University of Houston Clear Lake

Building Smart Drones using ArduCopter and Telemetry

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Introduction

- AmeriDuo teaches hand-on robotics and programming to young students.
- AmeriDuo's mission is to inspire the next generation of great minds to become science and technology leaders and innovators, by engaging them in exciting mentor-based programs that build science, technology, and engineering skills.

Project Overview

- This Project aims to build Smart Drones using Arducopter and Telemetry by providing step-by-step tutorials for the high school students.
- The process of building the includes
    1. Gathering the components
    2. Assembling
    3. Calibration
    4. Building and testing the drone

MultiCopter and its types

- The commonly known helicopter has one motor, while multicopter is a unique kind of aircraft that is equipped with two or more motors.
- Radio controlled multicopters are increasingly popular for aerial photography, and land surveying.
- Multicopters can be divided into the following type

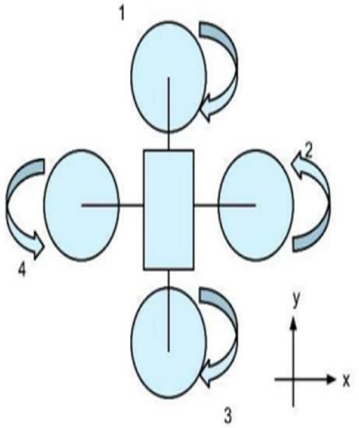
- Bicopter
- Tricopter
- Quadcopter
- Pentacopter
- Hexacopter
- Octocopter

Quadcopter

- Unnamed aerial vehicle (UAV) have capability to fly without an onboard pilot.
- Best solution to target places where it is impossible for a human to reach.
- A quadcopter is an aerial vehicle that uses four rotors for lift, steering, and stabilization. Unlike other aerial vehicles, the quadcopter can achieve vertical flight in a more stable condition.
- **Applications**: Product delivery, Aerial photography, Military rescue operations, Scientific research, etc.

Working principle

- While the drone and quadcopter technology of today is all modern, they still use the old principles of aircraft flight, gravity, action and reaction pairs.
- It is the propeller direction along with the drone's motor rotation and speed, which make its flight and maneuverability possible.
- The quadcopter's flight controller sends information to the motors via their electronic speed control circuits (ESC) information.



List of components

- Drone frame
- Motors
- Propellers
- Speed controller
- ArduPilot
- Radio transmitter and receiver
- OTG Connector
- GPS chip
- Battery
- Telemetry

Drone frame and motors

Drone Frame

- The frame of the quadcopter provides the physical structure for the entire aircraft.
- Hobby King S500 Glass Fiber Quadcopter Frame.

Motors

- The motors spin the propellers to provide the quadcopter with lifting thrust.
- Crazepony EMAX RS2205
- It has a potential voltage of 2600kv

Propellers and speed controllers

Propellers

- Propellers selection is important to yield appropriate thrust while not overheating the motors
- USAQ carbon Fiber Propellers
- Low resin with high carbon fiber content for light weight

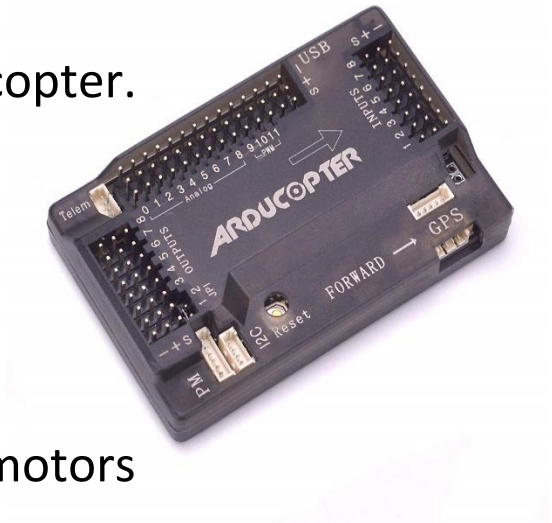
Speed Controllers

- Every motor needs an individual electronic speed controller
- Type: Makefire VGOOD
- Current: 40A ESC

Ardupilot and Battery

ArduPilot

- The flight controller is the “brain” of the quadcopter.
- It performs the necessary operations to keep the quadcopter stable and controllable.



Battery

- The battery provides electrical power to the motors and all electronic components of the aircraft.
- Lithium Polymer (LiPo) batteries are used, because they have high specific energy.

Radio transmitter and receiver ; GPS Chip

Radio transmitter and receiver

- A radio control system is made up of two elements, the transmitter you hold in your hands and the receiver you put inside your drone.
- A radio will have four separate channels for each direction on the sticks

GPS Chip

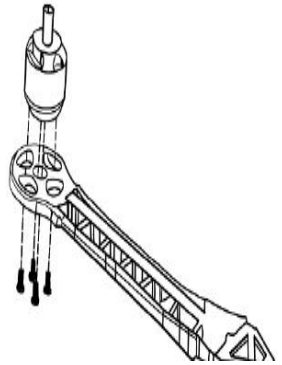
- GPS is the key to operating the UAV safely
- The most common use of GPS in UAV is navigation.
- And to track our drone

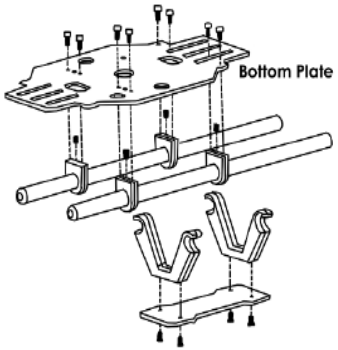
Telemetry

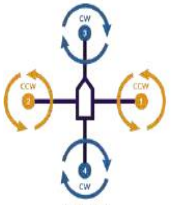
- Telemetry is what you use to send and receive data between your drone and your ground station.

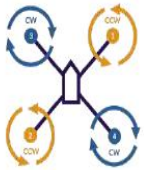
Assembling

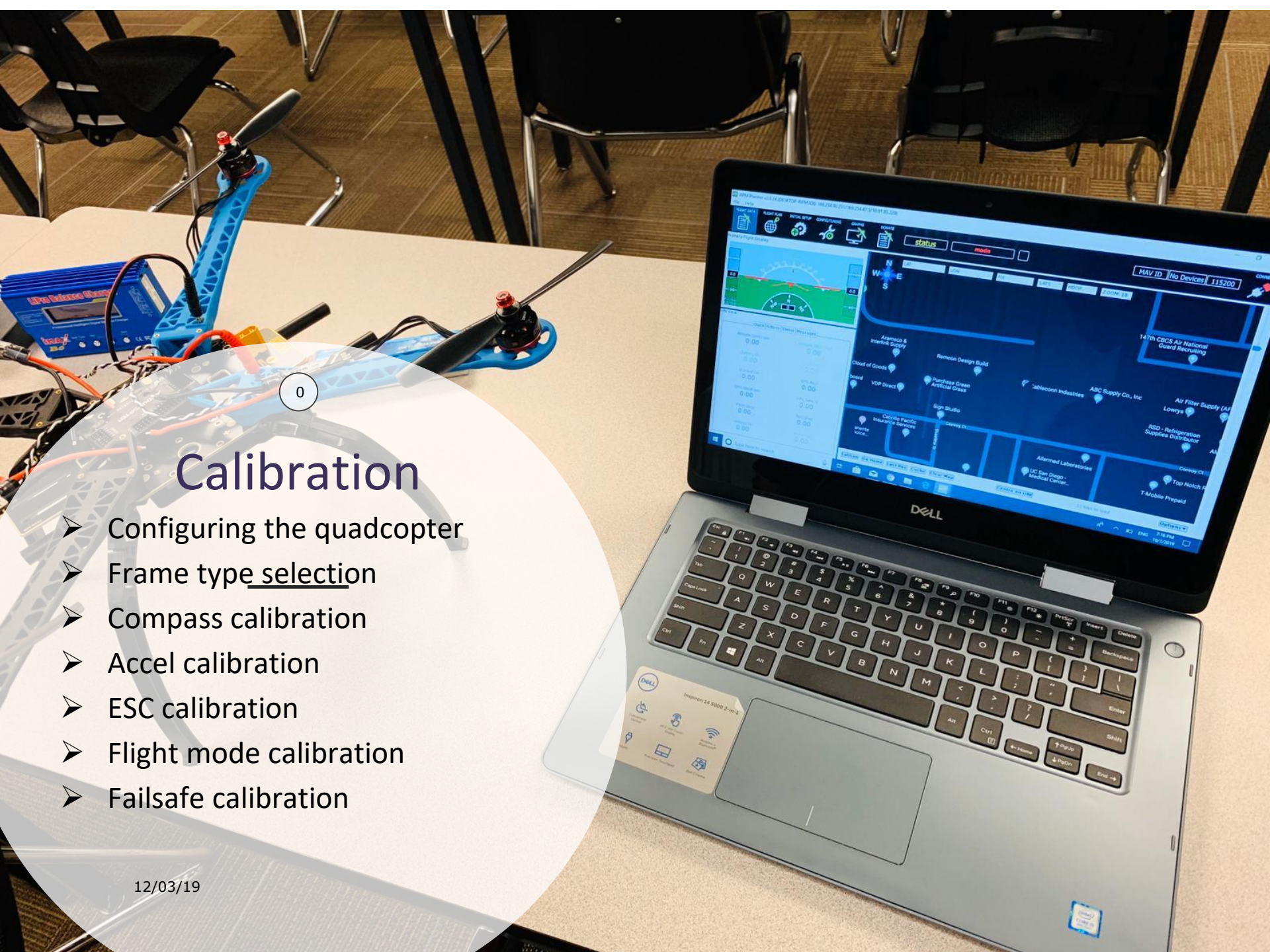
- Assembling the frame
- Connecting the motors
- Connecting the propellers
- Connecting the ESC
- Connecting the ArduPilot
- Connecting the battery
- Connecting the Telemetry











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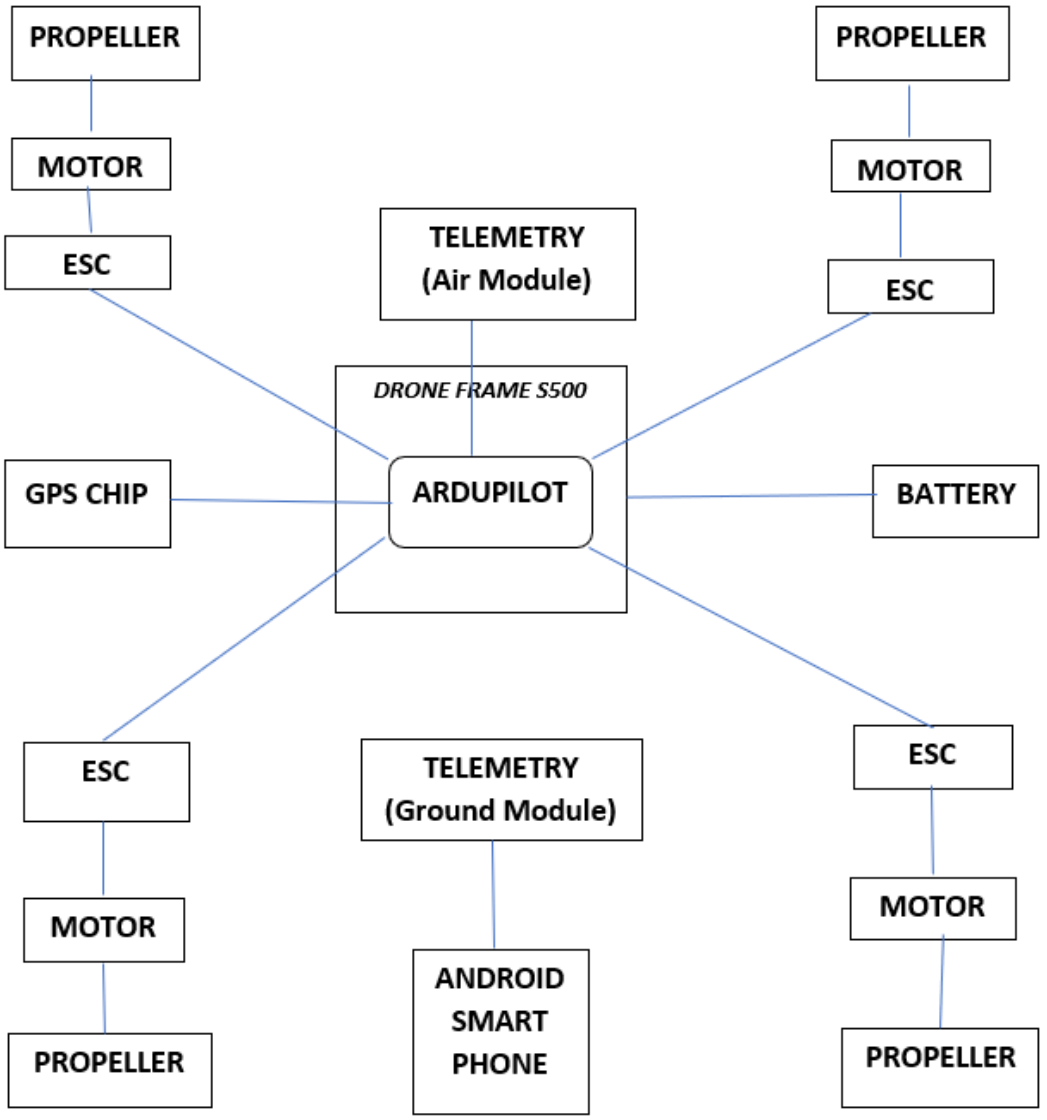
Calibration

- Configuring the quadcopter
- Frame type selection
- Compass calibration
- Accel calibration
- ESC calibration
- Flight mode calibration
- Failsafe calibration

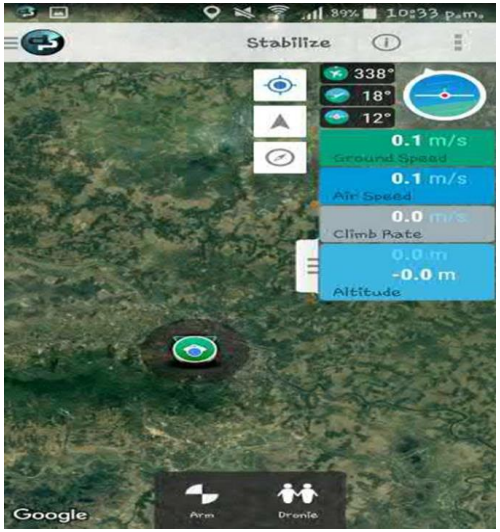
DESIGN


PROPELLER
MOTOR
ESC
PROPELLER
MOTOR
ESC
TELEMETRY
(Air Module)
DRONE FRAME S500
GPS CHIP
ARDUPILOT
BATTERY
ESC
MOTOR
PROPELLER
TELEMETRY
(Ground Module)
ANDROID
SMART
PHONE
ESC
MOTOR
PROPELLER

Building a Follow Me drone

- A Follow Me drone follows a device or an object; the device can be your phone or a device with some sensors that continuously communicate with the drone to get the right position.
- The follow me feature of ArduPilot is enabled using a smartphone with the Tower or DroidPlanner application.

Implementation



- Mission Planner software
- Tower application
- DroidPlanner2

- Programming in C++
- Package: Copter.h

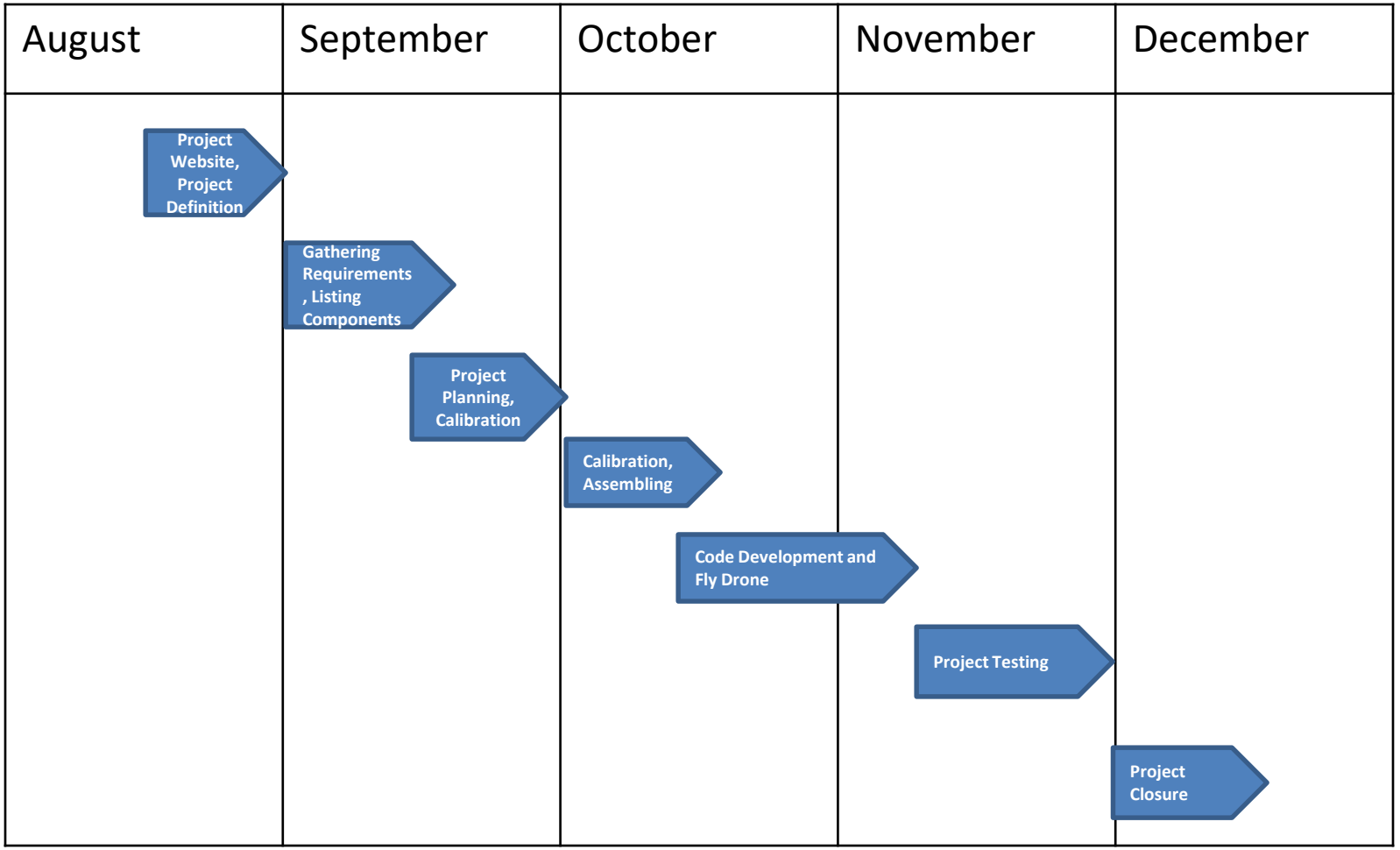
Arducopter Pin Configuration

PINS	CONNECTIONS
INPUTS	RADIO CONTROLLER RECEIVER
OUTPUT	FOUR ESC'S (SIGNAL, POWER AND GROUND CABLES)
GPS	GPS MODULE
12 C	12 C OF GPS MODULE
TELEM	TELEMETRY
POWER MODULE	BATTERY

Challenges

- Finding the compatible components for the Drone.
- Installing the correct firmware version in ArduCopter
- Setting up Modes and Channels of the remote controller for communicating to receiver of the drone
- Establishment and setting up the GPS for the Follow me drone
- Placing the motors in Clockwise and Counter-Clockwise direction

Project Plan



Conclusion

- Detailed step-by-step description of the assembling, calibration and building of the drone with pictures and videos is documented.
- Identified a set of right and compatible components with minimum cost.
- Recorded the details of a set of reliable vendors for purchasing the components.
- Documented the software and code used to control and fly the drone.
- Successfully calibrated the components using Mission Planner software.
- Built the drone to fly and control using Remote Controller, Telemetry and GPS.

Lessons learned and future work

- Working with this emerging technology gave us a great opportunity to learn knowledge of hardware components used for building the Drone and the wireless communication between components.
- Gained practical experience to work with C++ code of Drone in the real-world.
- Make Selfie and video capable drone for capturing pictures and records videos from the sky, which will be a best application for the weather forecasting.
- Create drone using Arduino Nano and ESP 8266 Wi-fi module for the better performance of drone in terms of controlling the drone.

References

- Sayed Omar Faruk Towoha “Building Smart Drones with ESP8266 and Arduino”, February 2018.
- Ty Audroins, “Designing Purpose-Built Drones for ardupilot Pixhawk 2.1”, December 2017, Packet Publishing Ltd.
- http://ardupilot.org/planner/

Thank you for your Attention!