A Project Report

On

AN INTEGRATED APPROACH OF PATH PLANNING WITH POWER MANAGEMENT FOR A SOLAR-POWERED UGV

Submitted in partial fulfillment for the award of the degree

of

Bachelor of Technology

in

Electronics and Communication Engineering

by

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SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS)

(Approved by AICTE & Affiliated to JNTUA, Ananthapuramu)

(Accredited by NBA for Civil, EEE, ECE, MECH, and CSE)

(Accredited by NAAC with 'A+' Grade, an ISO 9001:2015 Certified Institution)

Siddharth Nagar, Narayanavanam Road, Puttur-517583, A.P.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that the Project entitled "AN INTEGRATED APPROACH OF PATH PLANNING WITH POWER MANAGEMENT FOR A SOLAR-POWERED UGV" that is being submitted by

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is in partial fulfillment of the requirements for the award of BACHELOR OF *TECHNOLOGY in* ELECTRONICS AND COMMUNICATION ENGINEERING *to* JNTUA, ANANTHAPURAMU. *The results embodied in this Project report have not been submitted to any other University or Institute for the award of any degree.*

Internal Guide **Head of the Department**

Submitted for the project viva-voce examination held on ____________

Internal Examiner **External Examiner**

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ABSTRACT

With the advancement of autonomous technology, robotic systems have freed human operators from numerous tedious tasks where system endurance plays a crucial role. The current technology employed in solar-powered robotic systems is subject to design and power limitations, as well as varying environments. Intelligently harvesting energy from the environment and scheduling power consumption to optimize desired system performance will significantly improve the solar robot's endurance. Therefore, the goal of realizing energy autonomy for solar-powered robotic systems motivates this work. This project examines an integrated path planning and power management problem for a solar-powered unmanned ground vehicle (UGV). The proposed method seeks to minimize the travel time of the UGV through an area of known energy density by designing a smooth, heuristically optimized path and allocating the vehicle's power among its electrical components while the UGV harvests ambient energy along the designed path to satisfy the mission's strict energy constraints. A scalar field is first established to evaluate the solar radiation density at discrete locations. A modified particle swarm optimization method is applied to search for a minimal time path wherein the energy gathered is equal to or greater than the energy expended. The proposed modelling and optimization strategy is verified through computer simulation and experimental demonstration.

Key words: Solar-powered robotic systems, Solar-powered unmanned ground vehicle, Particle swarm optimization, path planning, and power management.

LIST OF FIGURES

SYMBOLS & ABBREVIATIONS

ACRONYM	ABBREVIATION
UGV	Unmanned Ground Vehicle
IEDs	Improvised Explosive Devices
DRDO	Defence Research And Development Organization
UAV	Unmanned Aerial Vehicle
GA	Genetic Algorithm
DRL	Deep Reinforcement Learning
RPN	Region Proposal Network
TSP	Traveling Salesman Problem
GPS	Global positioning system
Li-poly	Lithium polymer
PV	Photo-voltaic
DC	Direct current

CHAPTER-1
INTRODUCTION

1.1 Unmanned Ground Vehicle (UGV)

An unmanned ground vehicle (UGV) is a vehicle that touches the ground and has the ability to function and perform task without any human on board. Automated vehicles can operate off-road and on-road while navigating, and can be used in military operations such as bomb detection, border patrol, cargo transport, search, rescue, etc. to reduce the danger to the soldiers and to fulfill other tasks. UGVs can be used in many applications where driver presence may be inconvenient, dangerous or impossible. Vehicles typically have a number of sensors that monitor the surroundings and make autonomous decisions about vehicle behavior or communicate information to other operators who will be driving the UGV. These types of vehicles mainly use sensors to monitor their surroundings and automatically make their own decisions in unpredictable situations and unknown information, or they use this information to transmit this information through various means of communication to the operator controlling the UGV when assistance is needed. These UGVs can send visual feedback to ground station operators. We have proposed four main UGV specifications. Metal detectors and robots that search for metal or bombs have fire extinguishers. The UGV is tasked with patrolling the border between the two areas without human guidance.

In many unmanned systems, an increased vehicle endurance is directly proportional to a reduction in operating expenditures (power, fuel, etc.). Several approaches have been proposed to prolong a vehicle’s operating time, such as energy efficient path planning and the application of power consumption models and saving strategies under different paths.

The basic functioning of a UGV is that it operates in contact with the ground and without any on-board or explicit human presence. The most advantageous application of UGVs is that it can be used in an environment where it may be inconvenient, dangerous, or impossible to have a human operator present. Usually, the UGV vehicle accommodates few sensors to observe and analyse the environment, and then it will either communicate with its human operator to pass on the existing information and take further decisions or automatically tune itself to react to the environment. If it has to choose to pass on the information to the human operator then all its teleoperation will be conducted under the human operator. These UGVs have successfully proved themselves to be the land-based counterpart to various unmanned aerial and ground vehicles. One of the main reasons for the development of these UGVs is to perform a variety of dull, dangerous, and louring activities for both civilians and the military people.

Based on its application and significance UGVs include the following components:

1. Platform
2. Sensors
3. Guidance Interface
4. Communication link
5. System Integration Features

UGV for military purposes must have a robust chassis which can give better results in all-terrain. The main objective of our project is to carry the load consisting of first aids, necessary equipment required for soldiers. UGV includes some sensors which are used for navigation, another is environment detection. Sensors can include compasses, odometers, gyroscopes, cameras for triangulation, laser, and ultrasound range finders, and infrared technology. Unmanned ground vehicles are mostly Remote-Operated and Autonomous, although Supervisory Control is used to refer to situations in which a combination of decision-making by UGV systems and the remote human controller. UGV contains a tank to drive to tackle all types of terrains and to continuously assist the soldiers. UGV carries all types of loads or the extra ammo for soldiers and automatically follows them with the help of GPS communication. We can also use this kind of system for soldier tracking from base camp which is very useful in dangerous areas. UGV provides service in all terrains.

An **unmanned ground vehicle** (**UGV**) is a military robot used to augment the soldier’s capability. This type of robot is generally capable of operating outdoors and over a wide variety of terrain, functioning in place of humans. UGVs have counterparts in aerial warfare (unmanned aerial vehicle) and naval warfare (remotely operated underwater vehicles). Unmanned robotics is actively being developed for both civilian and military use to perform dull, dirty, and dangerous activities.

There are two general classes of unmanned ground vehicles:

1. Tele-operated
2. Autonomous.

1.1.1 Tele-operated UGV

A Tele-operated UGV is a vehicle that is controlled by a human operator at a remote location via a communications link. All cognitive processes are provided by the operator based upon sensory feedback from either line-of-sight visual observation or remote sensory input such as video cameras. A basic example of the principles of Tele-operation would be a toy remote control car. Each of the vehicles is unmanned and controlled at a distance via a wired or wireless connection while the user provides all control based upon observed performance of the vehicle.

There are a wide variety of Tele-operated UGVs in use today. Predominantly these vehicles are used to replace humans in hazardous situations. Examples are explosives and bomb disabling vehicles.

1.1.2 Autonomous UGV

An autonomous UGV is essentially an autonomous robot but is specifically a vehicle that operates on the surface of the ground. A fully autonomous robot in the real world has the ability to:

- Gain information about the environment.
- Work for extended durations without human intervention.
- Travel from point A to point B, without human navigation assistance.
- Avoid situations that are harmful to people, property or itself, unless those are part of its design specifications
- Repair itself without outside assistance.
- Detect objects of interest such as people and vehicles.

A robot may also be able to learn autonomously. Autonomous learning includes the ability to:

- Learn or gain new capabilities without outside assistance.
- Adjust strategies based on the surroundings.
- Adapt to surroundings without outside assistance.

Autonomous robots still require regular maintenance, as with all machines.

1.2 Motivation

Daksh is an electrically powered and remotely controlled robot used for locating, handling and destroying hazardous objects safely. Daksh speaks for the ingenuity of the R&DE (E). It is a battery-operated robot on wheels and its primary role is to recover improvised explosive devices (IEDs). It locates IEDs with an X-ray machine, picks them up with a gripper-arm and defuses them with a jet of water. It has a shotgun, which can break open locked doors, and it can scan cars for explosives. Daksh can also climb staircases, negotiate steep slopes, navigate narrow corridors and tow vehicles. Alok Mukherjee, a scientist, said: "With a master control station (MCS), it can be remotely controlled over a range of 500 m in line of sight or within buildings. Ninety per cent of the robot's components are indigenous. Figure 1.2.1 shows Daksh - Remotely Operated Vehicle developed by DRDO.

Figure 1.2.1 Daksh - Remotely Operated Vehicle developed by DRDO

1.3 Solar-Powered Robotic Systems for UGVS

There is a great deal of interest in the robotics community in developing long-duration solar-powered robotic systems for UGVs that utilize the energy from the environment and charge storage batteries as backups for sustained operation. For example, the Mars Opportunity Rover, which persistently explores unknown areas on Mars, has been working for ten years using only solar power. Another example is the "cool robot" designed to carry payloads during summer in the Antarctic, where the solar radiation distribution is assumed to be uniform. These examples demonstrate the unique role of long-duration solar-powered robots in both civil and extra-terrestrial applications where a constant power supply is not readily available.

While operational areas such as Mars or the Antarctic may be considered to have a uniform solar energy distribution for some period of time, many environments feature nonuniform distributions which require careful planning, including both power schedule and movement plan, to make the most of their available ambient energy. Despite this, research on solar-powered vehicles has focused primarily on their design aspects, i.e., reasonable dimensions, payload, weight, etc. On the other hand, the energy efficient deployment and operation of UGVs using non-renewable energy in surveillance, monitoring or tracking missions has received much attention. Examples include power allocation among UGVs to maintain area coverage, path planning to explore unknown areas with limited power, power consumption models and conservation strategies in path searching, among others. However, little attention has been paid to simultaneous energy harvesting and power management of solar-powered unmanned vehicles. Although dynamic power management microcontrollers have been investigated and implemented in unmanned vehicles, these controllers simply allocate power according to the solar energy available to the system at each moment, where available power is first allocated to the motors to maintain motion, and the remainder is used to charge a backup battery. Without long-term mission planning, such controllers cannot guarantee persistent operation and global optimal performance in nonuniform solar radiation distribution area.

For example, consider a vehicle equipped with a solar panel which must traverse an area with a nonuniform solar energy distribution through a subregion which offers little available solar power. For missions that require minimal travel time while constraining the vehicle's net energy change, it is insufficient to travel at a constant energy-efficient speed. The vehicle would instead benefit from using knowledge of the area's solar energy density to generate a motion plan such that the vehicle would travel quickly through low-energy regions and slowly enough through high-energy areas so that it would satisfy its energy constraint.

This project describes an integrated path planning and power management method to minimize the travel time of a solar-powered UGV though an area of known energy distribution, subject to a net energy constraint, by optimizing the UGV's path and power allocation schedule against a scalar field interpolation of solar radiation distribution. Characterizing solar radiation distributions is a nontrivial problem; previous research has emphasized the importance of precise estimation of the solar radiation distribution and its impact on mission success for solar-powered UGVs.

CHAPTER-2
LITERATURE SURVEY

Tang et al., (2022) given an analysis and description of the CA functions, including the CA process, state sensing, conflict detection, and conflict resolution. Then, an overview of the recent progress in CA technologies is systematically provided, particularly in terms of sensing techniques, conflict detection, and conflict resolution. The state-sensing methods include ground-based and air-based sensing technologies, and cooperative and non-cooperative sensing. The conflict-detection methods contain conflict detection with certainty and without certainty. The conflict-resolution methods include methods for individual UAVs and for UAV formation. In addition, several challenging problems are introduced to develop a lucid research direction. This review gives a unique perspective and contributes toward the further development of CA approaches for UAVs.

Fei et al., (2022) studied a UAV pair-supported relaying in unknown IoT systems, which consists of transmitter and receiver. Their goal is that transmitter gathers the data from each device then transfers the information to receiver, and receiver finally transmits the information to the destination, while meeting the constraint that the amount of information received from each device reaches a certain threshold. This is an optimization problem with highly coupled variables, such as trajectories of transmitter and receiver. On account of no prior knowledge of the environment, a dueling double deep Q network (dueling DDQN) algorithm is proposed to solve the problem. Whether it is in the phase of transmitter's receiving information or the phase of transmitter's forwarding information to receiver, the effectiveness and superiority of the proposed algorithm is demonstrated by extensive simulations in comparison to some base schemes under different scenarios.

Chandrakanth et al., (2022) aimed to address this limitation and propose a deep learning-based algorithm for terminal guidance of aerial vehicle BVR with only bearing information about the target of interest. The algorithm operates in search and track modes. they describe both the modes and also discuss the challenges associated with this kind of deployment in real time. Since the weight and power requirements of the payload directly translate to the cost of deployment and endurance of aerial vehicles, they have configured a custom lightweight convolutional neural network (CNN) with minimal layers and successfully deployed the system on Jetson Nano, the smallest GPU available from NVIDIA as of this writing. We evaluated the performance of the proposed algorithm on proprietary and open-source datasets and achieved detection accuracy greater than 98.6% on custom datasets.

Yuan et al., (2022) proposes an area coverage path planning method for a fixed-wing unmanned aerial vehicle (UAV) based on an improved genetic algorithm. The algorithm improves the primary population generation of the traditional genetic algorithm, with the help of better crossover operator and mutation operator for the genetic operation. More specifically, the good point set algorithm (GPSA) is first used to generate a primary population that has a more uniform distribution than that of the random algorithm. Then, the heuristic crossover operator and the random interval inverse mutation operator are employed to reduce the risk of local optimization. The proposed algorithm is verified in tasks with different numbers of paths. A comparison with the conventional genetic algorithm (GA) shows that our algorithm can converge to a better solution.

Chen et al., (2021) study focused on the automatic path planning of heterogeneous UAVs with different flight and scan capabilities, and try to present an efficient algorithm to produce appropriate paths for UAVs. First, models of heterogeneous UAVs are built, and the automatic path planning is abstracted as a multi-constraint optimization problem and solved by a linear programming formulation. Then, inspired by the density-based clustering analysis and symbiotic interaction behaviours of organisms, an adaptive clustering-based algorithm with a symbiotic organisms search-based optimization strategy is proposed to efficiently settle the path planning problem and generate feasible paths for heterogeneous UAVs with a view to minimizing the time consumption of the search tasks. Experiments on randomly generated regions are conducted to evaluate the performance of the proposed approach in terms of task completion time, execution time and deviation ratio.

Tang et al., (2021) this paper introduces a CPP method based on a Region Optimal Decomposition (ROD) that overcomes this limitation when applied to the path planning of an Unmanned Aerial Vehicle (UAV) in a port environment. The principle of the approach is to first apply a ROD to a Google Earth image of a port and combining the resulting sub-regions by an improved Depth-First-Search (DFS) algorithm. Finally, a genetic algorithm determines the traversal order of all sub-regions. The simulation experiments show that the combination of ROD and improved DFS algorithm can reduce the number of turns by 4.34%, increase the coverage rate by more than 10%, and shorten the non-working distance by about 29.91%.

Overall, the whole approach provides a sound solution for the CPP and operations of UAVs in port environments.

Lei et al., (2021) focused on the applications of UAVs based remote sensing of different traits with different phenotyping sensors. In this review, the UAVs platforms and the phenotyping sensors were briefly introduced. The applications of UAVs to obtain and analyze plant phenotype traits were introduced and summarized by the traits in a more comprehensive way. A comparison of different phenotyping sensors was conducted. Furthermore, the challenges and future prospects of phenotype information acquisition and data analysis using UAVs as remote sensing platforms were also discussed. Since the current studies from various countries and researchers were fragmented to just explore the feasibility of UAVs based high-throughput phenotyping, this review aimed to provide the researchers and readers the current applications of UAVs for high-throughput phenotyping and how the studies were conducted, provide guidelines for future studies.

Chen et al., (2021) studied the coverage path planning problem of autonomous heterogeneous UAVs on a bounded number of regions. First, with models of separated regions and heterogeneous UAVs, they propose an exact formulation based on mixed integer linear programming to fully search the solution space and produce optimal flight paths for autonomous UAVs. Then, inspired from density-based clustering methods, they design an original clustering-based algorithm to classify regions into clusters and obtain approximate optimal point-to-point paths for UAVs such that coverage tasks would be carried out correctly and efficiently. Experiments with randomly generated regions are conducted to demonstrate the efficiency and effectiveness of the proposed approach.

Theile et al., (2021) proposed a new method to control an unmanned aerial vehicle (UAV) carrying a camera on a CPP mission with random start positions and multiple options for landing positions in an environment containing no-fly zones. leverage end-to-end reinforcement learning (RL) to learn a control policy that generalizes over varying power constraints for the UAV. By using map-like input channels to feed spatial information through convolutional network layers to the agent, they are able to train a double deep Q-network (DDQN) to make control decisions for the UAV, balancing limited power budget and coverage goal. The proposed method can be applied to a wide variety of environments and harmonizes complex goal structures with system constraints.

Biundini et al., (2021) studied the Coverage Path Planning (CPP) at finding the best path to coverage of a determined area respecting the operation's restrictions. Photometric information from the terrain is used to create routes or even refine paths already created. Therefore, this research's main contribution is developing a methodology that uses a metaheuristic algorithm based on point cloud data to inspect slope and dams structures. The technique was applied in a simulated and real scenario to verify its effectiveness. The results showed an increasing 3D reconstructions' quality observing optimizing photometric and mission time criteria.

Liu et al., (2020) they aimed to design a fully-distributed control solution to navigate a group of unmanned aerial vehicles (UAVs), as the mobile Base Stations (BSs) to fly around a target area, to provide long-term communication coverage for the ground mobile users. Different from existing solutions that mainly solve the problem from optimization perspectives, we proposed a decentralized deep reinforcement learning (DRL) based framework to control each UAV in a distributed manner. Our goal is to maximize the temporal average coverage score achieved by all UAVs in a task, maximize the geographical fairness of all considered point-of-interests (PoIs), and minimize the total energy consumptions, while keeping them connected and not flying out of the area border. We designed the state, observation, action space, and reward in an explicit manner, and model each UAV by deep neural networks (DNNs). We conducted extensive simulations and found the appropriate set of hyperparameters, including experience replay buffer size, number of neural units for two fully-connected hidden layers of actor, critic, and their target networks, and the discount factor for remembering the future reward. The simulation results justified the superiority of the proposed model over the state-of-the-art DRL-EC3 approach based on deep deterministic policy gradient (DDPG), and three other baselines.

Wu et al., (2019) they proved that deep reinforcement learning can be successfully applied to an ancient puzzle game Nokia Snake after further processing. A game with four directions of movement. Through deep intensive learning and training, the Snake (or self-learning Snake) learns to find the target path autonomously, and the average score on the Snake Game exceeds the average score on human level. This kind of Snake algorithm that can find the target path autonomously has broad prospects in the industrial field, such as: UAV oil and gas field inspection, Use drones to search for and rescue injured people after a complex disaster. As we all know, post-disaster relief requires careful staffing and material dispatch. There are many factors that need to be considered in the artificial planning of disaster relief. Therefore, they designed a drone that can search and rescue personnel and dispatch materials. Current drones are quite mature in terms of automation control, but current drones require manual control. Therefore, the Snake algorithm proposed here to be able to find the target path autonomously is an attempt and key technology in the design of autonomous search and rescue personnel and material dispatching drones.

Yao et al., (2019) aimed to generate UAV feasible routes which maximize the cumulative probability of finding a single and stationary target within the required time. First, Gaussian mixture model is used to approximate the prior likelihood distribution, and several river segments with high detection probability corresponding to Gaussian components can be extracted. With the consideration of quantified factors, the river subregions are prioritized by the approximation insertion method and then allocated to UAVs. Moreover, to meet the terminal time constraint, the so-called positive/negative greedy method is proposed to expand or contract waypoints. Finally, the performance of our proposed algorithm is evaluated by simulations on a real river map, and the results verify its good performance in various scenarios.

Wang et al., (2019) proposed a deep reinforcement learning (DRL)-based method that allows unmanned aerial vehicles (UAVs) to execute navigation tasks in large-scale complex environments. This technique is important for many applications such as goods delivery and remote surveillance. The problem is formulated as a partially observable Markov decision process (POMDP) and solved by a novel online DRL algorithm designed based on two strictly proved policy gradient theorems within the actor-critic framework. In contrast to conventional simultaneous localization and mapping-based or sensing and avoidance-based approaches, their method directly maps UAVs' raw sensory measurements into control signals for navigation. Experiment results demonstrate that our method can enable UAVs to autonomously perform navigation in a virtual large-scale complex environment and can be generalized to more complex, larger-scale, and three-dimensional environments. Besides, the proposed online DRL algorithm addressing POMDPs outperforms the state-of-the-art.

Challita et al., (2019) studied an interference-aware path planning scheme for a network of cellular-connected unmanned aerial vehicles (UAVs) is proposed. In particular, each UAV aims at achieving a tradeoff between maximizing energy efficiency and minimizing both wireless latency and the interference caused on the ground network along its path. The problem is cast as a dynamic game among UAVs. To solve this game, a deep reinforcement learning algorithm, based on echo state network (ESN) cells, is proposed. The introduced deep ESN architecture is trained to allow each UAV to map each observation of the network state to an action, with the goal of minimizing a sequence of time-dependent utility functions. Each UAV uses the ESN to learn its optimal path, transmission power, and cell association vector at different locations along its path. The proposed algorithm is shown to reach a subgame perfect Nash equilibrium upon convergence. Moreover, an upper bound and a lower bound for the altitude of the UAVs are derived thus reducing the computational complexity of the proposed algorithm. The simulation results show that the proposed scheme achieves better wireless latency per UAV and rate per ground user (UE) while requiring a number of steps that are comparable to a heuristic baseline that considers moving via the shortest distance toward the corresponding destinations. The results also show that the optimal altitude of the UAVs varies based on the ground network density and the UE data rate requirements and plays a vital role in minimizing the interference level on the ground UEs as well as the wireless transmission delay of the UAV.

Cui et al., (2016) this paper presents a navigation system that enables small-scale unmanned aerial vehicles to navigate autonomously using a 2D laser range finder in foliage environment without GPS. The navigation framework consists of real-time dual layer control, navigation state estimation and online path planning. The navigation state estimation consists of real-time onboard motion estimation and trajectory smoothing using the GraphSLAM technique. The onboard real-time motion estimation is achieved by a Kalman filter, fusing the planar velocity measurement from matching the consecutive scans of a laser range finder and the acceleration measurement of an inertial measurement unit. The trajectory histories from the real-time autonomous navigation together with the observed features are fed into a sliding-window based pose-graph optimization framework. The online path planning module finds an obstacle-free trajectory based the local measurement of the laser range finder. The performance of the proposed navigation system is demonstrated successfully on the autonomous navigation of a small-scale UAV in foliage environment.

Lee and Kim (2016) they proposed an effective initialization method for genetic algorithm-based robot path planning. Experimental results comparing genetic algorithms with conventional initialization methods and the proposed initialization method showed that the proposed method leads to high quality paths in a significantly shorter execution time.

Ren et al., (2016) introduced a Region Proposal Network (RPN) RPN is trained end-to-end to generate high-quality region proposals, which are used by Fast R-CNN for detection. They further merge RPN and Fast R-CNN into a single network by sharing their convolutional features---using the recently popular terminology of neural networks with 'attention' mechanisms, the RPN component tells the unified network where to look. For the very deep VGG-16 model, our detection system has a frame rate of 5fps (including all steps) on a GPU, while achieving state-of-the-art object detection accuracy on PASCAL VOC 2007, 2012, and MS COCO datasets with only 300 proposals per image. In ILSVRC and COCO 2015 competitions, Faster R-CNN and RPN are the foundations of the 1st-place winning entries in several tracks. Code has been made publicly available.

Chee and Zhong (2013) reports the development of an unmanned aerial vehicle capable of attitude estimation and stabilization through the implementation of a nonlinear complementary filter and proportional-integral rate controllers. Four infra-red sensors and an ultrasonic sensor are integrated with the main platform for the collision avoidance schemes and for altitude control, respectively. Critical mission capabilities for the vehicle such as altitude hold and collision avoidance are developed. An outdoor navigation scheme and collision avoidance algorithms are also proposed to enhance the vehicle autonomy. Experimental results have shown that the implemented attitude and altitude controllers are effective and the platform is capable of navigating autonomously with user-defined waypoints. The collision avoidance algorithms allow the platform to avoid obstacles, both reactively and in the midst of navigation routines.

Sujit et al., (2013) Unmanned Aerial Vehicles (UAVs) equipped with downward-facing, low-cost cameras can be used for terrain mapping. Using a photogrammetric technique, structure from motion, one can create accurate models for less cost than current methods. During mapping, images at certain locations (points of interest (POIs) need to be taken from specified directions due to environmental conditions. As the area that needs to be mapped increases the number of POIs increase. Therefore, we need a route planning algorithm that can determine efficient paths taking kinematic constraints of the vehicle and the angle of arrival at the POIs into account. To determine an efficient solution, They cast the routing problem as a Traveling Salesman Problem (TSP) with angular constraints, and develop two new solutions based on multi-lookahead and multi-neighbour strategies. Simulations are carried out to evaluate the performance of the algorithms.

CHAPTER-3
PROPOSED SYSTEM

Navigation of UGV plays an important role for its successful operation. Further the navigation system requires the exact location of the UGV at every instant of time. To locate UGV generally GPS is used. But the main problem with GPS are not reliable everywhere, at the same time error in positioning GPS is very high with respect to the size of the UGV. Hence I am highly motivated to design a relative positioning of UGV where GPS signal is weak and also to locate the UGV with respect to controller reference.

The development path of UGVs is still very challenging and problematic. Due to its autonomous nature, many factors are involved in raising societal impacts and technological and ethical concerns. With the reduction in defence budgets due to the pandemic, countries like India, South Korea, Russia, and Thailand have reduced and paused their defence expenditure in the AV industry. One of the biggest challenges with autonomous vehicles is technology advancement, which is not at the stage where the perception of the environment is entirely predictable, and there are still many unforeseen dangers involved with it. Some other challenges include lack of communication technology, planning and policies and regulations. The maintenance of security and integrity of such systems is highly vulnerable and needs to be addressed. The policymakers need to streamline, structure and regulate the autonomous system considering its diverse nature of vehicles, their operating constraints and capabilities.

The autonomous segment in UGVs will certainly see the highest growth in the defence sector with the increased use of small UGV and smart robots for military combat. These systems will have advanced AI, ML, and autonomous navigation capabilities that will allow UGVs to manoeuvre from pre-programmed locations and follow army convoys. The growth will be attributed to the growing defence needs and budgets and the increasing procurement of advanced robots for military operations. India needs a collaborative effort from all stakeholders, for which the Indian government needs to regularise and come up with a firm policy for autonomous vehicles. India has enunciated the indigenous development of combat systems and weapons with DRDO and its affiliates, and military–civil fusion will be a significant acolyte in this for the future of India's defence set-up. AVs will be an indispensable part of our lives, and therefore, it is necessary to understand the future technology needs of the military, as the future battlefield will be a rundown of high tech enabled unmanned systems that will overcome the challenges of sustaining legacy forces and keeping human combatants safe from harm's way.

3.1 Block Diagram of the Proposed System

An autonomous UGV (AGV) is essentially an autonomous robot that operates without the need for a human controller on the basis of artificial intelligence technologies. 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 AGV is completing

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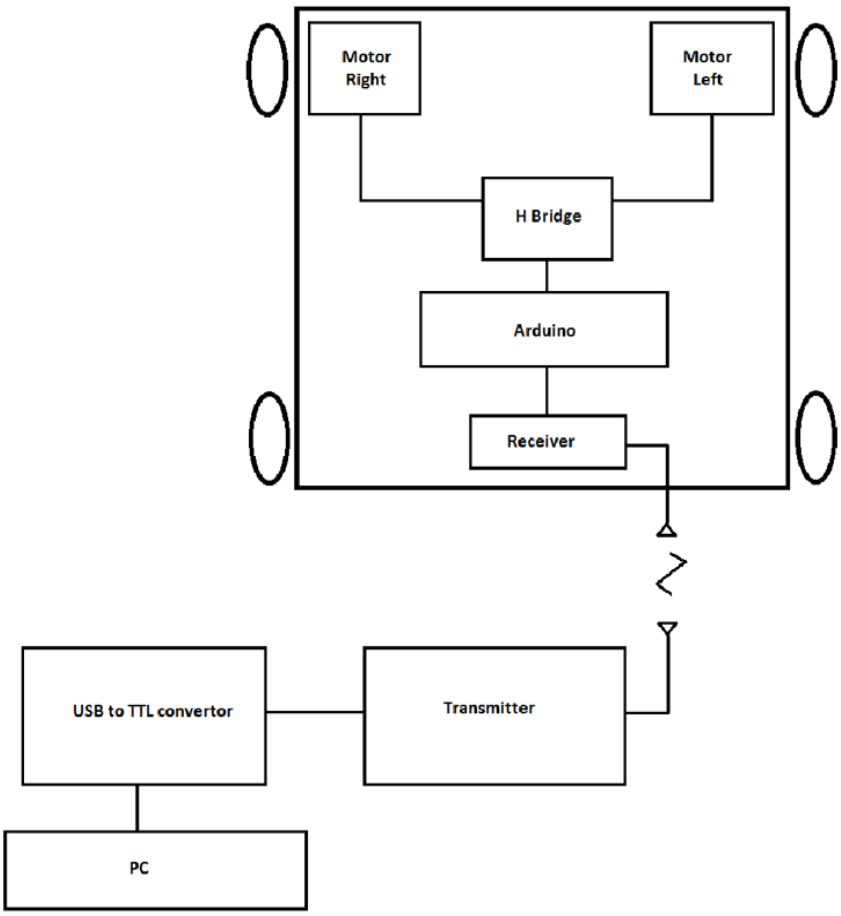


Figure 3.1 Vehicle power system block diagram

Common 5V DC motor is used. In this particular vehicle, the motors are mounted at the back end and each of them drives one of the front wheels through separate transmission. This system helps in turning the vehicle left or right using H-bridge. I've given separate 9V supply to the motors. Arduino pro-mini board is used to control the circuitry. The board has ATMEGA328 controller along with the necessary components.

H-Bridge :Four 5V relays and few other components are used to realize an H-bridge. A maximum number of 3 relays are required to be triggered at any given time

CHAPTER-4
HARDWARE DESCRIPTION

4.1 Arduino Microcontroller

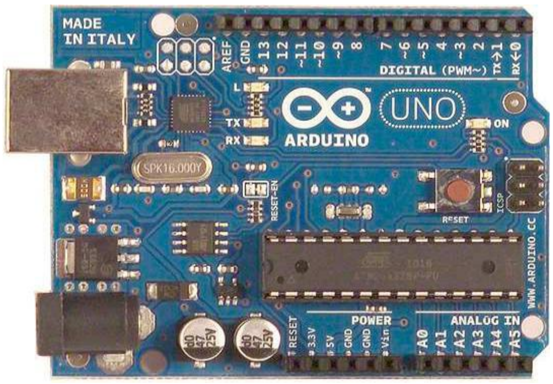


Figure 4.1.1 Arduino Uno Microcontroller (ATMEGA-328P)

For a vehicle to be capable of both executing and validating the prescribed motion plan, it must be capable of effectively gathering ambient solar energy and converting it to the operating voltage level, while also measuring the incoming and outgoing energy of the system. The demonstration vehicle, pictured in Fig. 2, is based on a Dagu 5 robot chassis [28] controlled by an Arduino Uno [29] and a wireless modem. The ambient solar energy is gathered through a top-mounted 18 W solar panel, which indicates the approximate intake power for this solar panel is 18 W under bright sunlight, i.e., a solar radiation density of 1kW/m^2.

4.2 Arduino Benefits

“Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software.” The open-source Arduino env ironment makes it easy to write code and upload it to the i/o board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing, avr-gcc, and other open source software.

ATMEGA 328P

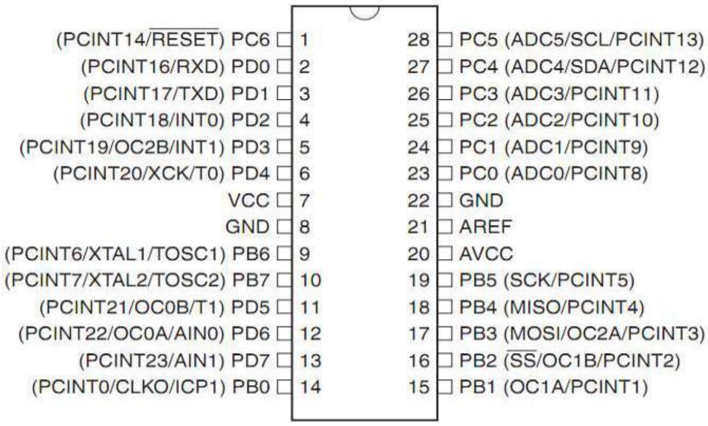


Figure 4.1.2 Pin Diagram Of ATMEGA 328P

PIN DESCRIPTIONS

1. **VCC-** Digital supply voltage.
2. **GND**- Ground.
3. **Port B (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2**

   Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit).The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

   Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

   Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier.

   If the Internal Calibrated RC Oscillator is used as chip clock source, PB7. . .6 is used as TOSC2...1 input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

4. **Port C (PC5:0)**

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5...0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

5. **PC6/RESET**

   If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C.

   If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running.Shorter pulses are not guaranteed to generate a Reset.

6. **Port D (PD7:0)**

   Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

7. **AVCC**

   AVCC is the supply voltage pin for the A/D Converter, PC3:0, and ADC7:6. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

8. **AREF**- AREF is the analog reference pin for the A/D Converter.

9. **ADC7:6**

   In the TQFP and QFN/MLF package, ADC7:6 serve as analog inputs to the A/D converter.

These pins are powered from the analog supply and serve as 10-bit ADC channels.

4.3 Servo Motors

A **servomechanism**, or **servo**, is an automatic device that uses error-sensing negative feedback to correct the performance of a mechanism. The term correctly applies only to systems where the feedback or error-correction signals help control mechanical position or other parameters. For example, the car's cruise control uses closed loop feedback, which classifies it as a servomechanism.

RC servos are hobbyist remote control devices servos typically employed in radio-controlled models, where they are used to provide actuation for various mechanical systems. Due to their affordability, reliability, and simplicity of control by microprocessors, RC servos are often used in small-scale robotics applications.RC servos are composed of an electric motor mechanically linked to a potentiometer. A standard RC receiver sends Pulse-width modulation (PWM) signals to the servo. The electronics inside the servo translate the width of the pulse into a position. When the servo is commanded to rotate, the motor is powered until the potentiometer reaches the value corresponding to the commanded position. RC servos use a three-pin 0.1" spacing jack (female) which mates to standard 0.025" square pins (which should be gold-plated, incidentally). The most common order is Signal, +voltage, ground. The standard voltage is 6VDC, however 4.8V and 12V has also been seen for a few servos. The control signal is a digital PWM signal with a 50Hz frame rate. Within each 20ms timeframe, an active-high digital pulse controls the position. The pulse nominally ranges from 1.0ms to 2.0ms with 1.5ms always being center of range. Pulse widths outside this range can be used for "over travel" -moving the servo beyond its normal range. This PWM signal is sometimes (incorrectly) called Pulse Position Modulation (PPM).

The servo is controlled by three wires: ground, power, and control. The servo will move based on the pulses sent over the control wire, which set the angle of the actuator arm. The servo expects a pulse every 20 ms in order to gain correct information about the angle. The width of the servo pulse dictates the range of the servo's angular motion. A servo pulse of 1.5 ms width will typically set the servo to its "neutral" position or 45°, a pulse of 1.25 ms could set it to 0° and a pulse of 1.75 ms to 90°. The physical limits and timings of the servo hardware varies between brands and models, but a general servo's angular motion will travel somewhere in the range of 90° - 120° and the neutral position is almost always at 1.5 ms. This is the "standard pulse servo mode" used by all hobby analog servos. RC servos are usually powered by the receiver which in turn is powered by battery packs or an Electronic speed controller (ESC) with an integrated or a separate Battery eliminator circuit (BEC). Common battery packs are either Ni-Cd, NiMH or lithium-ion polymer battery (Li-Po) type. Voltage ratings vary, but most receivers are operated at 5 V or 6 V.

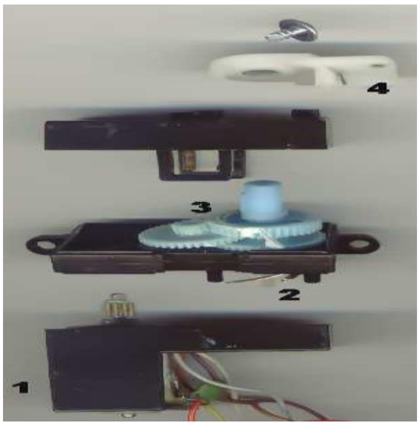


Figure 4.3.1 Servo motors

4.4 Battery

Lithium-ion polymer battteries, polymer lithium ion, or more commmonly lithium polymer batteries (abbreviated Li-poly, Li-Pol, LiPo, LIP, PLI or LiP) are rechargeable batteries (secondary cell batteries). Normally batteries are composed of several identical secondary cells in parallel addition too increase the discharge current capability.

This type has technologiccally evolved from lithium-ion batteries. Thee primary difference is that the lithium-salt e lectrolyte is not held in an organic solvent but in a solid polymer composite such as polyethylene or polyacrylonitrile. The advantages of Li-ion polymer over the lithium-ion design include potentially lower cost of manufacture, adaptability to a wide variety of packaging shapes, and ruggedness.

The voltage of a Li-poly cell varies from about 2.7 V (discharged) to about 4.23 V (fully charged), and Li-poly cellls have to be protected from overcharge by limiting the applied voltage to no more than 4.235 V per cell used in a series combination. Overcharging a Li-poly battery can cause an explosion or fire.

4.5 Solar Panel

Figure 4.5.1 Solar panel

A solar cell panel, solar electric panel, or solar panel, also known as a photo-voltaic (PV) module or PV panel, is an assembly of photovoltaic solar cells mounted in a (usually rectangular) frame. Solar panels capture sunlight as a source of radiant energy, which is converted into electric energy in the form of direct current (DC) electricity.

CHAPTER-5

SOFWARE DESCRIPTION

5.1 ARDUINO

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicate with software running on your computer (e.g. Flash, Processing, MaxMSP.) The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems: Inexpensive - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50

Cross-platform - The Arduino software runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows. Simple, clear programming environment - The Arduino programming environment is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with the look and feel of Arduino

Open source and extensible software- The Arduino software and is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.

CHAPTER-6
APPLICATIONS

- RECONNAISSANCE- Also known as Scouting, is the military term for performing a preliminary survey, especially an exploratory military survey, to gain or collect information.
- BOMB DISPOSAL- Used in defusing and deactivating Explosives as a result of which an added feature a robotic arm can be added.
- SEARCH AND RESCUE-In times of Natural calamities or man based disasters, it proves to be a reliable machine to locate people or objects with ease where it renders human effort futile.
- BORDER PATROL AND SURVEILLANCE- In times of military warfare or border encroachment, it is used to monitor alien force entering into the territory.
- ACTIVE COMBAT SITUATIONS- Widely used on the battlefield, UGVs equipped with Explosives, Weaponry and shields have proven to be handy expendables assets without the cost of human life
- STEALTH COMBAT OPERATIONS- Spying purpose without coming into the radar of the enemy is effective in war strategies.
- NEW EXPLORATIONS – Deep cave searches, underwater e xplorations and the currently executing Mars and outer planets exploration can be performed.
- To undertake dangerous missions which involves loss of human life.

CHAPTER-7
RESULTS

An unmanned ground vehicle (UGV) is a vehicle that operates while in contact with the ground and without an onboard human presence. UGVs can be used for many applications where it may be inconvenient, dangerous, or impossible to have a human operator present. 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. The UGV is the land-based counterpart to unmanned aerial vehicles and unmanned underwater vehicles. Unmanned robotics are being actively developed for both civilian and military use to perform a variety of dull, dirty, and dangerous activities. Figure 7.1 shows Solar panel UGV integrated with sensor

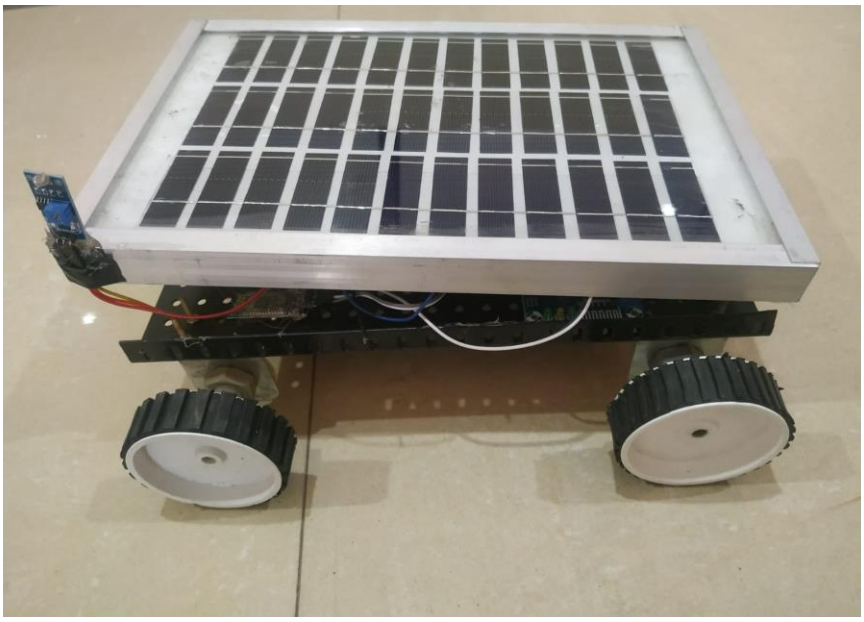


Figure 7.1 Solar panel UGV integrated with sensor (front side)

It is very important to mechanical design the UGV according to the application to maximize its performance. There are a number of factors to be considered before we first move to mechanical design these parameters are defined from application perspective each design have its own advantages and disadvantage. For example, consider a military based UGV for the surveillance purposes, now the mechanical design should be rugged to withstand the harsh environment. It should be able move in the off-road environment and agility is also a very dominant design factor, a differential drive could be implemented for that purpose. We are using a robust all-terrain mechanical chassis as the platform for our UGV which has off-terrain rugged wheels and a decent suspends ion system. A DC motor with gear box is used to drive both of the rear wheels and a servo motor is used to steer the front wheels right or left. Figure 7.2 shows Solar panel UGV (rear side)

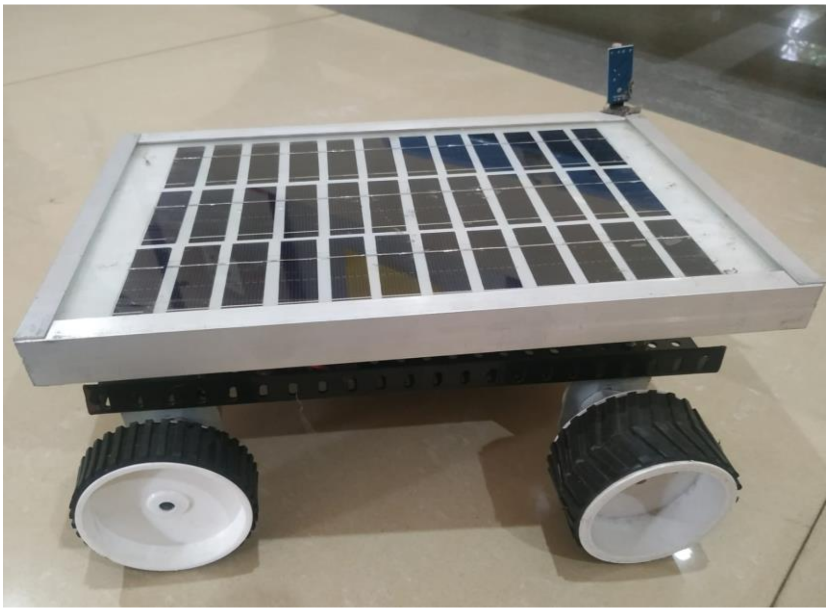


Figure 7.2 Solar panel UGV (rear side)

CHAPTER-8

CONCLUSION & FUTURE SCOPE

8.1 Conclusion

This project to be investigated an integrated path planning and power management method for a solar powered unmanned ground vehicle (UGV) which minimized the vehicle's travel time subject to net energy and power constraints. Virtual and real-world experiments, to be conducted in an indoor test environment, show that a differential-drive, power-constrained UGV operating under an optimized Pseudo-Dubins curve travelled across a known area more quickly than if conducted according to a naive straight line or an optimized Balkcom-Mason curve.

8.2 Future Scope

Unmanned Ground Vehicles, are controlled autonomous ground vehicles designed to complete the duties of soldiers while minimizing human supervision. These robots for military use can work outdoors on various terrains. UGVs result from a successful blend that combines artificial intelligence computers, computer technology, and cutting-edge processor technology.

In future, it will come with various sensors, cameras, and arms attached to their bodies. The UGV, as a big dog, is created as a four-legged bot; it can carry heavy items designed to carry soldiers. It can transport loads on uneven terrain. Robots like Packbots are small, light, and durable, and armies on their backs can carry them. They are controlled by the Pentium processor specifically designed to stand up to rough treatment; the chassis of Packbot includes a GPS, electronic compass, and temperature sensors integrated into it. Packbot manufacturer iRobot states that Packbot can reach speeds of greater than 8 miles per hour (13 kph), can be used in a matter of minutes, and can stand up to the pressure of a 6-foot (1.8-meter) drop onto concrete - which is equivalent of 400 grams of force. Its design permits it to flip.

REFERENCES

1 Tang, J., Lao, S., Wan, Y. Systematic Review of Collision-Avoidance Approaches for Unmanned Aerial Vehicles, IEEE Systems Journal, Volume: 16, Issue: 3, September 2022, Pp. 4356 – 4367.

2 Fei Huang, Guangxia LI, Haichao Wang, Shiwei Tian, Yang Yang, Jinghui Chang. Navigation for UAV Pair-Supported Relaying in Unknown IoT Systems with Deep Reinforcement Learning. The Chinese Journal of Electronics ,Volume31, Issue3, May 2022, pp. 416-429.

3 Chandrakanth, V., Murthy, V.S.N. & Channappayya, S.S. UAV-based autonomous detection and tracking of beyond visual range (BVR) non-stationary targets using deep learning. J Real-Time Image Proc 19, 345–361 (2022).

4 Yuan, J.; Liu, Z.; Lian, Y.; Chen, L.; An, Q.; Wang, L.; Ma, B. Global Optimization of the UAV Area Coverage Path Planning Based on Good Point Set and Genetic Algorithm. Aerospace 2022, 9, 86.

5 Chen, J.; Zhang, Y.; Wu, L.; You, T.; Ning, X. An adaptive clustering-based algorithm for automatic path planning of heterogeneous UAVs. In Transactions on Intelligent Transportation Systems; IEEE: Manhattan, NY, USA, 2021; p. 3131473.

6 Tang, G.; Tang, C.; Zhou, H.; Claramunt, C.; Men, S. R-DFS: A coverage path planning approach based on region optimal decomposition. Remote Sens. 2021, 13, 1525.

7 Lei Feng; Shuangshuang Chen; Chu Zhang; Yanchao Zhang; Yong He. A comprehensive review on recent applications of unmanned aerial vehicle remote sensing with various sensors for high-throughput plant phenotyping . Computers and Electronics in Agriculture, Volume 182, March 2021, 106033.

8 Chen, J.; Du, C.; Zhang, Y.; Han, P.; Wei, W. A clustering-based coverage path planning method for autonomous heterogeneous UAVs. In Transactions on Intelligent Transportation Systems; IEEE: Manhattan, NY, USA, 2021; p. 3066240.

9 Theile, M.; Bayerlein, H.; Nai, R.; Gesbert, D.; Caccamo, M. UAV coverage path planning under varying power constraints using deep reinforcement learning. In Proceedings of the 2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Las Vegas, NV, USA, 24 October–24 January 2021; pp. 1444–1449.

10 Biundini, I.Z.; Pinto, M.F.; Melo, A.G.; Marcato, A.L.M.; Honório, L.M.; Aguiar, M.J.R. A framework for coverage path planning optimization based on point cloud for structural inspection. Sensors 2021, 21, 570.

11 Liu, C.H.; Ma, X.; Gao, X.; Tang, J. Distributed Energy-Efficient Multi-UAV Navigation for Long-Term Communication Coverage by Deep Reinforcement Learning. IEEE Trans. Mob. Comput. 2020, 19, 1274–1285.

12 Wu, C., Ju, B., Wu, Y., Lin, X., Xiong, N., Xu, G., Li, H., Liang, X.: UAV autonomous target search based on deep reinforcement learning in complex disaster scene. IEEE Access 7, 117227–117245 (2019).

13 Yao, P.; Xie, Z.; Ren, P. Optimal UAV Path Planning for Coverage Search of Stationary Target in River. IEEE Trans. Control Syst. Technol. 2019, 27, 822–829.

14 Wang, C., J. Wang, Y. Shen and X. Zhang, "Autonomous navigation of UAVs in large-scale complex environments: A deep reinforcement learning approach", IEEE Trans. Veh. Technol., vol. 68, no. 3, pp. 2124-2136, Mar. 2019.

15 Challita, U.; Saad, W.; Bettstetter, C. Interference management for cellular-connected UAVs: A deep reinforcement learning approach. IEEE Trans. Wirel. Commun. 2019, 18, 2125–2140.

16 Cui, J.Q., Lai, S., Dong, X., Chen, B.M.: Autonomous navigation of UAV in foliage environment. J. Intell. Robot. Syst. 84(1–4), 259–276 (2016).

17 Lee, J.; Kim, D.W. An effective initialization method for genetic algorithm-based robot path planning using a directed acyclic graph. Inf. Sci. 2016, 332, 1–18.

18 Ren, S., He, K., Girshick, R., Sun, J. Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks In: Advances in Neural Information Processing Systems, pp. 91–99 (Jan 2016).

19 Chee, K. and Z. Zhong, "Control navigation and collision avoidance for an unmanned aerial vehicle", Sens. Actuators A Phys., vol. 190, pp. 66-76, 2013.

20 Sujit, P.B.; Hudzietz, B.P.; Saripalli, S. Path Planning for Angle Constrained Terrain Mapping Using an Unmanned Aerial Vehicle. J. Intell. Robot. Syst. 2013, 69, 273–283.

ANNEXURE-A

SOURCE CODE

```
// Motor A connections
int enA = 9;
int in1 = 8;
int in2 = 7;
// Motor B connections
int enB = 3;
int in3 = 5;
int in4 = 4;

void setup() {
        // Set all the motor control pins to outputs
        pinMode(enA, OUTPUT);
        pinMode(enB, OUTPUT);
        pinMode(in1, OUTPUT);
        pinMode(in2, OUTPUT);
        pinMode(in3, OUTPUT);
        pinMode(in4, OUTPUT);

        // Turn off motors - Initial state
        digitalWrite(in1, LOW);
        digitalWrite(in2, LOW);
        digitalWrite(in3, LOW);
        digitalWrite(in4, LOW);
}

void loop() {
        directionControl();
        delay(1000);
        speedControl();
        delay(1000);
}

// This function lets you control spinning direction of motors
void directionControl() {
        // Set motors to maximum speed
        // For PWM maximum possible values are 0 to 255
        analogWrite(enA, 255);
        analogWrite(enB, 255);
```

```
        // Turn on motor A & B
        digitalWrite(in1, HIGH);
        digitalWrite(in2, LOW);
        digitalWrite(in3, HIGH);
        digitalWrite(in4, LOW);
        delay(2000);


                // Now change motor directions
        digitalWrite(in1, LOW);
        digitalWrite(in2, HIGH);
        digitalWrite(in3, LOW);
        digitalWrite(in4, HIGH);
        delay(2000);


        // Turn off motors
        digitalWrite(in1, LOW);
        digitalWrite(in2, LOW);
        digitalWrite(in3, LOW);
        digitalWrite(in4, LOW);
}


// This function lets you control speed of the motors
void speedControl() {
        // Turn on motors
        digitalWrite(in1, LOW);
        digitalWrite(in2, HIGH);
        digitalWrite(in3, LOW);
        digitalWrite(in4, HIGH);

        // Accelerate from zero to maximum speed
        for (int i = 0; i < 256; i++) {
                analogWrite(enA, i);
                analogWrite(enB, i);
                delay(20);
        }
```

```
        // Decelerate from maximum speed to zero
        for (int i = 255; i >= 0; --i) {
                analogWrite(enA, i);
                analogWrite(enB, i);
                delay(20);
        }

        // Now turn off motors
        digitalWrite(in1, LOW);
        digitalWrite(in2, LOW);
        digitalWrite(in3, LOW);
        digitalWrite(in4, LOW);
}
```

ANNEXURE-B

ANNEXURE-B

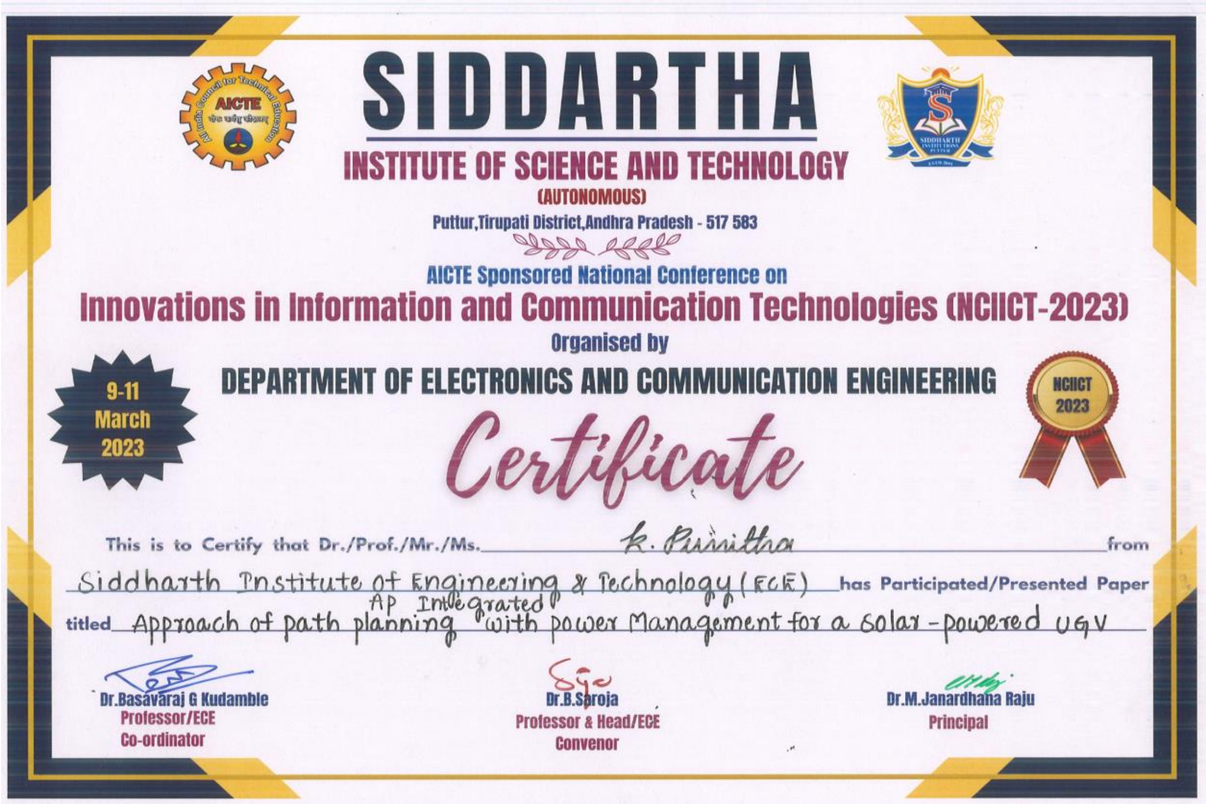
PROJECT BUDGET DETAILS

S.NO	COMPONENT NAME	COST (₹)
1	Solar panel	1400
2	Ultrasonic sensor	500
3	Arduino microcontroller board	750
4	Motor (4No.s)	300
5	Motor Interfacing circuit	500
6	Battery	600
7	Hardware base and wheels	700
8	Adapter and USB cable	300
	Total	**₹5,050**

ANNEXURE-C

ANNEXURE – C

CONFERENCE CERTIFICATES AND PROCEEDING COPY



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NCIICT_126 An Integrated Approach of Path Planning with Power Management for a Solar-Powered UGV

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ABSTRACT: With the advancement of autonomous technology, robotic systems have freed human operators from numerous tedious tasks where system endurance plays a crucial role. The current technology employed in solar-powered automated systems is subject to design, power limitations, and varying environments. Intelligently harvesting energy from the environment and scheduling power consumption to optimize desired system performance will significantly improve the solar robot's endurance. Therefore, the goal of realizing energy autonomy for solar-powered robotic systems motivates this work. This project examines an integrated path planning and power management problem for a solar-powered unmanned ground vehicle (UGV). The proposed method seeks to minimize the travel time of the UGV through an area of known energy density by designing a smooth, heuristically optimized path and allocating the vehicle's power among its electrical components. At the same time, the UGV harvests ambient energy along the designed way to satisfy the mission's strict energy constraints. A scalar field is first established to evaluate the solar radiation density at discrete locations. A modified particle swarm optimization method is applied to search for a minimal time path wherein the energy gathered is equal to or greater than the energy expended. Computer simulation and experimental demonstration verify the proposed modelling and optimization strategy.

NCIICT_127:IoT based organic farming using aquaponic method

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ABSTRACT: IoT (Internet of Things) based organic farming using the aquaponic method with Arduino can be an innovative approach to agriculture. Aquaponics is a method of farming that combines aquaculture (fish farming) and hydroponics (soil-less plant cultivation) in a symbiotic relationship. In an aquaponic system, waste produced by the aquatic animals is broken down by bacteria into nutrients that can be used by the plants, while the plants help to filter the water for the aquatic animals. By using Arduino, a microcontroller, it is possible to automate various aspects of the system, such as monitoring and controlling water temperature, pH, and dissolved oxygen levels, as well as automating the delivery of food to the fish and the watering of the plants. . This can help to optimize the growth of both the plants and the fish, leading to increased efficiency and productivity. Additionally, the use of IoT technology allows for remote monitoring and control of the system, enabling farmers to optimize their operations and make informed decisions about their crops and livestock. Overall, the use of IoT and Arduino in organic farming using the aquaponic method can lead to more sustainable and efficient agriculture practices. The proposed system has the potential to improve the efficiency and sustainability of organic farming, while also reducing the use of chemical fertilizers and pesticides. There is a huge opportunity of the Internet of Things to transform the methodologies applied and processes followed with automation to make operations more efficient leading to better crop yields.

NCIICT_128: Automatic Brain Tumor Tissue Detection based on Hierarchical Centroid Shape Descriptor in T1 weighted MR images.

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ABSTRACT: Finding brain tumor tissue enables the localization of an abnormal cell mass in a slice of magnetic resonance imaging (MR). For post processing of the extracted region of interest, such as tumor segmentation, the automation of this procedure is helpful. This research provides a novel method that combines the k-means method and the hierarchical centroid shape