RC/Semi-Autonomous Quadcopter

Authors: Hyun Myung Kang, Omar A. Hussein, Rose Ibarra, Nhu Le, Emmanuel Matthews, Natalia Perez
Advisor: Morgan Kiani

TCU Department of Engineering
College of Science Engineering

SciCom Let's Talk Science

Autonomous drones have been commercially available for decades. The integration of sensors has allowed robots to interact with their environment and resulting in autonomy. This quadcopter team takes on the challenge of creating an autonomous quadcopter using a frame, motors, electronic speed controllers, propellers, a Raspberry Pi, and an RPLidar. The team attempted remote control flight of the drone through pre-installed software—QGroundControl. The onboard computer will collect data using the RPLidar and optical flow sensors then send the data to the flight controller. Setting the robot (talker) and the virtual machine (listener) as nodes, they can communicate with each other through ROS master.

Introduction

In this project, an autonomous quadcopter was created by using many components and software to interact with its surrounding environment. Remote control flight of the drone was attempted through pre-installed software, named QGroundControl. The onboard computer will be used to collect data using RPLidar sensor to send the data to the flight controller. By setting the robot (talker) and the virtual machine (listener) as nodes, they can communicate with each other through ROS master.

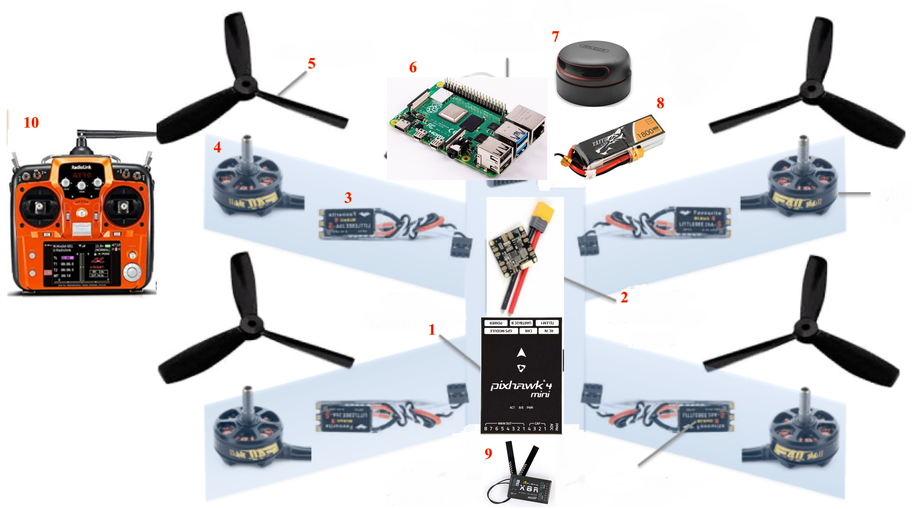
Breakdown of Team

Hardware	Software	Poster
Natalia Perez	Hyun Myung Kang	Nhu Le
Omar A. Hussein	Emmanuel Matthews	Rose Ibarra
Rose Ibarra		
Nhu Le		

Inspiration

- Mars Helicopter, Ingenuity, made by NASA is the source of inspiration for our quadcopter.
- Ingenuity was built to further explore unknown territory autonomously.

Hardware Layout



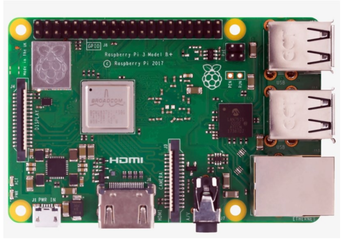
1. **Flight Controller:** controls the ESCs and consists sensors such as IMU, gyroscope, and pressure sensor
2. **Power Management Board:** serves the purpose of a Powre Module as well as a Power Distribution Board
3. **Electronic Speed Controllers:** controls and regulate the speed of an electric motor
4. **Brushless Motors**
5. **Propellers**
6. **Raspberry Pi:** on-board computer
7. **LiDAR Sensor:** light detection and ranging sensor
8. **Lithium Battery:** rechargeable battery
9. **Receiver**
10. **Transmitter**

Integrated Technology

RPLidar

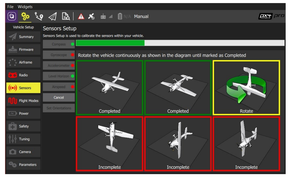
The RPLidar A2: Lidar sensor emits pulsed light waves into he surrounding environment. The pulses bounce off surrounding objects and return to the sensor. The sensor will then calculate the distance through the time it took for each pulse to return to the sensor. It is based on laser triangulation ranging principle and uses high-speed vision acquisition and processing hardware developed by Slamtec. It has a sampling rate of 8000 times per second as well as a range of 12 meters.

Raspberry Pi



The Raspberry Pi 4 B: It is a series of single-board computers which provides a set of general purpose input/output and allows users to control electronic components for physical computing. For this research purpose, it processes data from the sensors and utilize navigation algorithms to provide autonomy.

QGroundControl



QGroundControl is an open-source coded program that allows the user to configure, calibrate, and fly a MAVLink enabled drone.

ROS

Robotic Operating System: A set of software libraires and tools that help people build robot applications. From drivers to algorithms, and with powerful developer tools, ROS provides open source resources to all users.

Troubleshooting/Challenges

Transmitter and Receiver Signal

Problem: The receiver was not recognizing the signal from the transmitter.

Solution: The radio communication protocol that was used for this specific transmitter and receiver was Serial Bus communication. We switched the setting of the communication protocol in the receiver.

Take off

Problem: The quadcopter was not able to take off.

Attempted Solution: We recalibrated the power system of the motors with Qgroundcontrol as well as the direction of the rotation of the motors. Lastly, we made sure we utilized appropriate propellers for either counter and counter-clockwise directions.

Powering Raspberry Pi with a single power distribution board

Problem: Power connection from the flight controller to Raspberry Pi will not be enough to power up both the Raspberry Pi as well as the RPLIDAR intact with Raspberry Pi.

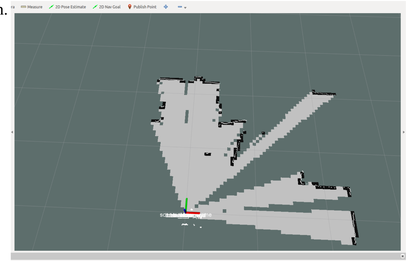
Possible Solution: We might have to add an additional smaller battery pack to power them individually.

Ongoing Research

Navigational Algorithms

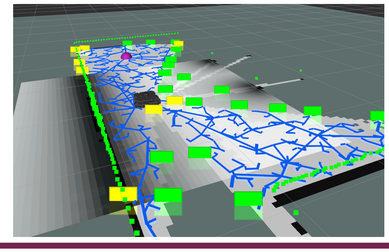
Hector Simultaneous Localization and Mapping Algorithm (SLAM):

Hector SLAM is one of the most popular SLAM methods that require only 2D Light Detection and Ranging Sensor (LIDAR) data. It does not require any odometry or IMU-sensor data as well as on platforms that exhibit roll/pitch motion. Typically, inside of buildings are GPS denied environment. Thus, the Hector SLAM algorithm is utilized to estimate the robot's position with its data collected from LIDAR to build a 2D map and localization in the same frequency at which LIDAR scans. The robot uses Robot Operating System (ROS) and Rviz (figure on the bottom) to display laser data on the ground station.



Path Planning Algorithm for SLAM Based:

The navigational module generates robot trajectories which take into account exploration regarding the goal position and SLAM demands regarding preferable localization points. Different path planning algorithms include A*, D*, and Dijkstra algorithms.



Conclusion

The unmanned aerial vehicle was attempted to fly through remote-controllably as well as autonomously. With the limited time and skillsets, our team was not able to accomplish the desired result in time. We, however, learned the hardware setup of a quadcopter as well as how to integrate LIDAR sensor with Robotic Operating System to implement navigational algorithms. In the future, we would like to further implement this technology to ground vehicle so that we are able to run more test trials in the aspect of software and for greater simplicity.

Acknowledgement

We thank Dr. Kiani for her support and her dedication to making sure the research project successful. We would like to thank Ms. Tammy Pfrang for her technical support and her helpful assistance in logistics. Finally, we are grateful to the TCU College of Science and Engineering and SciCom for giving us this opportunity to conduct undergraduate research.