Capstone Project Report
On
Design and Development of a Multi-Terrain UGV

Submitted to
Lovely Professional University, Phagwara

In partial fulfillment for the Capstone Project

In

Mechatronics Engineering
(Seventh Semester 2022)
By

Mohit

Adarsh P

Lavish

Amith S

Mohan Kuchi

Under the guidance of

Dr. Udai Chandra Jha

Professor
Department of ME
Lovely Professional University, Phagwara

DEPARTMENT OF MECHANICAL ENGINEERING
LOVELY FACULTY OF TECHNOLOGY & SCIENCES
LOVELY PROFESSIONAL UNIVERSITY, PHAGWARA (PUNJAB)

DECLARATION

We, the students of B.Tech Mechatronics Engineering of capstone group MC079 hereby declare that the Project titled "**Design and Development of a Multi-Terrain UGV**" which s submitted by us to Department of Mechanical Engineering, Lovely Faculty of Technology & Sciences, Lovely Professional University, Phagwara, Punjab in partial fulfillment of the capstone project-I, has not been previously formed as the capstone project report.

Phagwara

Date: November 16th, 2022

Name	Reg. No.	Signature
Mohit	11904083	
Adarsh P	11902158	
Lavish	11904295	
Amith S	11901789	
Mohan Kuchi	11903191	

Department of Mechanical Engineering,

Lovely Professional University, Phagwara

CERTIFICATE

On the basis of Project submitted by the students of Capstone group MC079 of B.Tech Mechatronics Engineering, hereby certify that the Project "**Design and Development of a Multi-Terrain UGV**" which is submitted to Department of Mechanical Engineering, Lovely Faculty of Technology & Sciences, Lovely Professional University, Phagwara, Punjab in partial fulfillment for Capstone Project is an original contribution with existing knowledge and faithful record of work carried out by them under my guidance and supervision. To the best of my knowledge this work has not been submitted in part or full for the Capstone Project in this batch.

Phagwara

Date: November 16th, 2022

Dr. Udai Chandra Jha

Professor

Department of Mechanical Engineering

Lovely Professional University, Phagwara

Table of Contents

Abstract

Humans operate in hazardous conditions and terrain to complete many tasks, which are very risky and not optimal. The UGV is a platform that solves this problem. For military and civilian purpose UGV solve many critical operations without risking lives, this also gives very coordinated and heterogenic system integration for a huge and complex deployment.Key methodology to develop UGV study on already existing UGV systems and studying their capability to understand current technology then extracting and developing the design criteria for the UGV platform with optimal problem solutions and analyzing various problems related to the application of UGV.

A problem-solving approach is constituted from extensive study of current and development technologies and their emergence. 1000 meters or a 750-meter fiber optic tether. The car can go up and down stairs and through regular doors. The human operator supplies all necessary intelligence, controls and steers the vehicle, recognizes and distinguishes targets, and decides where to deploy charges. The operation with the goal to remove unexploded munitions from tiny regions, usually one at a time. Reviews of the autonomous ground platforms that have been created by academic institutions and research teams and are specifically intended to handle agricultural chores were carried out. The creation of autonomous cars can be of great interest, especially for those applications where mechanization advancements are limited, as cost reduction and safety enhancements are two of the most important factors for farmers. In order to build and prototype agricultural ground unmanned vehicles.

The unmanned ground vehicle is intended to take the role of people in a variety of military and civilian applications, such as transport, distribution, shuttle, cleaning, patrol, scouting, and combat. Unmanned ground vehicles are projected to soon drastically alter both human life and the nature of field combat. Environment perception, motion planning, chassis dynamics control, and cloud control are the unmanned ground vehicle's core technologies.

Key words: Unmanned Ground Vehicle, Autonomous system, model, Control system, optimal operation.

I. INTRODUCTION

Unmanned ground vehicles are intended to replace humans in a variety of civilian and military applications, including transportation, delivery, shuttles, cleaning, patrol, reconnaissance, and combat. In the near future, unmanned ground vehicles are widely expected to significantly change human life and land combat patterns. Key technologies for unmanned ground vehicles are environment awareness, motion planning, chassis dynamics control, and cloud control.

Using the properties of unmanned ground vehicles, disparate systems can work together to perform many complex tasks. Tracking of moving targets is an important basis for maintaining relative positioning and formation in heterogeneous cooperative systems. In this paper, we first introduce a collaborative tracking task and a heterogeneous system of unmanned ground vehicles. In order to maintain the initial stability of UAV, a control method based on SBUS protocol is proposed to simulate remote control.

[1] Moving target detection and tracking mainly includes the following classical methods: frame difference method7, mean shift algorithm8, optical flow method9.

MeanShift is simple and easy to implement. However, it does not track well for fast-moving or scale-varying targets.They compared KCF and TLD with the proposed algorithms. However, the UAV was only used to record video as a test dataset for comparison and the study was not physically validated.

In hazardous search and rescue locations, unmanned ground vehicles can replace rescue workers in tasks such as incident location, hazardous material identification, toxic gas collection, and security surveillance. This article presents a new Terrain Adaptive Omnidirectional Unmanned Ground Vehicle (TAOUGV) for underground search and rescue missions. The proposed system consists of three main parts: obstacle detection, terrain adaptive machine module and control module.

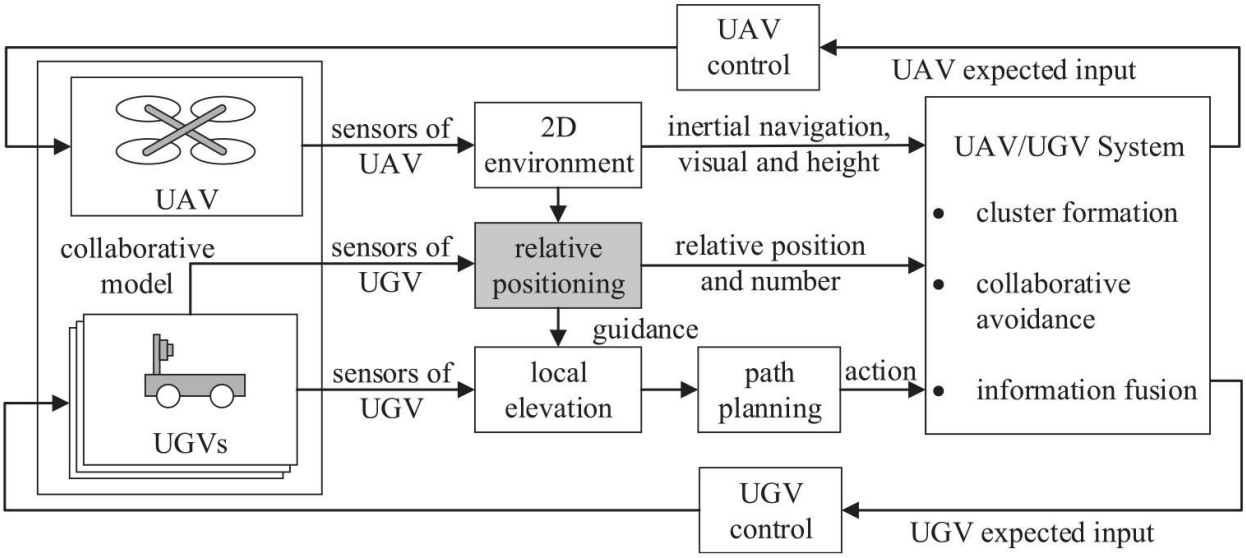
II. METHODOLOGY

A. Design

In the design stage, we utilize our advanced project design skills to produce the most effective solutions and clever ideas to suit our requirements. It goes both for the Hardware as well as the Software designing. In hardware, we are looking at the mechanical design of the UGV and the controller design, that is, the electronics part. In software, we are looking at the development of a suitable algorithm that enhances the efficiency of the robot by taking faster and precise decisions.

Fig: Mechanical Hardware Design of the UGV

Design stage being the very first stage plays an important role as most errors are to be removed at this stage itself. Firstly designing a model keeping in mind the final product, then testing and analyzing the model to see if it meets our requirements. If any major change is required it is done itself at the designing stage to stay cost effective.



[2] Fig: UAV/UGV heterogeneous system.

UAV/UGV: unmanned aerial vehicle/unmanned ground vehicle; 2D environment: two-dimensional environment.

B. Development

[3]The mechanical and electrical components of the UGV are determined and kinematic equations of the selected mechanical drive topology are obtained. The trajectory tracking algorithm is simulated in MATLAB/Simulink using the kinematic model of UGV. Also, hybrid filters have been developed to improve the performance of a low-precision GPS. Moreover, simultaneous localization and mapping (SLAM) algorithms are developed for autonomous driving in environments without GPS access.

As for the robust structure development we will have to go through a material selection process and will have to choose the best material which is best suited for all sorts of environmental conditions and can sustain all sorts of terrain conditions. While developing the body of the UGV, we need to take care of the welding and assembly of the UGV so

as there are no leakages in the body, so it can even go into water submerged places and can come out without any trouble.

For the development of electronic parts, we need to pay special care to its packaging and placement in the system. So that even if the outer structure is hit by something the internals of the UGV still remain intact and the UGV can be still operated easily without much trouble. Controllers and processors with high efficiency and high performance will be needed so that the UGV can be quick and precise, especially during the object tracking task.

REQUIREMENTS

The requirements for the project to be carried out are:

1. Extensive study on current pending problems and UGV technologies
2. Extraction of core requirements and capabilities for UGV.
3. Preliminary designing for the UGV and design evaluation.
4. Material Selection for the development of UGV, so that it can sustain in all sorts of environment and terrains
5. Software, communication and control system.

These are the basic requisites for the project paper to be carried out in Lovely Professional University.

CONCLUSION

A. Design

It is important for any UGV to have a compact and optimizable design. A good design with appropriate materials is required for it to be able to withstand harsh environmental conditions and provide the best performance in multi-terrain environments. To make UGV fast and accurate, design plays a major role, so we design our UGV with proper design. For it to be able to work in different terrains, we are using chain drives (bogies) as they are more robust and multi-terrain adaptable, and for the UGV to be more functional, we are designing replaceable end effectors.

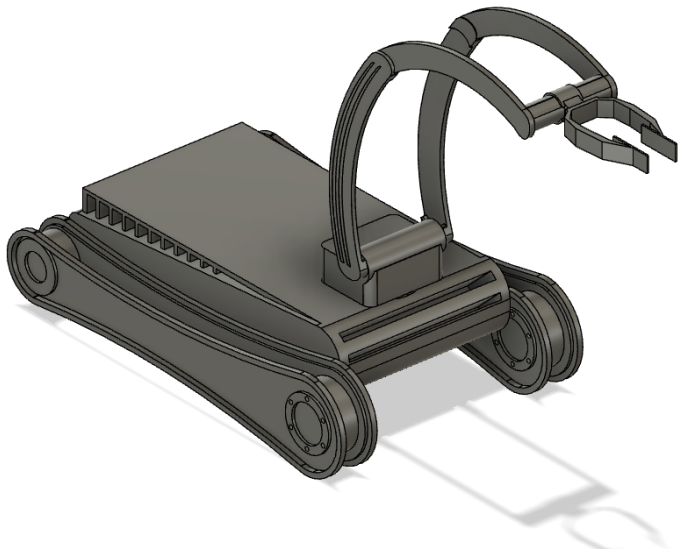
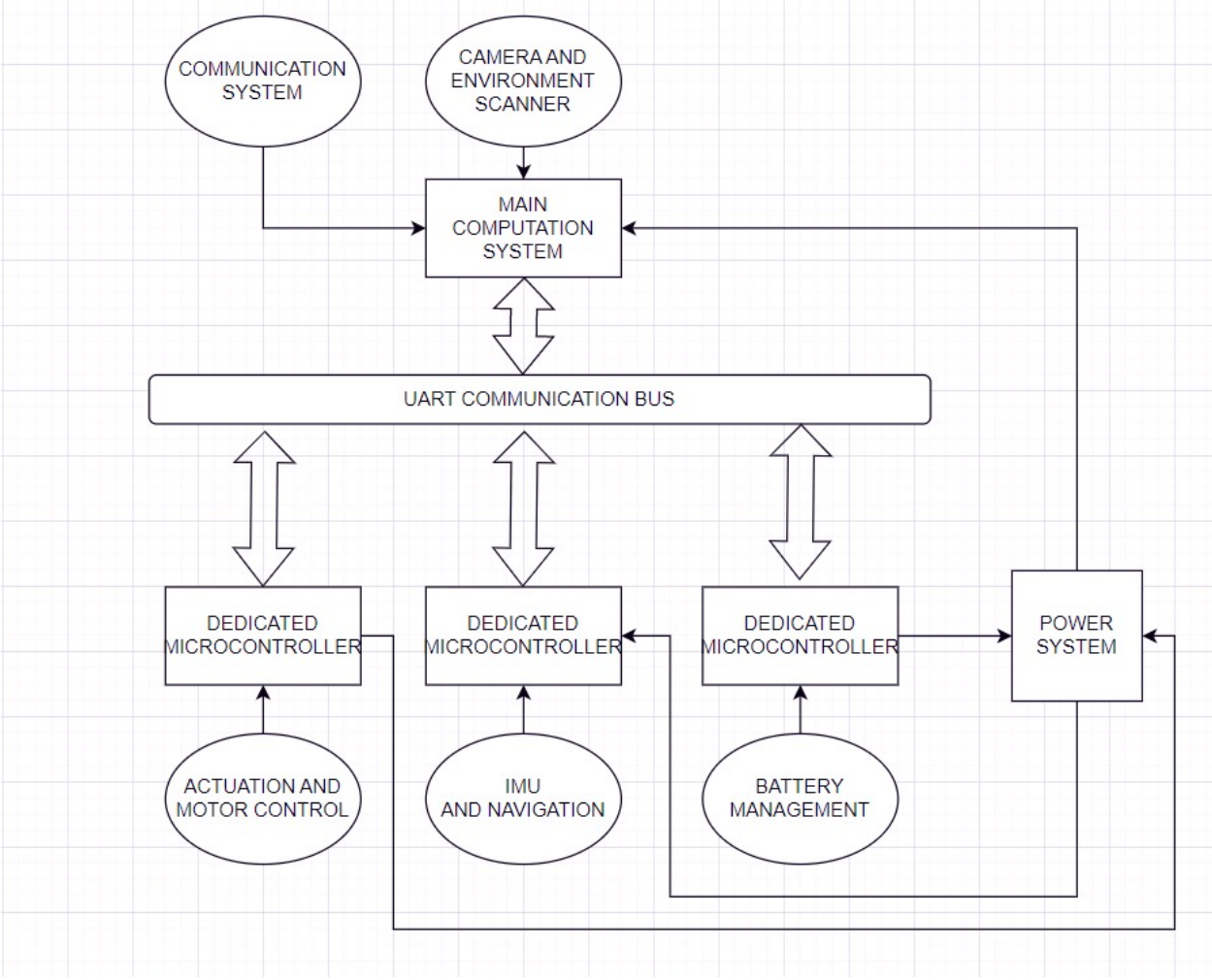


Fig: Design of the UGV

B. Development

From analysis a common factor found in system design is that any autonomous and automated system requires not only redundant softwares but also the electronics designs and architecture. UGV is a platform which operates in environments that are very harsh and unpredictable. In environments like battlefields or high radiation fields, the system is subjected to many errors and uncertain events. With this on consideration it was designed to conduct specific tasks with dedicated micro-controllers.



This system architecture is designed with the main computer managing heavy computation and high density data sensors like camera and environmental sensors. Main computer also manages the communication system. The dedicated micro-controllers have specific roles, the actuation and motor control tasks are performed by microcontroller 'A' from main computer decision and commands, this ensures that the main computers are always protected from back emf, electrical surges etc.

REFERENCES

[1] Singer, P. (2009a). Military robots and the laws of war [Electronic version]. *The New Atlantis: A Journal of Technology and Society*, .

[2] Hager CE, Kwon H, Zarzhitsky D, et al. A cooperative autonomous system for heterogeneous unmanned aerial and ground vehicles. In: Infotech at aerospace 2011, St. Lousi, MI, 29–31 March 2011.

[3] Ömer Cihan Kıvanç1* , Tahir Eren Mungan1 , Berkin Atila1 , Gürkan Tosun2 1 Department of Electrical and Electronics Engineering, Istanbul Okan University, Istanbul, 34959, Turkey 2 Research and Development Directorate, TOFAS, Bursa, 16110, Turkey