Navigation, Guidance & Control Program for GPS based Autonomous Ground Vehicle

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***Abstract*— In this chapter, an introduction of navigate a vehicle autonomously, the control action of the system must know at least two things, its own current position and direction of movement. Location can be find by either from an outside system source with technology such as the Global Positioning System (GPS), or by calculation of mathematical equation a followed path from a known source point with the use of electronic compasses, inclinometers, and rotational counters. However, under any scheme, the outcome is to somehow generate the positional information of the vehicle so that the vehicle could be guided to follow a path and reach the target. In addition of this, the direction sensing devices are also used for getting the values of current heading of vehicle so that it could be steered to move towards target location. GPS has advantage over other position detection mechanism that it also provides an estimate of vehicle's current heading based on the previous two positional coordinates. While the current heading provided by GPS is not accurate enough under some conditions, it is envisaged to accommodate GPS as the only sensor for guiding the autonomous vehicle to follow the trajectory in outdoor applications.**

***Keywords*— Electric Vehicle, Arduino IDE, GPS Sensor, Guidance and Navigation and Program Code**

I. INTRODUCTION

An Autonomous Vehicle (AV) is a self-driven vehicle that does not demand an operator to navigate and fulfill its tasks. Autonomous vehicles are a now a day's very innovative developed subset of robotics engineering and can come in three general forms; air, ground and water. Possible applications for the include precision formation aeronautics, investigating areas too dangerous for human life (i.e. radioactive areas or fires), checking line integration of underwater system and exploring the surface of other planets. One possible task of an autonomous vehicle is to navigate a pre-programmed route while avoiding any obstacles the vehicle may encounter. [11] This function is useful in applications such as an autonomous log-skidder, security surveillance robot, fire suppression system, and a terrain-mapping vehicle. The vehicle can accomplish this task by using sensors to "see" where it is and what is around it.[12] These sensors vary from close range infrared sensors to longer ranged high frequency radar and global positioning system. Control and guidance are vital aspects of AV research and many techniques have been proposed in literature which range from fully autonomous and intelligent systems to laser and radar guided systems and line followers. Various algorithms have been developed for the guidance mechanism and different techniques have been implemented for the control of the autonomous vehicles. Some of the techniques use guide tape, laser and even gyroscopic guidance. For instance, in a vision based lane detection of an autonomous vehicle, different algorithms were used to get the optimum guidance and navigation results.[15] In another method, a path generation algorithm was developed using a sensor platform and two electric motors which make the panning and tilting motions.

The usefulness of autonomous ground vehicle (AGV) in such a wide area of applications motivated us to undergo with the development of such a system. To accomplish certain task the AGV must be equipped with relevant sensors and actuators. However, to serve any useful purpose the AGV must move autonomously based on the data of navigational sensors. To navigate a vehicle autonomously, the control system must know at least two things, its own current position and direction of travel. [13]Location can be determined either from an outside source with technology such as the Global Positioning System (GPS), or by calculating a travelled path from a known starting point with the use of electronic compasses, inclinometers, and rotational counters. However, under any scheme, the outcome is to somehow generate the positional information of the vehicle so that the vehicle could be guided to follow a path and reach the target. In addition of this, the direction sensing devices are also used for getting the values of current heading of vehicle so that it could be steered to move towards target point. GPS has advantage over other position detection mechanism that it also provides an estimate of vehicle's current heading based on the previous two positional coordinates. While the current heading provided by GPS is not accurate enough under some conditions, it is envisaged to accommodate GPS as the only sensor for guiding the autonomous vehicle to follow the trajectory in outdoor applications.

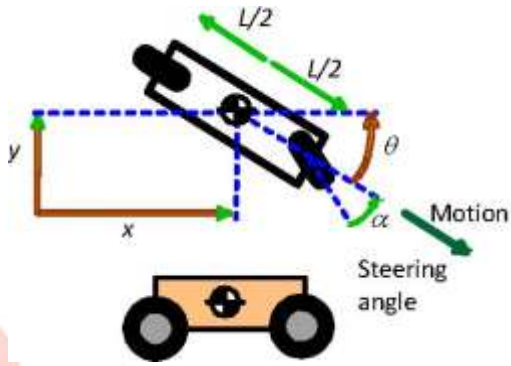
II. AUTONOMOUS GROUND VEHICLE OVERVIEW

"Development of Navigation, Guidance & Control Program for GPS based Autonomous Ground Vehicle (AGV)" has been undertaken with the aim of developing navigation & guiding program for Atmel ATMega328 microcontroller which could be used as control unit for exhibiting the autonomous behaviour of AGV. In this project work the necessary data is extracted from the GPS and further used to generate cross track errors based on the 2-point guidance scheme. The first point is being the coordinates of the point where the vehicle has to reach and second point is continuously acquired by the controller with the help of GPS sensor. [12]The Navigational & Guidance Program developed under this project is responsible for collecting & parsing

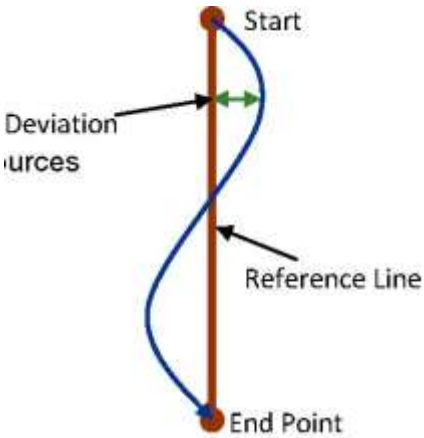
the GPS data & producing the various errors based on this. In the guidance part, the program computes the distance between these two points and draws an imaginary line between them. After computation of the reference heading and using current heading acquired through GPS sensor it generates the heading error which is passed to PID controller and subsequent PWM generation for aligning the motor with the imaginary reference line. Beside this another module keeps track of the current speed and tries to maintain it at a level of 4 kmph satisfying the requirement of faithful current heading from GPS. As it is proposed under this project the vehicle would be used to move in obstacle free surface hence at present no obstacle avoidance mechanism is incorporated. The outcome of this whole project would be a GPS based AGV which could be able to travel to a destination point without any intervention of human. The software developed under this project is responsible for exhibiting this autonomous behavior of the vehicle.

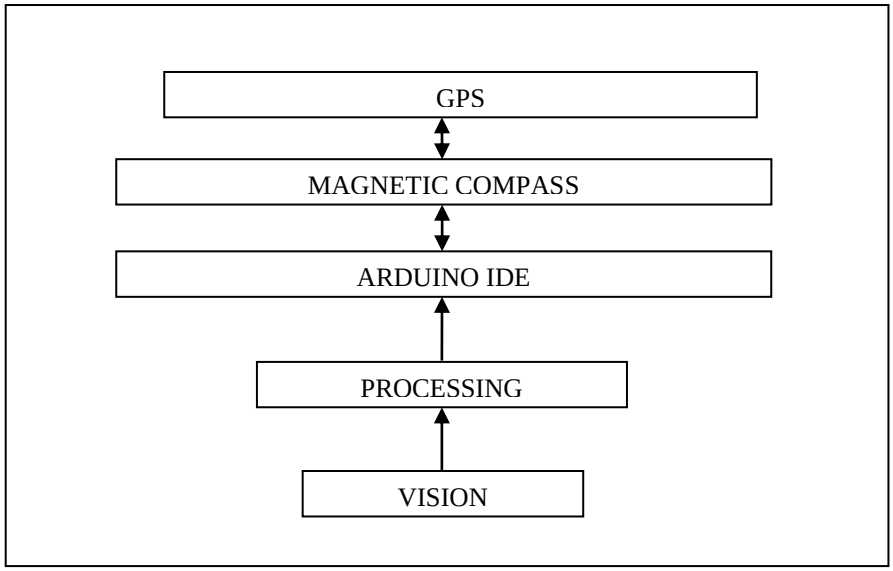
Autonomous Guided Vehicle Overview

The project „Development of GPS based Autonomous Ground Vehicle' involves following work –



1. Literature Survey
2. Functional Requirements for the system
3. Block Diagram of System
4. Development Approach
    a. Mathematical Model Based development using MATLAB/SIMULINK
        i. Development of Vehicle model
        ii. Guidance and Control Algorithm
        iii. Parameter tuning of Controller
5. System Development
    a. Selection of major COTS items
    b. Development of Hardware
        i. Subsystem Approach using ready available resources
        ii. Custom Hardware based approach
6. Development of Software
    a. GPS Data parsing
    b. Heading Sensor"s Data parsing
    c. Guidance Algorithm Transformation
    d. Control Algorithm Transformation
    e. Generation of Steering and Motion commands
7. System testing to meet project objective
    a. Modifications if required





III. INTELLIGENT PROGRAMMING

The task of writing a computer program is also related to other areas of intelligence. Much of basic research in programming, theorem proves, and vehicle problem solving overlaps. In a scientific manner existing the compiler already do "automatic programming".[15] They take in a complete source code of specification of what programming to accomplish, they write an object code program to do it. Automatic programming mean here is "super compiler" or a program that could take high level of instruction from a designed program. [16]The high level instruction might be precise statement in a formal way of language. It would be require further statement between the machine and the operator in order to resolve ambiguities. The task of intelligent program code to achieve a stated result is closely related to the task of proving that a given program achieves a better result. [17] Many automatic programming systems produce a verification code of the output program as an added advantage

TABLE -1 LITERATURE REVIEW OF AGV

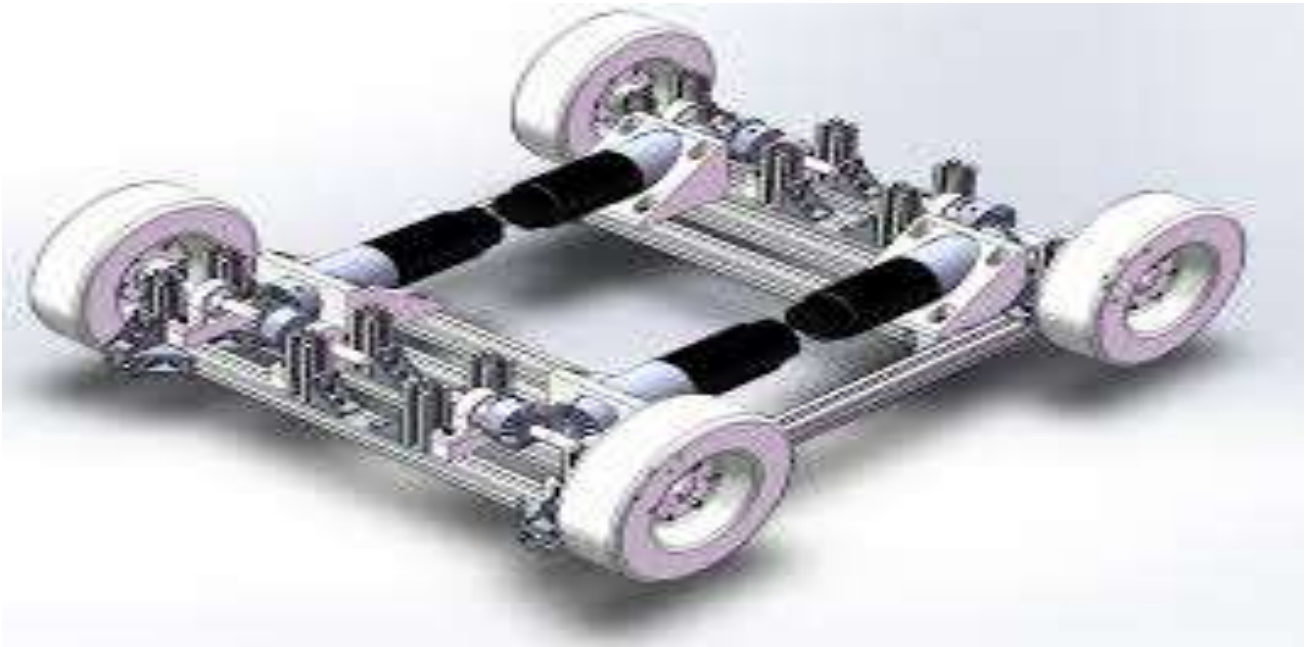
S. No	RESEARCH AREA	GOAL	REFERENCES
1.	Neural Based Approach	For obstacle detection and assisting of human	Horn (1981), Jones (1999) and Romdhani (2001)
2.	Distributed Sensor Network Approach	This intelligent machine design for avoiding obstacle which may be static or dynamic.	Haralick (1993), Gavrilla (1999), Granum (2001), Lang (2003) and Moreno (2003)
3.	Vision Based Approach	This moving machine design for industrial purpose.	Adam (2000), Zhou (2001), Treptow (2005), Hyams (2005) and Yoshimi (2006)
4.	Silhouette Extraction Approach	The machine design for industrial and as a human assisting agent.	Gavrilla (1999), Lindstrom (2001), Wang (2003), Topp (2005)
5.	Peer-to-Peer Communication Approach	Autonomous indoor machines is very important and design for indoor challenging task.	Coaniciu (2003), Fritsch (2003) and Marti (2008)
6.	Optical Flow and Kalman Filter	Motion analysis moving machine.	Borenstein (1991), Motai (2005) and Mataric Maja (2007)
7.	Integration of Curve Matching Framework	For real-time obstacle avoidance.	Wolfson (1990) and Rastogi (1997)
8.	Obstacle Avoidance with Kinect 3-D sensor Approach.	For detecting of human motion and control.	Beymer (2002), Ramanan (2003), Marti (2008) and Ilias (2014)
9.	Wireless Communication	Finding location and to used for as a path finder.	Sandeep (2010), Welch (2011) and Awad (2014)
10.	Fuzzy Logic Based Approach	Hurdle avoidance walking machine.	Burridge (2001) and Song (2014)
11.	LabVIEW and FPGA Approach	Industrial Application.	NI Systems
12.	Classical Motion Planner	Machine intelligence according to the environment.	Latombe (1991)
13.	Cell Decomposition Approach	Moving machine for hospital and airport used as a payload machine.	Nelson (1997) and Perez (2008)
14.	Heuristic Planning Approach	As a load machine for house application.	Koren (1991) and Jefferies (2003)
15.	Embedded Based Approach	Design for complex environment.	Kim (2004) and H.Hu (2006)
16.	Dynamical Based Approach	Obstacle avoidance and find a safe path	Tomasi (1992), Pratihar (2002) and Lee

		for moving machine.	(2006)

Four Arrow Keys for directions:

→	←	↑	↓	Control
F	F	F	F	No Function
F	F	F	T	Back/Reverse
F	F	T	F	Straight Move
F	T	F	F	Left
T	F	F	F	Right

AGV PROTOTYPE MODEL DEVELOP IN DEI LAB



V. RESULTS

The program is developed for guiding the vehicle autonomously based on the GPS data and limited lab testing has been carried out. Next test is performed while the vehicle was allowed to run on ground. Latitude and longitude of point inside the ADRDE is preferd to the arduino along with the program as Destination Point (DP). The max value of duty cycle of motor is made lower and release of steering command after 200 ms is made in program to avoid these things and the tests were conducted again. The holding of turn command is also increased for 400 ms and the tests were carried out with modified hardware. However the system was found to be not working as per the expectation. The GPS of update frequency of 1 Hz as the only sensor for guiding the vehicle autonomously is found to be incapable up to this point of testing. It is felt strongly that either we should employ the GPS sensor with higher frequency of update rate or magnetic compass. It is also felt that if the vehicle has to move the long distance then finally its steering got stabilized

VI. SUMMARY

. As per the project objective I have developed the software which could be utilised for guiding & controlling the vehicle autonomously. In the present state the reference position (Lat, Lon) of origin is taken as current ADRDE position. Since in this project 1 Hz GPS sensor is utilized, the stepped output in both (steering & speed) is observed. However if the current heading information is obtained through magnetic compass then the performance would be superior. The integration of command shaper

will be first done in the software for smooth movement and the tests would be carried out. Unsatisfactorily result under this condition would lead to inclusion of magnetic compass for heading information

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