Designing a UAV to monitor the needs of humans in R&D environment

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Research Areas

3D printing an Unmanned Aerial Vehicle, creating drone simulations, designing a gripper to pick small objects such as water bottles and designing a smart kill switch for the drone as well as for the public safety has been the main focus of this research. This research has been built upon some existing research areas such as Unmanned Aerial Vehicles, Autonomous control, Engineering Design, Innovative technology, Robotics, Multirotors, Artificial Intelligence, and Smart systems are the research topics included in this research.

Motivation or Background

I was initially interested in Robots (Unmanned Ground Vehicles). But when I was introduced to drones, it was overwhelming to realize how much UAVs can do to help people. Whether it be capturing a beautiful scener y, escaping a human, or delivering packages, drones have the potential to help humans in almost every aspect of life.

The idea behind researching Unmanned Aerial Vehicles was to help humans overcome some of the most challenging tasks as well as advance in their daily lives. With the hope of accelerating the process of normalizing the use of drones.

Objectives

1. Design and build an Unmanned Aerial Vehicle.
2. Design a gripper for the UAV capable of firmly picking up small objects such as water bottles, packages, etc and delivering them to another place.
3. Design a SAEF (Self Activated External Fail-safe Landing System) for the UAV to preserve the safety of the drone as well as its surroundings.

Process

The research is divided into three parts as described in the objective. In order to understand the mechanism and physics of a drone, I started off from scratch. Under the supervision of my mentor, I 3D printed parts of the drone. After building the hardware, the microcontroller was tuned for new Kp, Ki, and Kd values in cleanflight. The drone was then simulated before physically being tested.

After several stable drone flights, the next part was to implement a gripper on the drone. For the purpose of detecting objects, 2 cameras were attached to the drone (one to scan for horizontal x direction and the other for vertical y direction) Extensive research on drone grippers was done to see what kind of gripper would be best for the drone to pick up objects. The physical design for the gripper is yet to be completed.

The second part would have marked the end of the research if my senior design team would not have been interested so interested in this research. Maybe it was a coincidence but after the gripper design, I left the project due to senior design and the sponsoring company for our senior design project wanted us to design a kill switch capable of safely bringing down the drone in the event the communication between the drone and the user is lost. And so I got to expand upon my research.

Although the primary task of the kill switch is to detect the loss of RF and GPS signals and bring down the UAS safely to the ground, there are some additional functionalities of the system in order to aid the drone pilot and increase the effectiveness of the system overall. One of these additional capabilities is to maintain a bi- directional RF link (20-100 km) to provide status of "kill-switch" as active or inactive every 60 minutes. Another capability is to allow the UAV to go in "sleep mode" in order to save battery life after providing the UAV status to the user The kill switch system also allows the UAV to do local tracking using RFID Tags, Satellite trackign and R tracking and FID tag is used for the post descent recovery.

Results

For the first part of the project, the drone was built successfully and the parameters were tuned in a way that a stable flight was achieved (physical design).

Fig. 2
Final look of the drone with 3D printed parts, R pi, designed circuit board, and power supply

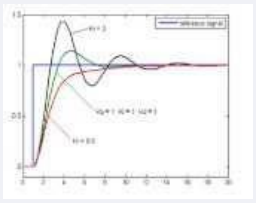

Fig. 3
Response of PV to step change of SP vs time for Ki (Kp and Kd held constant)

Although the gripper was not complete, but computer vision was implemented on the drone.
The Kill switch design is complete and will be implemented and tested by the end of this year.

Figure 1. Safe landing of the drone in case of GPS and RF signals lost

Skills and Experience

The skills and experience required to conduct this research include familiarity with Linux Operating system, Robot Operating System, Python and C++ programming languages, Fusion 360, gazebo, PID controller, cleanflight, RFID tags, raspberry pi zero, and pixhawk.

Prior to working on this research, I had experience working in Robotics And Motion (RAM) lab with chatbots, animatronics, and game development. I learned skills necessary for this project during the summer prior to conducting this research.

What I Learned

This research helped me gain a lot of new skills such as using ROS, raspberry pi, pixhawk, etc. I also learned a lot about mechanism of UAVs, their role in research and development, and how they can impact our society.

The skills and experience that I got out of this research also opened up an internship opportunity for me in the industry. I was hired solely because I had conducted this research in the Autonomous Control and Engineering lab.

Future Plans

Since this research became a part of my senior design project, I will be working on this project until we have implemented the physical design of the gripper and the kill switch.
There is a lot of research to be done on UAVs and especially on the risks of flying a drone in general public. There is absolutely no way for a UAV to come back to where it was sent off without any outer interference from the pilot.
There is a possibility that I or one of my team members might take on this project and expand it further to solve the unsolved problems as part of masters thesis in the future.

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