សាកលវិទ្យាល័យភូមិន្ទភ្នំពេញ

ROYAL UNIVERSITY OF PHNOM PENH

ការសិក្សា និងការរចនាបង្កើតម៉ាស៊ីនកាត់ស្មៅស្វ័យប្រវត្តិដោយ ប្រើ GPS SYSTEM

A Study and Design on Autonomous lawn mower relied on GPS System

A Final Project

In partial fulfillment of the requirement for the degree of

Bachelor of Telecommunication and Electronic Engineering

ឈៀង ខានុន

CHHIENG KHANUN

JULY 2023

សាកលវិទ្យាល័យភូមិន្ទភ្នំពេញ

ROYAL UNIVERSITY OF PHNOM PENH

មហាវិទ្យាល័យវិស្វកម្ម

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Examination Committee:

Dr. Thap Tharoeun	**(Chairperson)**
Dr. Kim Phirun	**(Vice-Chair)**
Professor: Kuong Samnang	**(Member)**

JULY 2023

COMMITTEES APPROVAL

Final Report and Entitled

ការសិក្សា និងការរចនាបង្កើតម៉ាស៊ីនកាត់ស្មៅស្វ័យប្រវត្តិដោយ

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ឈៀង ខានុន

Chhieng Khanun

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Dr. Thap Tharoeun	**Dr. Kim Phirun**
Supervisor	Vice Chair

Professor: Kuong Samnang

Member

Abstract in Khmer

មនុស្សគ្រប់គ្នាឆ្ងល់ថាតើយានយន្តបើកបរដោយខ្លួនឯងមានសុវត្ថិភាពដែរឬទេនៅពេលវេលារីកចម្រើនទៅមុខ ហើយបច្ចេកវិទ្យារថយន្តមានការរីកចម្រើនខ្លាំង។ វាពិតជាគួរឱ្យរំភើបណាស់ក្នុងការស្រមៃមើលពិភពលោកមួយដែលរថយន្តទាំងអស់មានលក្ខណៈអគ្គិសនីនិងបើកបរដោយខ្លួនឯងទាំងស្រុងប៉ុន្តែវាមិនគួរឱ្យទុកចិត្តទេហើយវាក៏អាចក្លាយជាការពិតនាពេលអនាគត។បច្ចេកវិទ្យាយានយន្តស្វ័យប្រវត្តិកំពុងអភិវឌ្ឍយ៉ាងឆាប់រហ័សហើយអ្វីដែលធ្លាប់ជាទិដ្ឋភាពឧត្តមគតិនៃខ្សែភាពយន្តបែបវិទ្យាសាស្ត្រនាពេលអនាគតគឺជាការពិតសម្រាប់មនុស្សជាច្រើន។ខណៈពេលដែលកម្រិតជាក់លាក់នៃមុខងារពាក់កណ្តាលស្វ័យប្រវត្តិកំពុងចាប់ផ្តើមលេចឡើងនៅក្នុងឡានជាច្រើន, បច្ចេកវិទ្យាគ្មានអ្នកបើកបរទាំងស្រុងនៅតែស្ថិតក្នុងដំណាក់កាលសាកល្បងរបស់ខ្លួនហើយមិនទាន់ត្រូវបានប្រើប្រាស់ទូលំទូលាយដោយសាធារណនៅឡើយទេ។ គម្រោងនេះកំពុងប្រើសាកល្បងដោយស្វ័យប្រវត្តិក្នុងប្រព័ន្ធបញ្ជារបស់យន្តហោះដ្រូនឬយន្តហោះគ្មានមនុស្សបើក។បន្ទាប់ពីបានស្រាវជ្រាវអំពីដំណើរការរបស់វាខ្ញុំបានធ្វើការវិវឌ្ឍន៍និងបន្ថែមមុខងារមួយចំនួនទៀតដើម្បីអាចអោយវាបើកបរលើដីនិងបូកបញ្ចូលមុខងារសម្រាប់កាត់ស្មៅនៅក្នុងតំបន់វាលដូចជា វាលស្មៅខាងមុខផ្ទះ , តារាងបាល់ទាត់ , តារាង វាយកូនបាល់ ....។

ប្រព័ន្ធ Autopilot ត្រូវបានប្រើកុំព្យូទ័រឬទូរស័ព្ទទំនើបដើម្បីបង្កើតសញ្ញាឬព័ត៌មានសម្រាប់បញ្ជូនបន្តពីផ្នែកផ្ទាល់ដី(GS)ទៅប្រព័ន្ធត្រួតពិនិត្យការបញ្ជាផ្នែកខាងលើនិងទទួលបានព័ត៌មានពីការអានល្បឿនបច្ចុប្បន្នរបស់រថយន្តកម្ពស់ និងទីតាំង។ បន្ទាប់មកប្រព័ន្ធត្រួតពិនិត្យការហោះហើរនិងកែតម្រូវផ្នែកត្រួតពិនិត្យទិន្នន័យរបស់យានយន្តដើម្បីរក្សាកម្ពស់និងល្បឿនខណៈនិងរក្សាបាននូវស្ថេរភាពអ័ក្សបញ្ឈរនិងបណ្តោយ។ការកែតម្រូវកំហុសគឺជាសមត្ថភាពដ៏សំខាន់នៃប្រព័ន្ធអូតូម៉ូត។កំហុសកើតឡើងនៅពេលយានយន្តមិនដើរតាមកន្លងដែលរំពឹងទុក។ យានយន្តគួរតែអាចវិលត្រឡប់ទៅកន្លងដែលបញ្ជាដោយប្រព័ន្ធស្វ័យប្រវត្តិនោះ បន្ទាប់ពីប្រព័ន្ធស្វ័យប្រវត្តិធ្វើការកែប្រែកំហុស។

គម្រោងនេះនឹងជួយសន្សំប្រាក់បន្ថែមទៀតនៃការចំណាយលើកម្មករ ពេលវេលា និងកាត់បន្ថយ កាបូនឌីអុកស៊ីតនៅក្នុងបរិស្ថានពីព្រោះបច្ចេកវិទ្យាគ្មានអ្នកបើកបរដើរដោយអគ្គិសនីនិងពន្លឺព្រះអាទិត្យ។

Abstract

As automobile technology advances and self-driving cars become more common, everyone questions their security. It's wonderful to see a future where all cars are electric and completely self-driving, but it's not unrealistic and it may happen. Technology for autonomous vehicles is evolving swiftly, and what was once a futuristic notion from a science-fiction movie is now a reality for many people. Although many automobiles are starting to have some limited levels of semi-autonomous functioning, entirely driverless technology is still in the experimental stages and is not yet being utilized extensively by the general public. Furthermore, there are tight rules and control around these studies. This project makes use of an autonomous in a drone microcontroller that is identical to one used in agriculture, but I modified it to drive on the ground and cut grass in an open area.

Computers are used by autopilot systems to produce the control output. After reading the vehicle's current speed, posture, height, and position, the control software sends a control signal to the flight control system, a lower-level actuator controller. Then, in order to maintain height and speed while guaranteeing lateral, vertical, and longitudinal stability, the flight control system modifies the vehicle's control surfaces. One of the autopilot system's most important capabilities is error correction. When the aircraft deviates from the anticipated states, an error occurs. Once the problem has been fixed by the autopilot system, the aircraft should be able to return on its own to the states specified by the flying job.

It will help to humanity because it uses electricity and solar power, which saves time and the environment by reducing carbon dioxide.

SUPERVISOR'S RESEARCH SUPERVISION STATEMENT

TO WHOM IT MAY CONCERN

Name of program: Bachelor of Telecommunication and Electronic Engineering

Name of candidate: **Chhieng Khanun**

Title of research report: **A Study and Design on Autonomous lawn mower relied on GPS System**

To certify that the report carried out for the above titled bachelor's final report was completed by the above name candidate under my direct supervision. This Project materials have not been used for any other degree. I played the following part in the preparation of this research report. He always gives us a good idea and allowed us know about how to do and study in electronic. Moreover, lecture teach us some that make us know about major.

Supervisor's name: **Dr. Thap Tharoeun**

Supervisor 'signature: ....

Date: ....

CANDIDATE' S STATEMENT

TO WHOM IT MAY CONCERN

This is to certify that the final report by: CHHIENG KHANUN.

Herby present entitled **"A Study and Design on Autonomous lawn mower relied on GPS System"**

For the Degree of Bachelor of Engineering at the Royal University of Phnom Penh is entirely our own work and, furthermore, that it has not been used to fulfill the requirements of any other qualification whole or in part, at this or any other University or equivalent institution.

No reference to, or quotation from, this document may be made without the written approval of the author.

Signed by: **Chhieng Khanun** ....

Candidate's signature: …………………………

Date: ..../................/................

Signed by Supervisor: **Dr. Thap Tharoeun**

Supervisor's signature: ....

Date: ..../................/................

ACKNOWLEDGMENTS

My name is Chhieng Khanun I am a 6th Generation Bachelor of Telecommunication and Electronic Engineering in Royal University of Phnom Penh (RUPP). The completion of this project would not be possible without the support of many great minds. It always reminds me of those who always encouraged, supported, and allow me to complete my project.

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Additionally, my most profound appreciation goes to **Dr. Kim Phirun, Dr. Math Sa, Mr. Chheang Vuthy, Mr. Houn Seak**, and all professors, for their time, effort, and understanding in helping me succeed in my studies. Their vast wisdom and wealth of experience have inspired me throughout my studies.

Finally, I would like to extend my sincere gratitude to all of the participants in my study. Their willingness to share their experiences and insights has been invaluable to my research and has helped to make this project a success. Thank you for your time and contribution.

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CHAPTER 1: INTRODUCTION

A field mower robot, frequently appertained to as a lawn-cutting robot, is a robotic machine made to automatically trim and maintain a field. These robots can be programmed to cut the lawn on a set schedule or in response to the rate at which the lawn is growing and use GPS to navigate and mow the field. Some robotic field mowers are also fitted with capabilities like remote control via a smartphone app, theft protection, and handicap recognition. In this Practical Work, you'll learn about the APM autopilot system and Mission Planner, the ground control program that controls it. also, you'll discover how to connect Mission Diary with the APM. For the APM and Pixhawk series' affordable open source open tackle autopilot systems, A Ground Control Software (GCS) result is called Mission Planner. Using Mission Planner, which also offers real-time telemetry readings, configuration, and tuning options, as well as the capability to produce operations for the autopilot, it's possible to upgrade the software of the autopilot.

1.1 Motivation

To navigate and mow the field, lawn-cutting vehicles employ a range of technology. Some cut the entire field in an arbitrary pattern, while others employ more complex algorithms similar to helical patterns to ensure that the entire field is trimmed unevenly. The detectors that the robots typically have let them fete impediments like trees, jewels, and auditoriums, and they will change their course consequently to avoid destroying these places. A slice medium, similar to a roll of blades or a rotary blade, is generally installed on the robots. The robot can be programmed to cut the lawn at a particular height and the slice height can be modified to suit the length of the lawn. Mulching is another point that certain robots have. which returns lawn parings to the field as a natural toxin after being finely trimmed. Overall, using lawn-cutting robots to manage a field is practical and effective. Compared to mortal field mowing, they can save time, energy, and trouble while icing that the field is maintained in good shape all time long.

1.2 Project Objective Summary

There are 5 objectives in my project:

1. To introduce autopilot in APM or Ardupilot in Mission planer
2. Using 3dr telemetry for autopilot similar to agriculture drone
3. To design a new type of lawn mower that can drive on grass and mud
4. To depend on self-operation using high quality in low cost
5. To save time in cutting grass
6. To improve our safety while cutting
7. To update solar system that can back up at less than 4 hours of drive time
8. To save more money on hired workman
9. To reduce carbon in our environment and use electric vehicle

1.3 Type of autonomous vehicle

1. autonomous lawn mover
2. Agriculture drone
3. Autonomous road cleaner
4. autonomous delivery
5. Autonomous tractor
6. Autonomous car
7. Boat navigation

1.4 Project Specification

This device was created to be used in agriculture and requires only a minimal setup in software on a laptop or smartphone application called mission planer that uses telemetry and GPS systems to navigate and provide real-time information about the position, speed, and altitude of a drone and Rover, as well as other crucial operational data to fly without the need for a human operator.

1.5 Products Architecture and components

In the system overview, there are available components which include the APM flight controller which is a unique and complex technology that enables the Autonomous vehicle to drive without a human controller. The capacity for the drone to travel and navigate in space is provided by this system, which is made up of several components that function together. It also needs the 3dr telemetry that uses communication systems to transmit the data back to a central location Subsequently, the data is analyzed to monitor and control the remote system. Furthermore, the solar system is the point that maintains the power system to make our lawn mower can run for less than 4 hours.

1.6 Applications

Autonomous vehicle Allows us to explore multiple lesser-known possibilities for autonomous vehicles, from openly accessible applications to sector-specific use cases.

- Delivery vehicles, shuttles, and robots.
- trucking, logistics, heavy machinery, and transportation.
- Drone and boat navigation

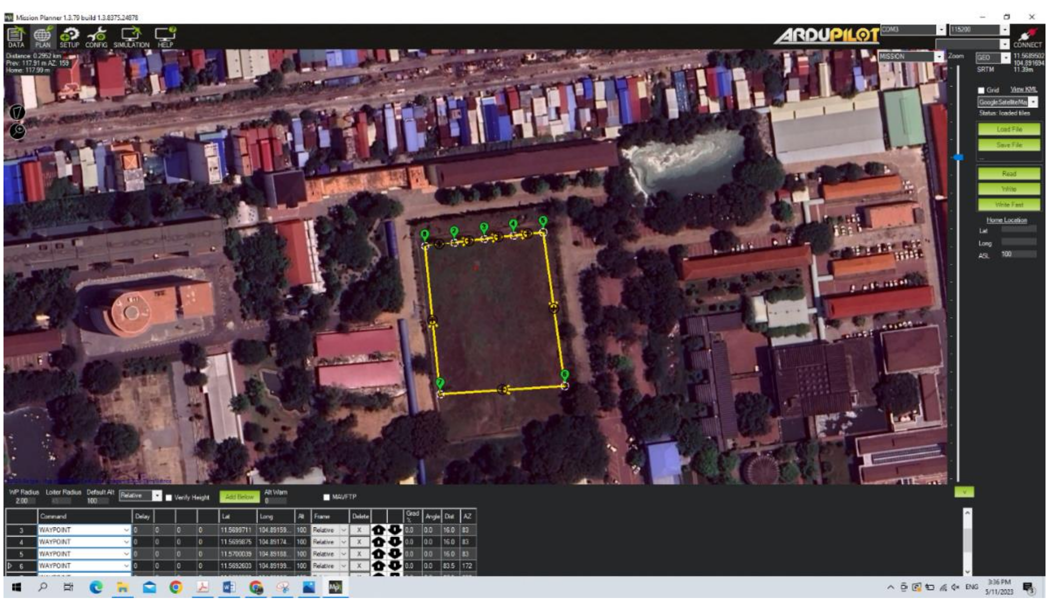

Figure 1: Application of autopilot in mission planer

CHAPTER O2: BACKGROUND STUDY

2.1 Autonomous lawn mower Overview

An autonomous lawn mower is A robotic system made to autonomously trim and maintain a lawn is called a grass-cutting robot, often referred to as a lawn mower robot. For navigation and lawn mowing, these robots apply GPS and algorithms.

This robotic lawn mower uses autopilot to set boundaries on the map I create in the mission planner before performing its task independently. The controller for the autopilot is APM or Ardupilot. For the 3DR, telemetry is used for the autopilot mission and GPS tracking. The purpose of the mission planner is to follow our lawn mower and limit the map that we want it to travel on.

2.2 Background Study of Autonomous Vehicle

Autonomous automobiles are autos that can operate independently of a human driver. a scientific development that aims to revolutionize transportation and is currently one of the biggest trends.

Although tests with various nations and companies started several years ago, the deployment of driverless vehicles may speed up in the coming decade.

Electric vehicles, connectivity, and autonomous driving all directly relate to each other in the automobile sector. Given that data transmission is crucial for the successful operation of autonomous vehicles, a connection must therefore be effective enough to meet these requirements.

2.3 Background Study of autopilot using telemetry relied on GPS

Telemetry is the autonomous collection of data from distant sources and its wireless delivery. Telemetry typically functions as follows: At the source, sensors collect either physical information like temperature and pressure or electrical information like voltage and current. The data is subsequently transmitted by electronic equipment to distant locations for observation and analysis.

Telemetry measures electrical or physical data with a telemeter, which is a tool to measure various metrics such as pressure, speed, and temperature. These measurements are transformed into electrical voltages, which are then multiplexed with timing information to create a data stream that can be sent to a distant receiver. The receiver breaks down the data stream into its constituent parts before displaying and processing it following user preferences.

Due to safety features like assisted parking and braking systems, many vehicles already on the road are regarded as semi-autonomous, and a select number are capable of driving, steering, braking, and parking themselves. The GPS is a key component of autonomous vehicle technology, as are sophisticated sensing systems that can identify lane markings, traffic signals, and unforeseen impediments.

2.4 Problem Statement

Like any other region in the world, technology in Cambodia is constantly changing. It enhances and transforms people's lifestyles, while in Cambodia the majority of work is labor-intensive, which is why people's health is at risk and deteriorating.

2.5 Structure of the Research Project

An independent field mower needs different ways and processes to reach stylish performance. Some of these ways by step are

- Design and Component

Designing the system using precise measures and choosing the system's factors. For our tackle design, we're exercising essence and wood. It has a nice appearance and is compact. Flexible systems make installation simpler.

- Autonomous field mower

Designing the machine part developing and an algorithm to give the process of bus mode and lawn slice at home theater, especially on big fields like football fields, and golf fields. A variety of technologies are used by field-mowing vehicles to navigate and trim the lawn. While some trim the entire field in an arbitrary pattern, others employ more sophisticated algorithms, including helical patterns, to ensure that the entire field is inversely mowed. Compared to mortal field mowing, they can save time, energy, and trouble while icing that the field is maintained in good shape all time long.

CHAPTER 03: COMPONENT AND DATASHEETS

3.1 APM or Ardupilot

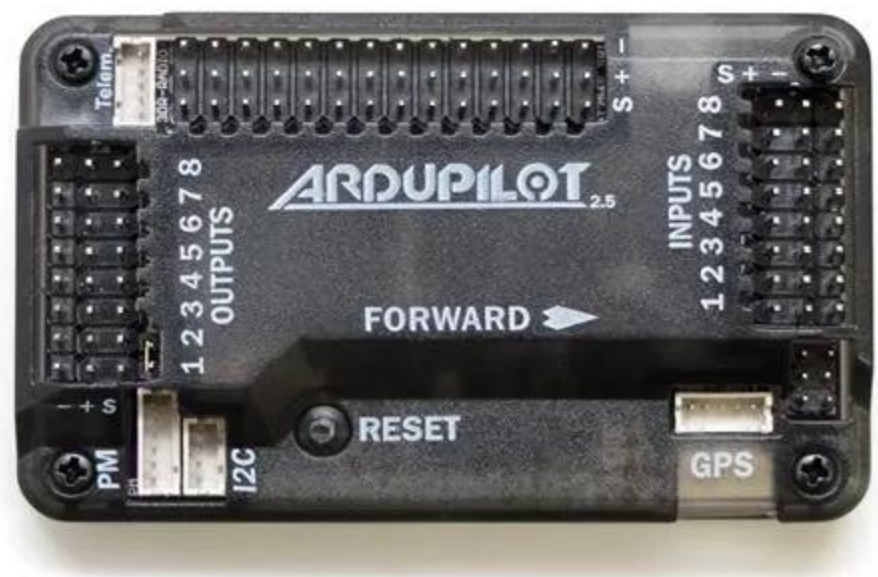

Figure 2: APM flight controller

Based on the Arduino Mega platform, Ardupilot Mega (APM) is a professional IMU autopilot. This autopilot flight controller is capable of operating rovers, multicopper helicopters, fixed-wing aircraft, and conventional helicopters. APM flight controller is a method for keeping track of important software application performance parameters using monitoring tools and telemetry data. The flight controller is used by practitioners to guarantee system uptime, boost service performance and response times, and enhance user experience.

1. data transmission port
2. analog sensor port
3. autostability gimbal output
4. ATMEGA2560 SPI online programming port (be useful for optical flow sensor)
5. USB port
6. remote control input
7. function selection jumper

8. GPS port
9. 12C external compass port
10. ATMEGA32U2 SPI online programming port
11. multifunction configurable MUX port (OSD is the defaulted output)
12. current voltage port
13. ESC power supply selection jumper
14. ESC output port
15. Input Voltage 12~16 VDC
16. Sensors: 3-Axis Gyro meter
    Accelerometer High-performance Barometer

3.2 Telemetry Ratio

Figure 3: Telemetry

Using telemetry data, which captures UAV state in real-time, pilots can keep track of position, attitude, and altitude for smooth and efficient flying. Depending on the sensors connected to the board, it may also be able to provide data on other parts and systems, such as battery voltage and rotor speed. Drone telemetry is the collection of information about an aircraft and its surroundings and the transmission of that information to an operator or ground control station (GCS). Sensors like drone autopilots, accelerometers, gyroscopes, and GPS, as well as components like aircraft power supply, can provide this data.

Features:

1. Band: 433MHz
2. Antenna connectors: RP-SMA connector
3. Output power: 100mW (20dBm), adjustable between 1-20dBm
4. Sensitivity: -117dBm sensitivity
5. Interface: Standard TTL UART
6. Connection status: LED indicators

Specifications:

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6. Connection status: LED indicators

3.3 GPS Module

- 

Figure 4: GPS module

The case and GPS antenna mount that come with the NEO-M8N GPS Module for APM APM2.52 Flight Controller protect the GPS from electromagnetic interference. The latest generation GPS module NEO-M8N is 0.6 meters, or about 0.9 meters, more accurate than the previous version NEO-7N's accuracy of 1.4-1.6 meters while consuming less power. High sensitivity is a characteristic of the module, which also incorporates active circuitry for ceramic patch antennas. To shield the module from the elements, a plastic casing is also provided. The module features a warm start rechargeable backup battery and produces precise location updates at 10Hz. The Ublox NEO-M8N may be scanned with Pixhawk and APM using its configured 38400 baud rate.

Features:

1. Built-in compass GPS module
2. Main chip: Ublox-M8N
3. With fast satellite searching speed and high precision
4. Includes round plastic shell and GPS folding support
5. Supply Voltage (V): 0.5~3.6 V

Specifications:

1. M8N GPS, with low power consumption and high precision, the ultimate accuracy is 0.6 meters, actually almost 0.9 meters
2. - Nav. update rate1 Single GNSS: up to 18 HZ
3. - Concurrent GNSS: up to 10 Hz
4. Anti-jamming Active CW detection and removal. Extra
5. Supported antennas Active and passive
6. - Odometer Travelled distance
7. – Data logger For position, velocity, and time (M8N)
8. - Operating temp. -40° C to 85° C
9. - Storage temp. -40° C to 85° C (M8N/Q)
10. - -40° C to 105° C (M8M)

3.4 MG996R Servo Motor

Figure 5: Servo motor

The MG995 metal gear servo motor is a high-speed standard servo that spins 180 degrees (60 degrees in each direction) and is used in radio-controlled vehicles, helicopters, cars, and many more radio-controlled models. A delivery of 12 kg/cm at 6 V and 10 kg/cm at 4.8 V is made.

a digital servo motor that utilizes PWM signals for quicker and more efficient operation. Modern internal circuitry provides quick renewal in response to external pressure, high holding power, and excellent torque.

contained in a robust, long-lasting plastic container, which keeps them dry and dust-free. This capability is tremendously useful for remote-controlled boats, monster trucks, and other vehicles. Both a 3-wire JR servo connection and Futaba connector compatibility are built-in.

Features

1. The Operating Voltage is +5V typically
2. Current: 2.5A (6V)
3. Stall Torque: 9.4 kg/cm (at 4.8V)
4. Maximum Stall Torque: 11 kg/cm (6V)
5. The Operating speed is 0.17 s/60°
6. Gear Type: Metal
7. Rotation: 0°-180°
8. Weight of motor: 55gm
9. Package includes gear horns and screws

3.5 GEAR MOTOR

Figure6: gear motor

An electric motor and gearbox are collectively referred to as a gear motor. Most of the time, a gearbox is added to a motor in order to enhance output torque and reduce shaft speed. With the inclusion of an adequately sized and constructed gearbox, gears may translate shaft speed and torque at particular ratios with minimal efficiency losses, enabling the creation of the perfect output speed and torque.

Features

1. Max power 10W
2. Voltage 12V DC
3. Speed 960 RPM
4. Max torque 12 Kg
5. Motor diameter 33mm
6. Shaft diameter 6mm

3.6 Battery Li-on NCR18650B

Figure 7: Battery Li-on NCR18650B

The Panasonic NCR18650B 4.2V High Capacity Lithium-Ion Cylinder Battery is among the finest 18650 cells currently available. Producers of laptop batteries utilize them for a number of purposes. Because of its powerful 3400 mAh capacity and maximum continuous discharge current of 4900 mA, it is the ideal energy source for high-performance packs. Only genuine Panasonic batteries are purchased by SIMPOWER. A large-capacity cylindrical cell with a 3400mAh capacity designed for pack manufacturing is the Panasonic Lithium NCR18650B.

Battery Specifications:

1. High energy density and high voltage ensure small battery dimensions
2. Stable power with a flat discharge voltage
3. Low self-discharge is impressive
4. Capacity (Ah): 3.4 Ah (3400mAh)
5. Charging Voltage (V): 4.2 V
6. Energy (Wh): 12.2 Wh
7. Energy Density (Wh/L): 730 Wh/L
8. Nominal Voltage (V): 3.6V-3.7V
9. Weight (g): 46 g
10. Diameter (mm): 18.06 mm (+/- 0.03 mm)
11. Height (mm): 65 mm (+/- 0.03 mm)
12. Max. Continuous Discharge rate: C Rating 2C (Maximum load/current 6.8A

3.7 Brushed Motor Speed Controller ESC 30A

Figure 8: Brushed ESC 30A

A "brushed ESC" or electronic speed controller was created for use with brushed DC motors. A brushed DC motor should theoretically run constantly if the right voltage is applied. To regulate motor speed, the brushed ESC only modifies voltage. Simply said, speed is improved by raising the voltage for a longer period of time and lowering it for a shorter period of time. Similar steps are reversed to slow down the motor. Since a brushed DC motor's speed is proportional to the supplied voltage, controlling its speed is often simple. Using the pulse width modulation (PWM) method, we must change the ratio of on-to-off time (duty cycle) in order to change the driving voltage of the motor. Remember that most hobby-grade RC car ESCs are brushed and support standard 1to2 to ms RC PWM signal input.

Features:

- Water-proof and dust-proof, suitable for all-weather condition races.
- Small size with built-in capacitor module.
- Three running modes: Fwd/Br, Fwd/Rev/Br , Fwd/Rev, fit for various vehicles (Fwd =Forward, Br=Brake, Rev=Reverse).
- Great current endurance capability.
- Built-in BEC output capacity.
- Automatic throttle range calibration, easy to use.

- Easy to set the ESC parameters with jumpers.
- Multiple protections: Low voltage cut-off protection for battery / Over-heat protection / Throttle signal loss protection. Convenient for outdoor use

Specifications

- Fwd. Cont. / Peak Current: 60A/360A
- Rev. Cont. / Peak Current: 30A/180A
- Voltage Range: 2-3S Lipo or 5-9 NiMH
- Motor Limit: 2S Lipo or 6 NiMH; 540 or 550 Size Motor: ≥12T or RPM
- 3S Lipo or 9 NiMH; 540 or 550 Size Motor: ≥18T or RPM< 20000/ 7.2V
- Resistance: Fwd 0.001Ω, Rev 0.002Ω
- BEC Output: 3A/5V (Linear Mode)
- PWM Frequency: 1KHz
- Size: 36.5mm x 32mm x 18mm
- Weight: 39g
- Running Modes: Forward /Reverse/ Brake Forward / Brake, Forward/ Reverse

3.8 Fly Sky-i6

Figure 9: Fly Sky i6

The FlySky FS-i6 entry-level RC set is an affordable choice for beginners while yet providing a respectable array of capabilities, telemetry, and versatile programming possibilities. For a reasonable amount, one may get a pre-programmed RC set with basic telemetry, which is more than adequate for hobby flying. An iA6 receiver with output formats for PWM, PPM, and iBUS is part of the package. The smaller size, on the other hand, has a tremendous impact on the youngster. While it may be controlled in Modes 1 and 2 using either the right or left hand, Modes 3 and 4 are simply chosen in the transmitter. Installing a new, open-source firmware that includes 10 channels and many other improvements on the transmitter is simple.

Features

Transmitter

1. Switches: one 3-way and three 2-way
2. 2 potentiometers
3. LCD with 128 × 64 pixels, white backlight
4. Teacher port
5. Built-in HF module
6. 10 channels
7. Power: 6 V (4x AA)

Receive

8. Dimensions: 40,4 x 21,1 x 7,4 mm
9. Working voltage: 4 - 6,5 V
10. No. of channels: 6
11. Output: PWM, PPM, iBus
12. Dual antenna diversity

3.9 Brushless ESC 30A

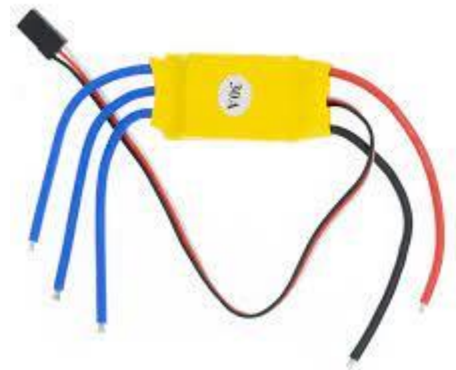


Figure 10: Brushless ESC 30A

Brushless ESC systems deliver three-phase AC power to brushless motors that are comparable to a variable frequency drive. Due to their effectiveness, durability, extended lifespan, and small weight, brushless motors are preferred among enthusiasts who like flying remote-controlled aircraft. This 30A BLDC ESC can drive motors and continuously run 30 Amps of load current thanks to a fully-configurable 5V, 3A BEC. The PCBs for the power MOSFETs for the ESC and the controller are on separate boards, and the device is well-built. 2-4 lithium polymer cells or 5–12 NiMH/NiCd batteries can power it. It has a dedicated microprocessor voltage regulator for effective anti-jamming capabilities.

Specifications

1. Output: 30A continuous; 40Amps for 10 second
2. Input voltage: 2-4 cells Lithium Polymer / Lithium Ion battery or 5-12 cells NiMH
3. BEC: 5V, 3Amp for external receiver and servos
4. Max Speed: 2 Pole: 210,000rpm; 6 Pole: 70,000rpm; 12 Pole: 35,000rpm

Features:

1. High-quality MOSFETs for BLDC motor drive
2. High-performance microcontroller for best compatibility with all types of motors at greater efficiency
3. Fully programmable with any standard RC remote control
4. Heat sink with high-performance heat transmission membrane for better thermal Management
5. Smooth, Linear, Precise throttle response
6. Low-Voltage cut-off protection
7. Over-heat protection

8. Separate voltage regulator IC for the microcontroller to provide the anti-jamming capability
9. Supported Motor Speed (Maximum): 210000RPM (2 poles), 70000RPM (6poles), 35000RPM (12 poles)

3.10 Brushless motor

An electric device called a brushless motor employs direct current (DC), but it lacks the mechanical brushes and commutator seen in a typical brush motor. Even though the upfront costs are higher, it outperforms brush motors in the long run and is more affordable. In general, brushless motors run for up to 50% longer on battery power than brushed motors and use less energy. The A2212/6T 2200KV Brushless DC Motor is suitable for RC quadcopters, aircraft, watercraft, and automobiles. The motor's RPM may be roughly calculated by multiplying the Kv value by the battery voltage. RPM/Volt units are used to measure Kv.

➔ **So 2200Kv = 2200 X 12.6v (3cells) = 27720RPM**

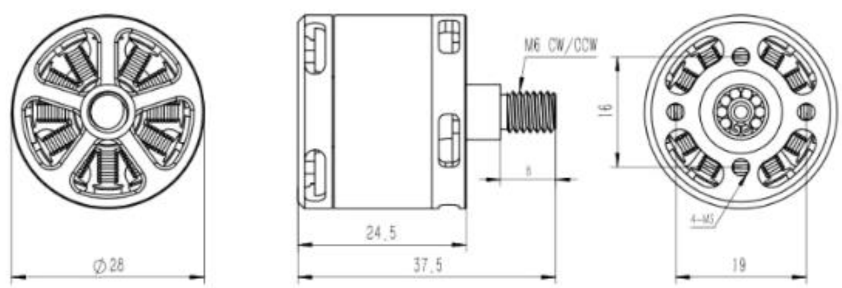
Figure 11: Brushless motor 2200kv

Specifications

1. Number of Cells: 2-3s lipo; 6-10 cell NiMh (2V to 12V)
2. Max Efficiency: 80%
3. Internal Resistance: 90mΩ
4. Max Current: 12A/60s
5. Max Watts: 239 W
6. Load Current: 21.5A
7. Shaft Size: 3.17mm

Table 1: Brushless Motor Specification

MODEL	KV (rpm/V)	Voltage (V)	Prop	Load Current(A)	Power (W)	Pull (g)	Efficiency (g/W)	Lipo Cell	Weight (g)
A2212	930	11.1	1060	9.8	109	660	6.1	2-4S	52
	1000		1047	15.6	173	885	5.1		
	1400		9050	19.0	210	910	4.3		
	1800		8060	20.8	231	805	3.5		
	2200		6030	21.5	239	732	3.1	2-3S	
	2450		6030	25.2	280	815	2.9		



3.11 Solar panel

A solar panel is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that generate electrons when exposed to light.

Figure12: solar panel

Table 2: Table Specifications of solar panel

Specifications	
Maximum Power	60W
Tolerance	± 3%
Open Circuit Voltage	22.2V
Short Circuit Current	3.56A
Maximum Power Voltage	18.2V
Maximum Power Current	3.3A
Module Efficiency	14.22%
Solar Cell Efficiency	17.26%
Series Fuse Rating	15A
Terminal Box	IP65
Maximum system voltage	1000V DC

Operating Temperature	-40°C - 85°C
Dimensions	630mm x 670mm x 30mm
Weight	5.1kg

3.12 Solar Charger Controller

Figure13: solar controller

In order to prevent the battery from overcharging, a solar charge controller controls the voltage and current that travel from the solar panel to the battery. It may be said that the 20A PWM solar charge controller acts as an (electronic) switch between the battery and the solar panels.

In bulk charge mode, the charger mode turns the switch ON. When necessary, the switch is "flicked" ON and OFF (pulse width modulated) to maintain the battery voltage at the absorption value.

Features:

(1) Automatically manage the working of solar panels and batteries in solar systems.

(2) Overloading and short-circuit protection.

(3) Build-in short-circuit protection, open-circuit protection, reverse protection, and overload protection.

(4) Protection from lightning strikes.

(5) Prolong the battery life cycle and keep the load working well.

(6) Easy to set up and operate.

(7) Suitable for small solar energy systems.

Specification:

- Voltage: DC 12V/24V
- Self-consuming: 10MA
- Rated Charge Current: 20A
- Rated Load Current: 20A
- Over-charge Protection: 14.4V/28.8V
- Over-charge Floating charge: 13.7V/27.4V
- Charge recover voltage: 12.6V/25.2V
- Over-discharge Protection: 10.7V/21.4V
- Over discharge Recover: 12.6V/25.2V
- USB output: 5V/3A

a. The Equation for solar panels and solar charger

- ➢ To find solar panels we need to know battery size and Average hours of direct sunlight. If the battery is 165.92W and the Average hours of direct sunlight are 4 hours.

> ⇨ **165.92w / 4h = 41w**

- ➢ So solar panel size **41w** is suitable for our battery.
- ➢ To find a suitable solar controller is :

> ⇨ **Size of solar / 12v or 24v**
>
> ⇨ **So 41 / 12V = 4A**

CHAPTER 04: ALGORITHM AND SOFTWARE

4.1. Algorithm

4.1.1 Structures

The whole structure was built lawn mower with a wooden base of 31 x 45 x 15 cm so it is similar to the car but it is a little bit higher because it needs a cutting motor under it. And about the solar system will be mounted on the top of the lawn mover and the size of the solar panel is 630mm x 670mm x 30mm which needs to charge and backed up for around 4 hours.

4.1.2 3Dr Ratio or SiK Telemetry Radio

- Utilizing a SiK Telemetry Radio or autopilot mode is one of the simplest ways to set up a telemetry link between your autopilot and a ground station. It's an open-source radio platform with typical "out of the box" ranges of more than 300 m, but the range may be extended to several kilometers by laying a patch antenna on the ground. The radio uses open-source firmware that was built particularly for MAVLink packets and work well with the Mission Planner, Copter, Rover, and Plane. It runs at a 433MHz frequency.
- The GPS module included in GPS drones enables them to pinpoint their location in relation to an orbiting satellite system. The drone may perform operations including location, autonomous flying, return to base, and waypoint navigation when connected to the signals of these satellites. Many sophisticated drones have the ability to create flight paths so they may independently organize flight photos as they fly. This is crucial to the operation of GPS. The drone generates waypoints with individual GPS coordinates. In addition to perfectly following the specified course, the GPS drone can hover and shoot at waypoints when in autonomous flying mode. Even while RTK/PPK will more precisely lock the item's position, When using the 3D mapping capability for an item, the drone's placement will be more accurate to 0.1 cm when equipped with a GPS function. An excellent feature for drone photographers, construction, agricultural, surveying, and inspection

4.1.3 Transmitter and Reviver

When we transition from autopilot mode to human control, we are in remote control mode. This feature enables us to manually operate our lawn mower, however, the control range is often less than that of an autopilot or telemetry radio. It has a range of 1500 meters. Magnetic interference affects a transmitter's range. The transmitter will function at a lower range if there is more magnetic interference anywhere, and it will operate at a higher range if there is less magnetic interference.

The FS-i6 is an international-compliant digital proportional radio control system that operates in the 2.4GHz global ISM band. Additionally, the transmitter's usage of AFHDS 2A (Automatic Frequency Hopping Digital System Second Generation) technology minimizes the transmitter's power consumption while simultaneously securing communication between you and your drone. These features, together with the transmitter's affordable price, have helped it become a well-liked option among drone enthusiasts all around the world.

In order to control all of the components on the lawn mover, the transmitter of the controller will send data from the hand controller to the receiver of the controller first. Once the receiver has received the data from the transmitter, it will then send it to the Ardupilot microcontroller.

4.1.4 APM Flight Controller

APM is a multipurpose, open-source flight control system that supports both quadcopters and rovers. The APM flight controller must connect its input pin to the radio reception pin in order to execute the hand remote feature. Therefore, data will be transmitted through the input pin of the APM Flight controller by the fly Sky i6 controller after being received by the receiver from the transmitter. After then, the flight controller will regulate and maintain the motor's speed while transmitting telemetry data to software that includes battery voltages, GPS coordinates, altitude, and speed.

4.1.5 Servo Motor

The servo motor performs as a lawn mower's wheel in this project, giving the vehicle the ability to turn left, right, and back. In the flight controller's mission planer software, the servo motor's sensitivity levels may also be changed.

4.1.6 Gear motor

The purpose of the gear motor in this instance is to enable the transfer of additional power to the back wheels for forward motion. This 910 rpm gear motor is excellent for use in muddy and grassy fields. An APM flight controller processes this gear motor using information from telemetry.

4.1.7 Grass trimer

Grass Cutter uses a 2200Kv brushless motor with a 27720RPM maximum speed. So using wire blades for grass trimming when mowing the lawn is helpful. And this motor's operation simply needs one switch on the transmitter and is connected directly to Esc, then the receiver.

4.2 Solar System

4.2.1 Solar Panel

One of the most practical designs for portable solar panels is the 12V folding model. Folding panels are portable and small when not in use. To recycle the electricity, the foldable solar panel will be mounted on the top of our lawnmower. A 40W, 12V solar panel is used.

4.2.2 Solar Charger Controller

A Solar Charger controller will be most satisfactory needed in this project it works to control and charge the battery and protect the battery from Overcharging and also balance the voltage of the battery. This 20A Solar Charger controller will be put under the solar panel and connected without being put to the battery

4.3 Control Software

4.3.1 Mission planner

Figure14: Mission planer Software

A ground control station for planes, helicopters, and rovers is called Mission Planner. Only Windows is compatible with it. For your autonomous vehicle, Mission Planner may be used as an additional dynamic control method or as a configuration tool.

➢ Here are a few examples of what you can accomplish using Mission Planner:

- Upload the firmware (the software) to the autopilot board that controls your car (such as the Pixhawk series or APM).
- Configure, tweak set up your car for maximum performance.
- You may check on the status of your car while it is in motion if the necessary telemetry hardware is used.
- Maintain telemetry logs, which are significantly more detailed than the logs from the onboard autopilot.
- Analyze and see the telemetry records.
- Drive your car from a first-person perspective

4.4 Tower application

There are several apps available for operating a drone on our smartphone or tablet, but Tower is appropriate for both novice and seasoned pilots. Flying a drone is doable without prior drone flying knowledge, similar to DroidPlanner: To build flights, just draw routes on a tablet or add waypoints. The app provides transmitter-free operation of all 3DR-powered helicopters and aircraft using any Android smartphone or tablet. Just a few examples include being able to quickly construct autonomous flights using Tower, utilizing a spline editor to deform around waypoints, and taking hands-free photos and videos of oneself using the 3PVTM Follow Me mode and automated "drone" features. Commercial and industrial clients may produce 3D scans of significant structures or geographic features using the software's new building mapper.

Figure16: Survey path in the Tower app

Figure15: Tower application

4.5 Configuration of Autonomous in Mission Planner

4.5.1 Set up firmware of Rover V4.2.3

Use a USB cord to connect the autopilot after installing the ground station on your computer, as seen below. Direct USB connections are made with the PC. Select the COM Port option from the dropdown menu next to the Connect button in the window's upper right corner if Mission Planner is your GCS. Choose AUTO or a particular board port. As indicated, set the baud rate to 115200. Don't press "Connect" just yet.

Select the icon that corresponds to your vehicle or frame type (such as a Quad, Hexa, or Rover) on the SETUP | Install Firmware screen of Mission Planner. In response to the "Are you sure?" question, say yes.

Figure17: Setting firmware

4.5.2 Set up GPS and Telemetry in the Mission planner

- With the help of the micro USB connection, join one of the radios to your computer.
- Plugging in the car's battery will provide power for the radio that is connected to the vehicle.
- The Initial Setup / Optional Hardware / SiK Radio page may be found by opening the Mission Planner.
- The baud rate should be set to 57600 after choosing the appropriate COM port. As seen in the image below, make sure the "Connect" button is unplugged.
- Pressing the Load Settings button should cause values, including the firmware Version, to appear in the Local and Remote regions.
- The default setting for most radios is 25, but it's better to modify this to a different number if you're going to be flying in an area where other pilots could be using the same radio.
- Following any adjustments, click the Copy Required Items to Remote button and then click Save Settings.

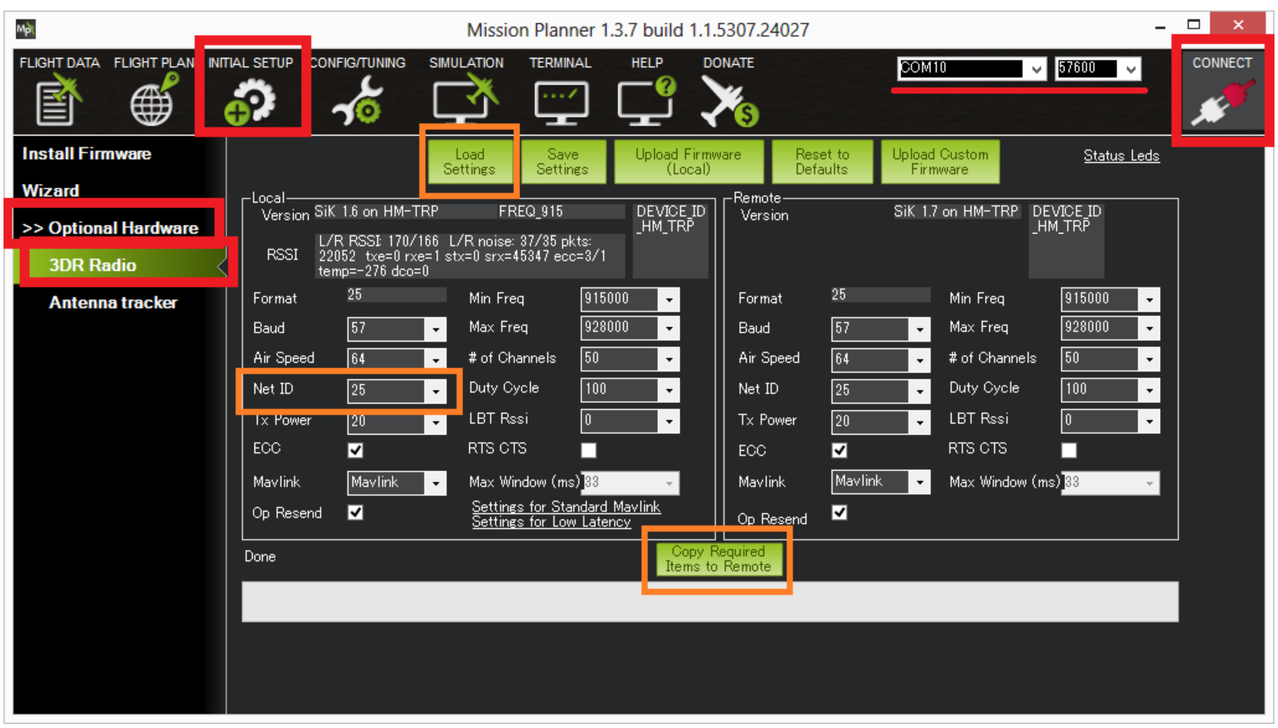


Figure 18: Set up GPS and Telemetry in mission planner

- Other parameters you may choose to update:
  - Baud (standard 57)
  - Air Speed (64 is the default).
  - ECC (by default, "on").
  - MAVlink (the default value is "MAVLink"): This option determines whether or not the transmission is optimized for MAVLink packets. If using a joystick or an Android tablet's virtual joystick to control the car, set it to "Low Latency."
  - Tx Power (default 20): the transmission power, where 1 = 1.3 milliwatts, 2 = 1.5 milliwatts, 5 = 3.2 milliwatts, 8 = 6.3 milliwatts, 11 = 12.5 milliwatts, 14 = 25 milliwatts, 17 milliwatts, and 20 milliwatts equal 100 milliwatts.
  - Duty Cycle (100 is the default)
  - Maximum Window (33 by default)
  - LBT Rssi (default value 0)
  - Hardware-based RTS CTS flow control. Using an ArduPilot firmware version that was released after mid-2016

CHAPTER 05: SYSTEM DESIGN

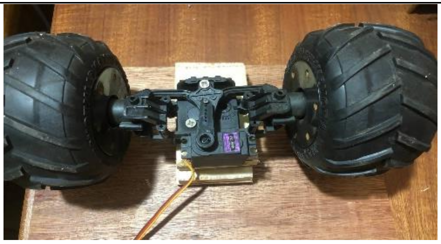
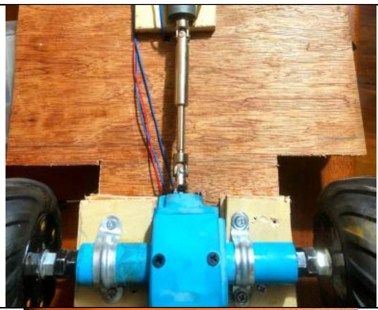
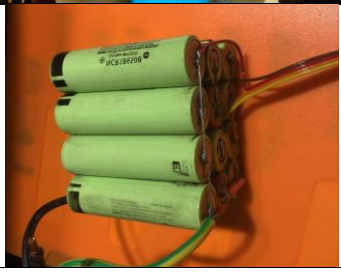
5.1 Design Requirements and Specification

This project's success depends on the quality of the components and technology used to complete the various stages and operate well. After testing the foundations of the drone flight controller and gear motor, the initial work was completed after sketching the job's structure to get an acceptable design. In order to make the works on this autonomous lawn mower efficient, it was important to have thorough information of the anticipated alterations according to characteristics in each section of each system, from the power of the battery, power of the motor, and effectiveness of GPS. Depending on the conditions of the location where we will conduct the test, the components were made for the design from the local market and imported from China. It was also suitable for providing hardware systems that could be correctly attached to the original design system. The team was able to enhance the components' constituent parts' quality thanks to these resources.

5.2 Table Material List

Table 3: Table Material

Component	Size (cm)	Quantity	Picture
Wheels	7.5x11	4 sets	
Wood	10.5x50x2.5	1	

Steering servo	13cm	1 set	
Axle	20cm	1 set	
12.2v battery	6x8x6	1set	

5.3 Apparatus Building Assembly

The motor and wheels must be large and strong to move mud and grass over the field, according to the field's conditions. The grass-cutting motor is mounted at the rear of the vehicle, near the ground, allowing for a greater angle of trimming.

Figure19: Autonomous lawn mower

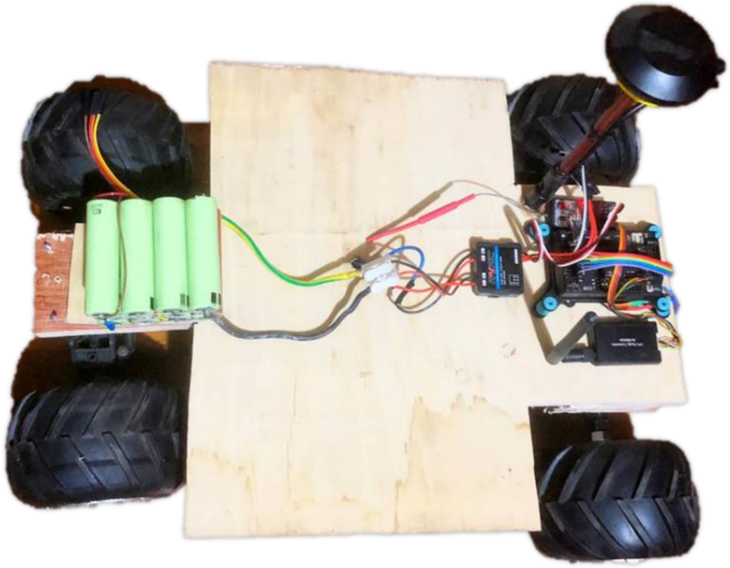
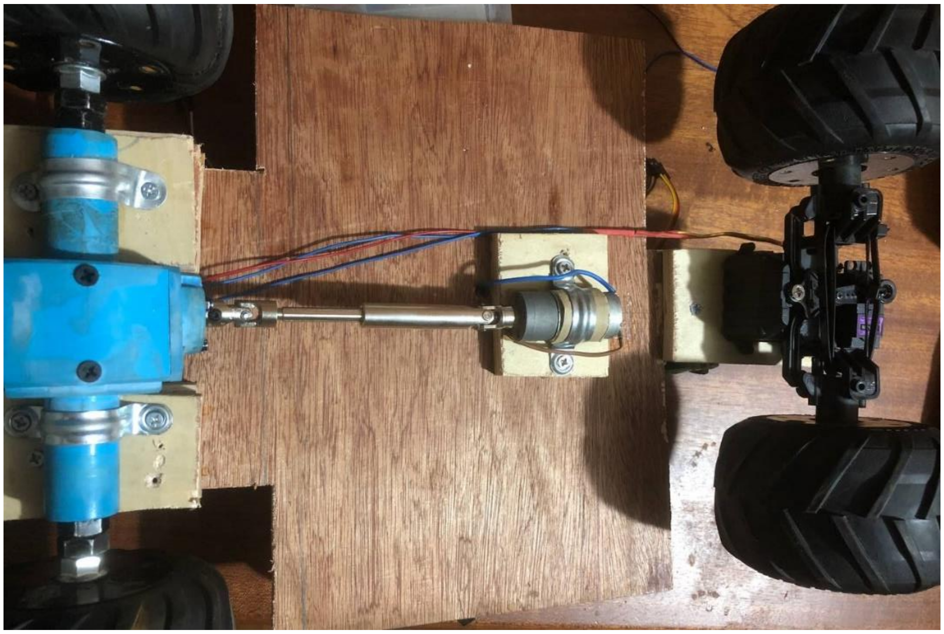
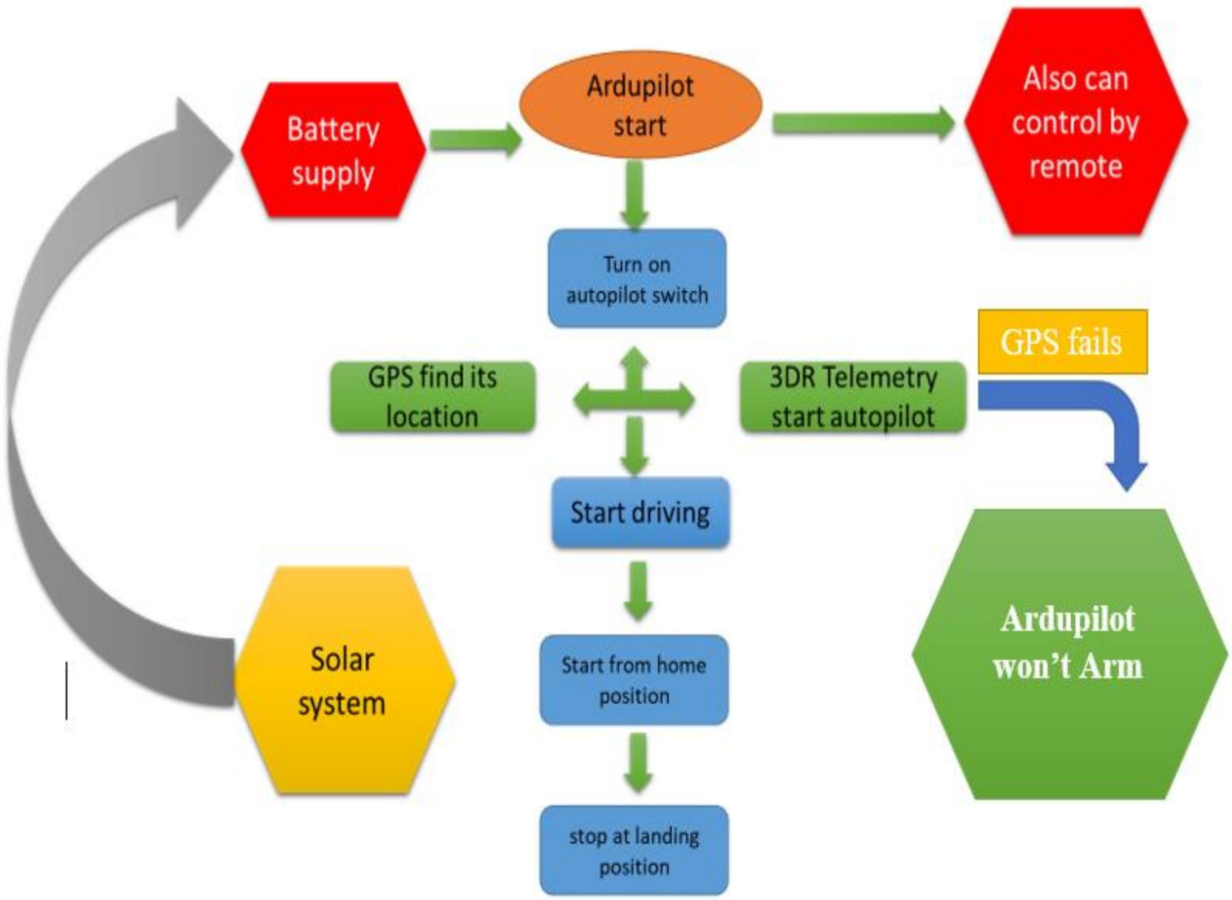


Figure20: Axle and Steering servo



5.4 Flow Chart



5.6.1 How to use it?

1. Go to create a pathway for driving in the mission planner

- Trop pins in the map to make the path for the vehicle to drive and set start point and stop point that stands for Home /land

2. When it's ready place the vehicle in clear position

- Connect battery
- Turn on the autopilot switch on the remote control then the vehicle will start doing its mission until to land point

5.6.2 How it works?

A. Autopilot Mode

1. GPS

- allowing them to know their position relative to a network of orbiting satellites.
- Connected to the signals of these satellites perform functions autonomous flight

2. Telemetry

- After GPS finds the location it will lock the position and then we can drop pins in the map to make the path for the vehicle
- Next, it will send data to the flight controller to control all of the components to work properly and start to drive on the point that we just pin.

B. Non-autopilot

- After we bind the transmitter with the receiver it can send data through all components by using a joystick or any switch on the transmitter
- Then the receiver will send data to the APM flight controller and all components are going to remote by hand
- If we want to change back to autopilot, just turn on the switch on the transmitter that we have set it

CHAPTER 06: SYSTEM ANALYSIS

6.1 Subsystem (Electrical Charger)

Charger for lithium-ion batteries for OEM. This microprocessor-controlled 3 Cell Lithium Ion Battery Charger is solely intended to charge 3-cell 10.8V or 11.1V Lithium Ion and Lithium Polymer (LiPo) batteries. It contains an LED indicator that displays the charger's current working mode. When there is no sunshine or when you need a speedy charge, this charger will be useful. It just takes 3 to 4 hours to charge a 12.6V, 13.6Ah 3-cell LiPo battery with this charger.

Figure21: Battery charger

6.2 Control system1 (Vehicle axle)

An axle connected to a wheelset that uses torque from a gearbox to move the wheels. The rotating force is called "torque". The axle acts as the power transmission path from the geared motor to the tires. This axle is made of PVC to cover the metal gears on the sides.

Figure22: Axle

6.3 Control system2

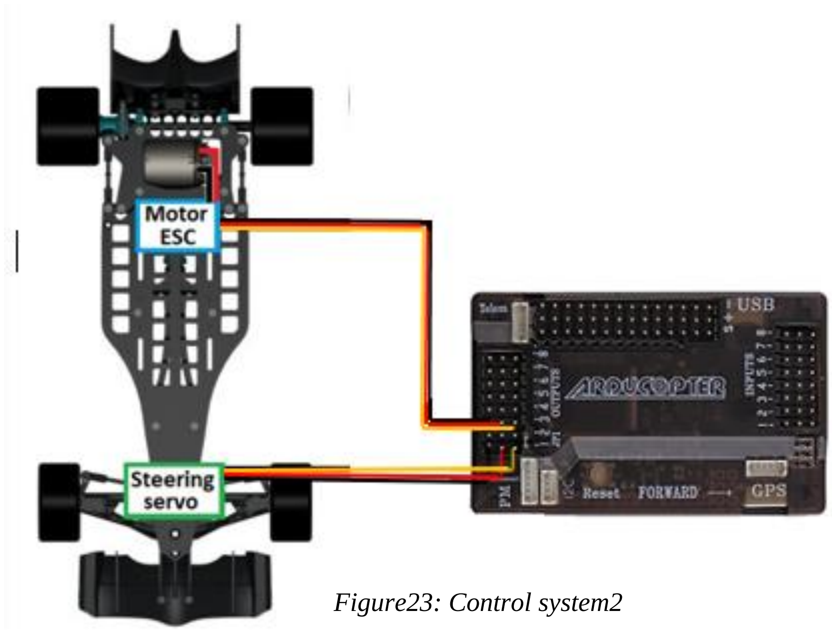


Figure23: Control system2

The majority of remote control automobiles include independent steering and throttle controls, much like regular cars do. The steering servo for these rovers should be linked to the autopilot's RC output 1, which typically moves the front wheels. These parameter values must be set for this configuration; in fact, they ought to be set by default.

Figure24: Configuration of servo and ESC

6.4 Control system3

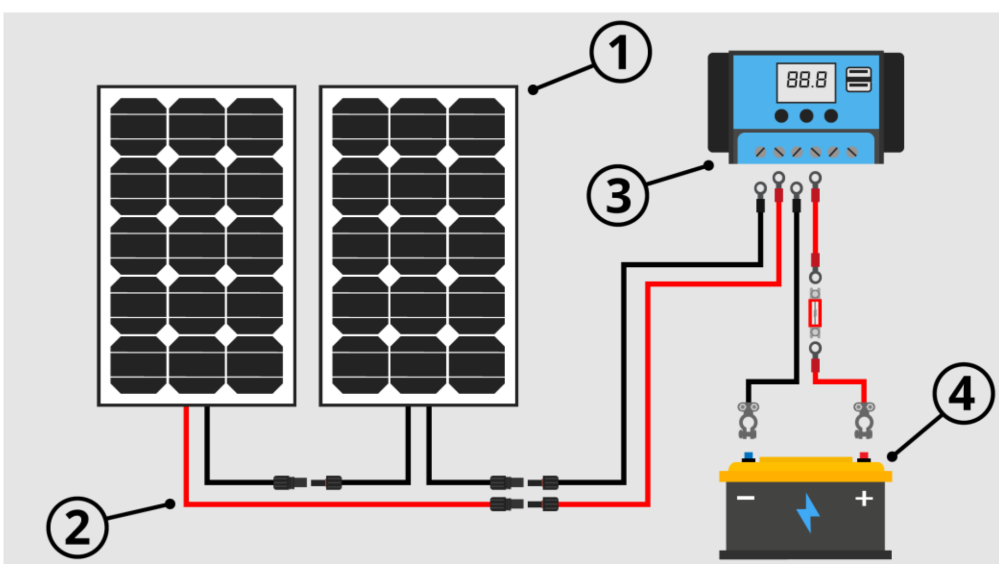


Figure25: solar and controller diagram

• The Solar panel is connected to input pin of solar controller

• Battery is connected to connect to the output pin of the solar controller and add one fuse

6.5 Control system2 (Receiver to flight controller)

The majority of remote-control automobiles include independent steering and throttle controls, much like regular cars do. The steering servo for these rovers should be linked to the autopilot's RC output 1, which typically moves the front wheels. These parameter values must be set for this configuration; in fact, they ought to be set by default.

Receiver

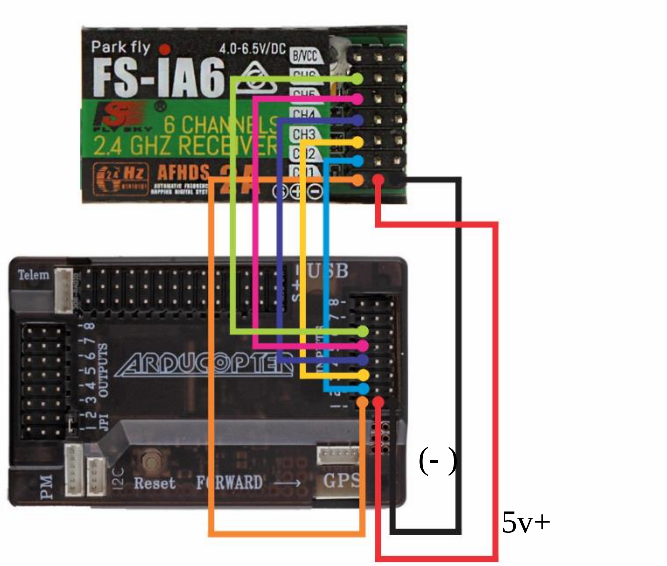


Figure26: Receiver and APM diagram

6.6 Flight controller to all RC components (Circuit Design)

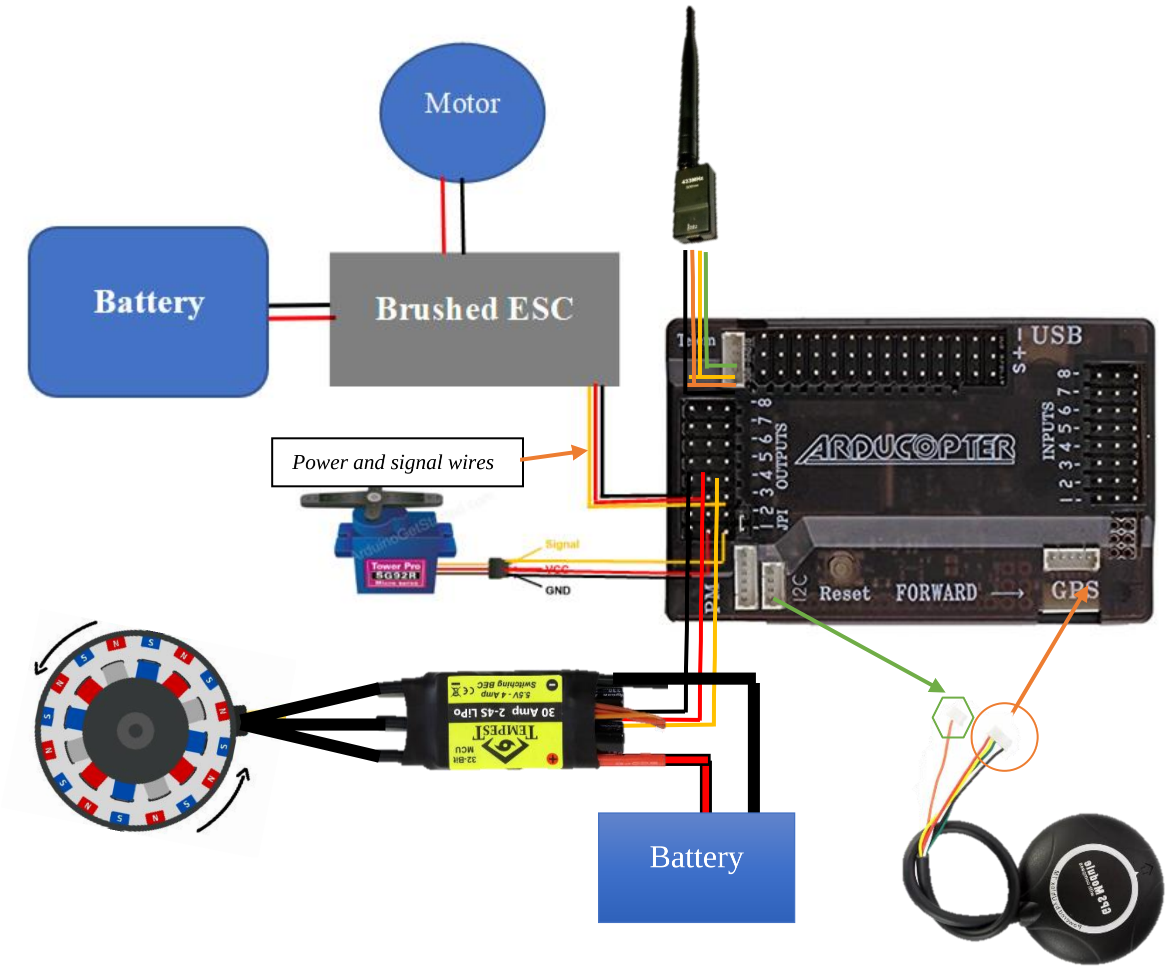


Figure27: RC component and APM diagram

The APM flight controller's circuit diagram connects to all RC parts, including the battery, ESC, gear motor, steering servo, telemetry, and GPS.

- Connect telemetry pin to APM
- GPS pin connected to APM
- The output pin for a servo motor is connected to channel 1 on the APM (VCC, GND, signal Pine).

The gear motor is an output of the ESC, and Buttery is connected to the ESC's input through the output pins (VCC, GND, and signal Pine) on channel 2 of the APM.

CHAPTER 07: CONCLUSION

7.1 Conclusion

Due to their mechanical design, software, and software implementation, autonomous lawnmowers are dependent on GPS. The operating system does not require limits or mechanical parts that let the machine go across the grass with high resistance; instead, it uses telemetry and GPS to navigate and mow big, complicated regions. Depending on the amount of sunlight, the solar system also aids in charging and maintaining the battery for a long period. Numerous devices with intelligent sensors have been created as a result of the recognition of the value of machine commands in assisting farmers distribute fertilizer over wide regions.

Finally, autonomous mowers employ GPS technology to travel and cut grass without boundaries in huge, complicated regions. Robotic lawnmowers with GPS capability can easily climb over hills and obstacles, plan several lawns, and design specific lawn sections. Additionally, convenient features like smartphone app control, blade stop technology, and rain sensor guarantee a hassle-free user experience. The usage of GPS-equipped autonomous mowers is a practical, cutting-edge method of maintaining your lawn that benefits both professionals and homeowners.

7.2 Future Work

We created an autonomous GPS-based lawn mower and discovered that the technology decreased labor, accidents, and wasted time and money. Because the system we created has its limitations even now. Future work on this complex will include the following: Improve GPS quality or find any GPS that is more efficiency

1. Adding smart sensor
2. Make it faster and work better
3. Long hour drive time
4. Can use without GPS

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