfully working :

- Obstacle mapping and avoidance
- Environmental parameters measurements and transmission
- Electronic compass reading and direction deviation control
- System working on off control based on set temperature
- Audio video transmission

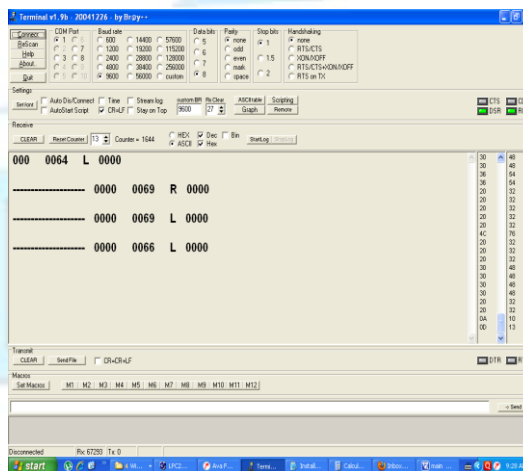
Software Requirments

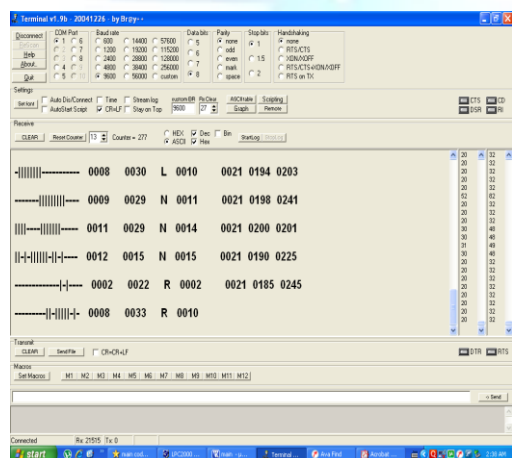
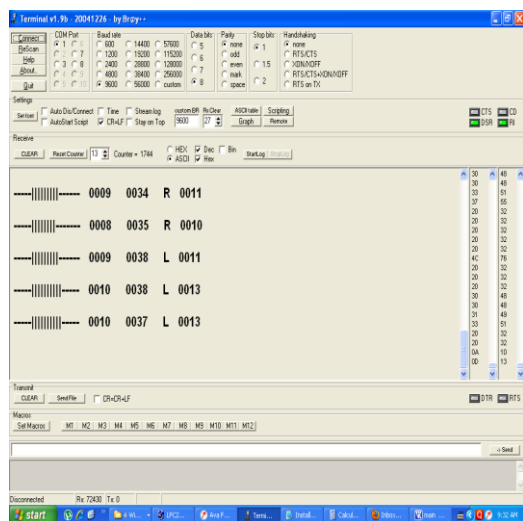
- Matlab 7.7
- Keil μ Vision IDE.
- Flash Magic
- Wing FTP Server v4.0.1

V Interfacing Of Hardware And Software

1. Obstacle mapping and avoiding:-
 Obstacle detection and UGV movements by using hardware
 Obstacle avoidance control by using software
2. Detection and transmission of environmental parameters:-
 Detection and transmission of all environmental parameters by Hardware display of environmental parameters by using software
3. Audio video transmission:-
 Audio video signal transduction by using hardware
 Recording and processing by using software
4. Navigation direction control:-
 Detection of navigation direction by using hardware
 Control of navigation direction by using software

VI Results





VII Advantages and Applications

Advantages:-

- UGVs can be used for many applications where it may be inconvenient, dangerous, or impossible to have a human operator present.
- UGVs can "draw first fire" from insurgents - reducing military and police casualties.
- Autonomous Navigation
- Autonomous Obstacle Mapping
- Autonomous Obstacle Avoidance
- Measurement, wireless transmission and recording of Environmental parameters such as Temperature & Humidity surrounding the UGV.
- Transmission and recording of the Audio & video clips of the environment surrounding UGV.

Applications:-

- The UGV is the land-based counterpart to unmanned aerial vehicles and remotely operated underwater vehicles.
- Unmanned UGVs are being actively developed for both civilian and military use to perform a variety of dull, dirty, and dangerous activities.
- There are a wide variety of remote-operated UGVs in use today.
- Predominantly these vehicle are used to replace humans in hazardous situations. Examples are explosives and bomb disabling vehicles.
- According to Carafano & Gudgel, UGVs have disarmed over 1000 roadside bombs in Iraq at the end of 2005.
- The importance of this is apparent since the amount of UGVs in use has shot up from 150 in 2004, to 5000 in 2005.
- Currently, UGVs are being used in Japan repairing nuclear reactors that are still emitting too much radiation to warrant a human presence.
- UGVs are being developed for peace keeping operations,
- Used for Ground surveillance operations,
- Used for Gatekeeper/checkpoint operations,
- Used for Urban street presence operations,
- Used to enhance police and military raids in urban settings.
- Furthermore, UGVs are now being used in rescue and recovery missions.
- These UGVs were paramount following 9/11, when searching for survivors at Ground Zero.

VIII CONCLUSION

- Successful real time code is generated by using Keil μ Vision IDE in C language and Flash Magic.
- Obstacles are identified in real time by the Ultrasonic ranging Module HC SR04 .
- Electronic Compass is successfully used for navigating the UGV in the specified direction.
- PC is successfully used for observation of Results data(Temperature, Humidity, Illumination, Video Snaps, & Audio Clips) with wireless communication by using ZigBee unit.
- FTP is successfully used for on line observation of Results data.
- Successful object identification is done by using the image processing on Matlab-Simulink tool chain with the Real time Workshop and the Freescale CodeWarrior compiler.

- If temperature exceeds set limit UGV stops navigation and activates relay.

IX Future Scope

- Our next step is to integrate the PTEM construction algorithm with our guidance algorithms for realtime waypoint navigation and obstacle avoidance.
- The PTEM construction algorithm will need to be enhanced to handle moving obstacles. Up until now, we have focused on PTEM construction with a single vehicle.
- In the future, we would like to explore multi-vehicle collaboration scenarios such as :
 - Sharing obstacle mapping data with platforms lacking obstacle detection
 - sensors and
 - (2) Obstacle mapping algorithm construction using multiple vehicles.
- We plan to investigate possible solutions of achieving real time implementation of our obstacle avoidance algorithm using a single computing unit such as an embedded PC.
- A single computer solution will greatly reduce the complexity of the control system architecture and significantly reduce the overall platform cost.

X References

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