OmniPilot™: Drone Flight Re-imagined
Project Proposal

Introduction

Objective

Piloting multi-copters and other UAV aircraft often involves the use of a hand held controller radio controller that was popularized for the first time in the 1950s. This controller was designed for flying radio controlled planes. The exploding modern era of miniature aircraft has shifted to multi-rotors but struggles as a result of being bound to a controller that has been largely untouched for decades.

OmniPilot™ is a control system for multi-rotors that puts intuitive response, customization, and precision first. By replacing the traditional joystick inputs with a single 3D joystick that detects motion in any direction, OmniPilot™ achieves the aforementioned goals. The instructions for OmniPilot™ are, “gently move the joystick the way you want to the drone to move.” This decreases training time, and makes multi-rotors more accessible for everyone: professional or hobbyist alike.

Background

The global multi-rotor market has been experiencing rapid growth every year since 2012, and is expected to continue to grow for the next 5 years.[2] Applications for both autonomous and manual drone piloting continue to be discovered every day, by consumers, militaries, and corporations alike. Unfortunately, piloting a drone manually is difficult.

Based on interviews with drone pilots, learning how to fly a quad-copter can take over 70 hours of practice and often involves several crashes. The best case crash would cost the pilot approximately $10 per crash (a replacement of propellers + the cost to purchase new ones), in the worst case scenario, the entire drone might have to be replaced costing several hundreds (or thousands) of dollars.

Autonomous piloting shows some promise; however, in the U.S. and several other countries, autonomous outdoor drone use is only legal if there is a manual override available, and a licensed drone pilot at its controls. The net result is that most drones today are flown using a combination of manual and semi-autonomous control- meaning manual control is still here to stay for the foreseeable future.
High-level requirements list

- Easy to teach how to pilot with and easy to handle for pilots of varying skill levels.
- Compatibility with multiple drones that are currently available in the market and for custom built drones.
- Precise and intuitive control that allows the pilot to perform common maneuvers with ease.

Ethics and Safety

Testing Safety

Since OmniPilot™ seeks to be a new control system for a drone, it will be necessary to conduct various tests during product development cycle, using a semi functional drone controller. Because of this, there will be several precautions that will be taken to ensure that no harm is done to any people involved in the process, the following are a list of testing policies that will be adhered to during development:

- No testing will be done alone.
- All testing will be done inside an enclosed indoor space to prevent the case of an out of control drone causing public harm.
- The drone, during testing, will only be flown inside a space that does not have any people in range. Piloting will be done from behind a barrier. This barrier can be set up in multiple ways:
  - A cuboid made of PVC covered with standard netting. This will serve as a testing space in scenarios where the location of demonstration cannot be controlled, as it can be moved and set up in various locations with enough space.
  - Racquetball / Squash Rooms or other rooms with a window to look through; also includes the IlliniDrones drone cage.
- The drone will be programmed with a failsafe to shut off and automatically crash when the it loses signal from the controller; this is in addition to a manual “shutdown” signal from the controller.
- No tester shall under any circumstances whatsoever attempt to catch, or otherwise crash a drone with physical force. It will instead either be attempted to land through the controller or allowed to automatically crash-land through the failsafe.
  - In the worse case scenario of an unresponsive drone: it will be allowed to simply run out of power or safely crashed into a wall or netting from behind the barrier.
Legal Restrictions

The Federal Aviation Administration (FAA) regulates the flight of drones in United States airspace, by all users commercial, civil, or private. The full text of the regulations covering unmanned aircraft can be found online [1].

In summary, the important rules are as follows:

- Small UAVs must weigh less than 25 kg.
- Small UAVs must be in direct line of vision of the pilot and visible without aids; excepting corrective lenses.
- Small UAVs may not operate on top of any persons not participating in the flight, under a covered structure (such as a tarp), or inside a vehicle.
- Small UAVs may not be operated from a moving vehicle unless in a sparsely populated area, and never operated from a moving aircraft.
- Small UAVs may not fly above an altitude of 400 ft above ground level or the building they are being flown from.
- A person operating a small UAS must either hold a remote pilot airman certificate with a small UAS rating or be under the direct supervision of a person who does hold a remote pilot certificate.
- **The FAA does not regulate drone flight indoors or in otherwise private spaces. Legal responsibility for indoor flight lies with the drone pilot.**

Ethical Considerations

In the event that anyone feels that the project is in breach of a professional code of conduct shall be brought up to the rest of the team and any appropriate changes shall be made. As a guiding principle, all engineers working on the project shall adhere to the IEEE code of ethics.

Misuse

Making drones accessible means increasing the potential for misuse of drones. This is an inherent issue in the increase in accessibility of any device. However, drone use is regulated and enforced at the federal level. Furthermore, the increase in accessibility of a device provides benefits that outweigh the negatives. For these reasons, misuse of the controller as a product is not considered further.
Design

Block Diagram

This design will allow for swappable transmitters enabling the controller to work with multiple drones on the market. Furthermore, by using a 3d joystick in place of a traditional input system piloting becomes easier across skill levels and allows for precise maneuvers. The rest of the parts of the block diagram help ensure ease of use and maintain features that users have come to expect of drone controllers.
Physical Design

The following is the enclosure of the controller. The mechanical design of the controller is outside of the scope of the project, it is left to an outside team, and the electronic systems design contained in the controller is the focus of this project.
Block Descriptions & Requirements

Power

Drone flight is typically outdoors. This means that the system needs to have a built in power source. This will be accomplished with a battery and a charging circuit to go with it. This is a basic feature of most drone controllers.

Requirements:
- The power system must satisfy, and exceed the basic voltage and current requirements of the controller processing systems. The power output must appear constant and stable to the other systems, and be able to supply the controller for at least the duration of a maximum flight time.
- The power system must be capable of handling the transient power demands of the controller.
- Power must adhere to safety standards

User Interface

The user interface is arguably the most important part of this project. By eliminating the use of multiple joysticks and with a unique physical design, we hope to achieve the goal of making piloting simpler for everyone.

Requirements:
- Must support features that are typical of drone controllers
  - Alarm for low battery
  - Inputs to control auxiliary transmission channels
- Must provide visual reference for orientation of the controller; i.e. must show which way is forward.

Transmitter System

The transmitter system allows for the use of the controller with multiple drones. This will be accomplished by creating a common port and custom housing for different transmitters.

Requirements:
- Must be compatible with off the shelf transmission modules
- Must adhere to FCC wireless standards
Control System

The control system, a micro-controller, will manage the task of interpreting the input from the 3d joystick, applying user specified tweaks, while also managing the rest of the user interface and providing output to the transmitter. It will also handle the USB port.

Risk Analysis

The control system is the largest block of risk for our drone controller. Though the consequences for safety would be minimal given our testing considerations, any point of failure within the control system could potentially result in crashing the drone we will be using to test the controller. A severe incident might set us back weeks, and given the short time frame for the project it would put us on a very tightly paced development process.

This is the highest risk due to the nature of developing a drone controller, any failure during the control process could result in loss of drone control, resulting in a crash. A worst case crash would cost both time and money in replacing the drone.

References
