User Manual

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1 Introduction

ParkingLotHawk is an aerial drone that will fly above the parking lot to gather information about slot availability and general parking lot status. The parking lot authorities will be able to access and visualize this information from an application on their Personal Computers (PCs). They will command the ParkingLotHawk only through an application running on their PC. The drone will be able to stabilize and move to different locations autonomously. Thus from the PC application, the operator will be able to launch or land the drone, after which they can either let the drone mutinously investigate the entire parking lot or have the drone investigate specific sections of the parking lot

2 Features

2.1 Hardware

The drone used for ParkingLotHawk is custom made and a majority of its body consists of 3D printed parts. There are several parts used in the construction of the aerial drone, as described below:

- Frame – A custom fabricated frame to house all of the other drone components.
- Battery Compartment – Separate compartment created to protect battery and maintain balance.
- Frame Arms (X4) – Removable arms built to facilitate repairs upon damage.
- Landing Legs (X4) – Removable legs built to facilitate repairs upon damage.
- GPS Mast – Elevate GPS 20cm above the drone components to help boost GPS signals.
- Enclosure – Closed space to house the electrical components and wiring.
- Top Plate – Mounting plate for electrical components.
- Dampening Plate – Mounts the drone components and reduces vibrations.
- Dampening Balls (X4) – Absorb vibrations.
- Propellor (X4) - Connects to DC Motors.
- Aluminum Foil Tape – Provides EM protection to reduce interference.

2.2 Electrical

In addition to the parts to build the drone, there are several key electrical components that are integrated to prepare for the drone operations. These include:

- Raspberry Pi 3B – Main controller of the drone and responsible for software operations.
- Navio2 – Physical flight controller hardware, contains various sensors and interfaces with motors and batteries.
- Radio Antenna and Receiver – Not for operator use.
- Camera – Used to acquire visual data.
- Electronic Speed Controller – Controls motors upon receiving signals from Navio2.
- GPS – Acquire drone location.
- Brushless DC Motors (X4) – Spin propellors.
- LiPo Battery – Power the drone.

2.3 Communication

Lastly, to make the drone operate properly, there are various software components that ensure the communication of the drone internally and externally through the following:

- ROS nodes – Communication between the internal processes on the drone.
- MavROS – Connect the flight controller with the drone software.
- Wifi – Connect the drone software and Operator's application.
- GUI – Communicate between the Operator and Operator's application

3 Description of User Interface

The user interface consists of two parts: Hardware Interface and Software Interface. The Hardware Interface will be limited in order to minimize damage to the product from improper handling, as well as decrease any technical experience required by the operator. The only Hardware Interface present is the disconnecting and reconnecting of the battery to the drone, and the mechanical On/Off switch.

The Software User Interface for ParkingLotHawk is used to control the drone from the operator's console. It starts with a Login Window that requests for username and password. It displays an error message if the credentials do not match. Once the operator successfully

logs in, the operator is presented with two windows.

The first window is the User Interface where the operator can view the location of the drone on the map and various information related to the drone. The information on the drone is displayed at the top of the window. There is also a logs window which displays the program status or any changes that occur in the software at the bottom of the window. The operator can control the configurations for the drone start-up from the left section of the window. The central map displayed in the window displays the current GPS position of the drone. It also allows the user to direct the drone's flight path via mouse-click from point A (drone position) to point B (drone destination), and trace its movement.

The second window displays the camera visuals and the occupancy map of the entire parking lot that is currently being explored by the drone. There exists a sliding divider in the center which divides the visual images from the camera on the left and the parking lot occupancy on the right, with the status of the parking spots being constantly updated by the drone's sensors.

4 Installation Instructions

In order to help the user control the drone, the User Interface package will be provided within a small storage device that will help install the required software components after launching it on the PC. In case of missing installation device, the user can also refer to the online link provided or contact the selected individuals under Section 12

5 Description of operation

There are many objects that are used during the operation of the User Interface application, with the major ones being focused on in the User Interface Objects table.

Table 1: User Interface Objects

Name	**Object Type**	**Description**
Username	Line Textbox	Allow user to input username.
Password	Line Textbox	Allow user to input password.
Login	Button	Enable user to login and access main application.
Logo	Label	Display Logo.
Connection	Label	Display Wifi connection Status.
Drone State	Label	Display the current state of the drone; whether it's still or in motion.

Table 1: User Interface Objects

Name	**Object Type**	**Description**
Drone Health	Label	Display any software issues or physical issues of the drone.
Altitude	Label	Display the Drone's altitude from the ground.
Battery	Progress Bar	Display the drone's battery status through the progress bar.
Logs	Textbox	Display the logs sent from the drone within a certain interval within the logs textbox.
Minimum Hover Height	Spin Box	Adjust the minimum hover height for the drone using the spinbox.
Desired Hover Height	Spin Box	Adjust the desired hover height for the drone using the spinbox.
Maximum Hover Height	Spin Box	Adjust the maximum hover height for the drone using the spinbox.
Connect	Button	Click to connect to the drone.
Configuration	Button	Click to configure drone height.
Take-off	Button	Click to Launch the drone.
Arm	Button	Click to startup the drone.
Autonomous Explore	Button	Click to automatically explore from the drone within the surroundings.
Compulsive Move	Button	Click for allowing user to control the drone's movement.
Autonomous Move	Button	Click to have the drone move automatically.
Land	Button	Click to land the drone.
Map	Web Engine Widget	Displays an online map that should have the ability to interact with the movement path of the drone.
Camera	Input	Display the visuals from the camera mounted in the drone.
Occupancy Map	Input	Display the status of the parking spots within the parking lot through the drone's sensors.

6 Drone Flight Checklist

Before the user starts to operate the drone, they are required to verify the following conditions to ensure its safety before launch:

1. Check all parts, including the drone's frame and its components (Refer to Section 2.2), for any damage.
2. Check the drone's ability to connect to the power supply by verifying the LED status after plugging the drone to the battery.
3. Check the current environment; whether there any strong external variables like rain, wind, heat, etc.
4. Test the drone application and whether it can be properly launched on the user's PC.
5. Determine if the drone is able to properly connect to the PC application.
6. Determine if the information provided by the drone and its components are accurately displayed in the application, within a certain margin of error.
7. Test the GPS by determining the current location of the drone and its changes, with respect to the movements of the drone.
8. Check if the drone properly responds to the commands issued from the application.
9. (*Optional*) Test for errors that can be caused manually and whether the application responds and displays it.
10. Test the clarity of the drone's camera and its ability to properly provide a visual of its surroundings.
11. Test the accuracy of the situation at each parking spot that is provided by the drone on the occupancy map.

7 Safety

In order to protect the safety of the user, the drone, and the user interface, various safety procedures need to be performed, as per the following:

- Perform a visual inspection for damages before each use to prevent any impact to the drone's performance.
- Check the current environment conditions to determine whether the product can be allowed to operate.

- Check the drone's estimated remaining battery life for its expected duration of operation.
- Read instructions provided on how to hold the product properly to prevent self-harm or damage the product through incorrect use.
- Test whether the product can inform the battery capacity before launch. If it is estimated to be less than 3 minutes of flight, it will prevent launch of the product.
- Test whether the drone automatically return to its original launch location and land once the estimated battery time is less than 1.5 minutes.
- Test the lowest height the drone hovers to check if it encounters any obstacles from the given height.
- Test if the drone causes any distraction, and operates properly when facing obstacles or individuals in the parking lot.
- Display a segmented image of the parking lot vs non-parking lot to the PC application to determine the product's perception of its environment.
- Upon entering into the Malfunction States, inform the user through the PC application if the product and application can successfully communicate.
- The user's login password shall be sufficiently complex to ensure safety against malicious users.
- Check if all the functions in the application are properly functioning when the product is not in Off State to detect malfunctions.
- Check if the mechanical Off switch is working in order to ensure that the product can be turned off even in the case of electronic failures, and can double as a kill switch.
- Keep a proper distance from the drone and do not attempt to hold it when it's in On State to prevent physical injuries.

8 Maintenance

Every moment, before the product is used to accomplish its tasks, it will need to be evaluated. Given below are a few methods to keep check if the drone is properly functioning before each use:

- The user should let the product be charged for 1 hour to maintain the availability of the product's user to the maximum.
- The user should visually inspect the drone for any damages.

- The user should determine if the product can sustain itself in wet environments, which ensures that the product will not be damaged.

9 Repair

In case of any damage to the product, the user can refer to Warranty in Section 11.

10 Technical Specifications

There are many details on the design of the drone and its various components. The user only requires to know the following specifications to have a better understanding of the drone's design:

Table 2: Technical Specification

Frame Size	210mm
Prop Size	5 inch
LiPo Battery	1000 - 1300mAh 3s/4s
Motor KV	2300KV - 2700KV
Motor Stator Size	2204 - 2206
Weight without Battery	250g - 450g

11 Warranty

The group will ensure that any damages that have occurred to the product and/or its application will be repaired free of charge within 6 months after the product's purchase. The user is required to contact the group under Section 12 upon any damages and have it shipped personally.

12 Contact

The following individuals can be contacted through username on email (Ex.: *username*@mcmaster.ca):

Table 3: Group Contact

Name	**Username**
Fady Zekry Hanna	zekryhf
Winnie Trandinh	trandinh
Muhammad Ali	alim102
Muhammad Khan	khanm120