Flight Using Sensor Feedback

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November 16, 2011

Abstract

My proposal is to program a model airplane to navigate to a sequence GPS points, and capture infrared images of the ground at those designated points. The purpose of this work is to create a UAV that can take accurate pictures of the land scape in infrared to allow gathering data about plants in the area.

1 Introduction

During the summer of 2011 two Allegheny College students, Ian Armstrong (2012), and Anthony Smith built a programmable airplane. In order for the plane to run they needed to install a motor and sensors. Additionally, they needed a small programable computer to control the airplane. By the end of their summer, they successfully built and programed the airplane to fly in a straight line.

An Arduino is a small affordable device that can be bought from http://Arduino.cc/EN/. The Arduino allows for average end-users to experiment with robotics the Arduino is âĂIJintended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environmentsâĂİ. The Arduino board is set up in such a way that users can use both digital and analog inputs in order for the Arduino to sense its environment. During this project we plan to use a programming language called Occam-Pi. Occam-Pi is a process oriented programming language. This type of programming language focuses on processes. However, Occam-Pi is not a native language on the Arduino so we have to install it on top of the existing language that is already on the Arduino.

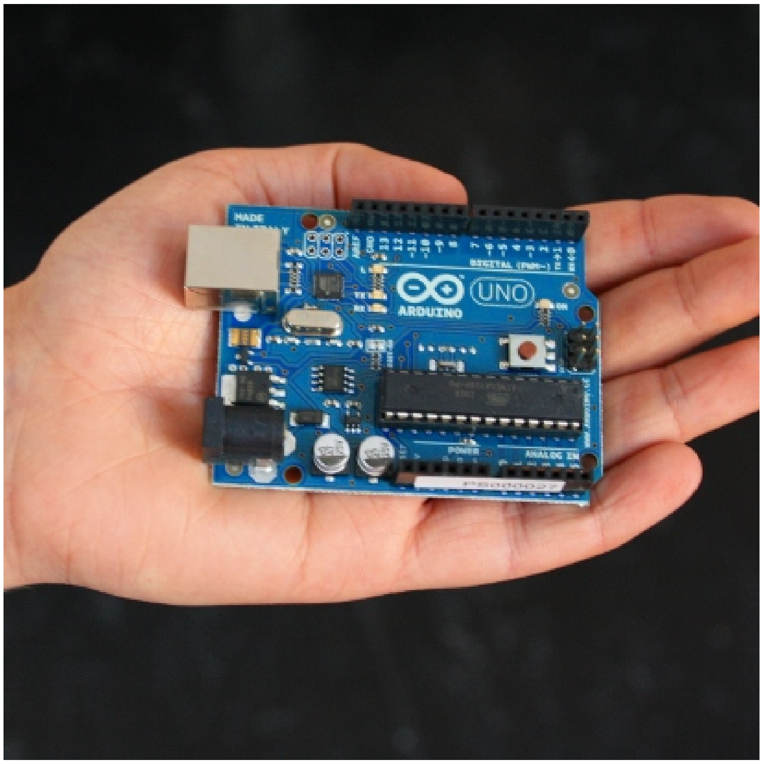

Figure 1: An Arduino [?]

For the purposes of my project we will be using what an Ardupilot.

Gyroscope sensors are widely used in order to to interpret the orientation of a divice. There are many different types of gyroscope sensors such as rotary gyroscopes, vibrating structure gyroscopes and optical gyroscopes.

Throughout all the different types of gyroscopes they all have at least one axis of measurements. Recently with acceleration of technology gyroscopes can now have up to 3 axis on a single gyroscope. 3 axis gyroscopes combined with 3 axis accelerometers "provide a full 6 degrees of freedom (DoF) motion tracking system [3] ".

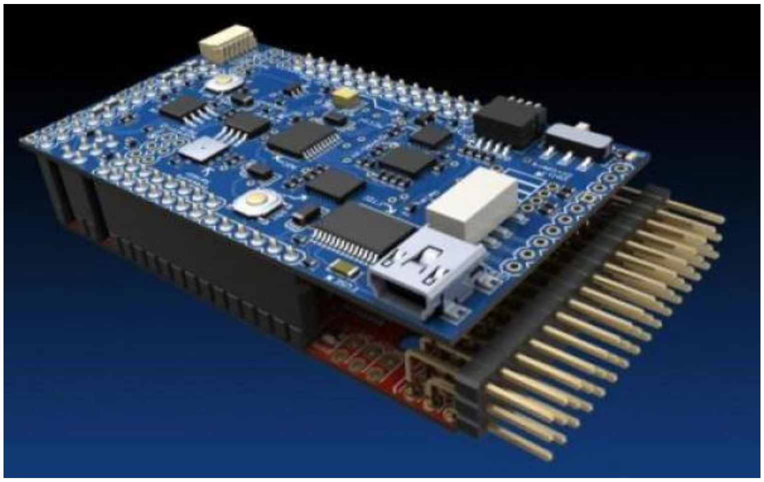

Figure 2: The Ardupilot [?]

Occam- Π

Currently the plane can fly in a straight line using only the gyroscope and accelerometer. However, the airplane has yet to execute a turn without . In part, this is because turns require a certain airspeed in order to execute successfully. This is a major challenge in programming an airplane because the accelerometer becomes easily confused due to multiple forces such as gravity and other G forces pulling in different directions. The conflicting sensor data is hard to interpret because the accelerometer reports the amount of force that it is pulled in. ****fill in more about why this matters****d

Implementing a wind speed sensor will enable the plane to measure its speed while turning. The plane can use the information to keep the proper air speed to stay aloft while turning. The second sensor is the GPS which has a two and a half meeter resolution.

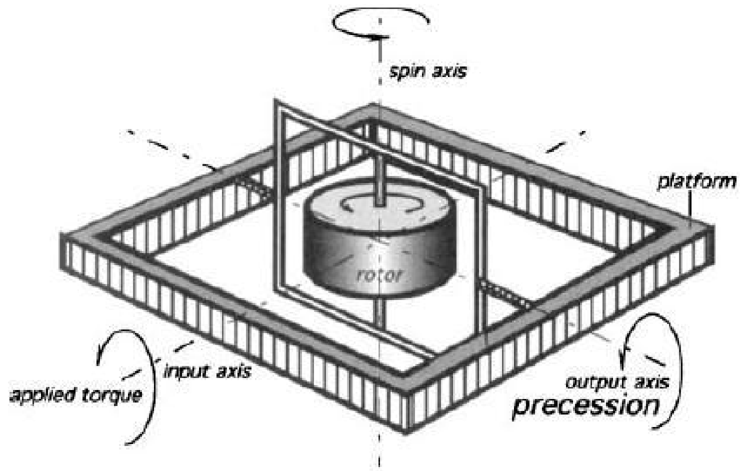

Figure 3: Rotary Gyroscope sensor [3]

This means that the GPS sensor will accurately pin point the planes position within a imaginary bubble two and a half meeter's wide.

Figure 4 shows a simple directional pattern that the airplane would follow. There are many uses that way point flying plane could be used for.

this paragraph should make clear to the reader what we do and why it is valuable

By completing an airplane that can reliably get from point A, to B, to C, many possibilities become practical. Figure 5 shows a infrared picture taken by a satellite in 2005 [1]. I hope to successfully program the plane to turn successfully, and be able to travel to select way points.

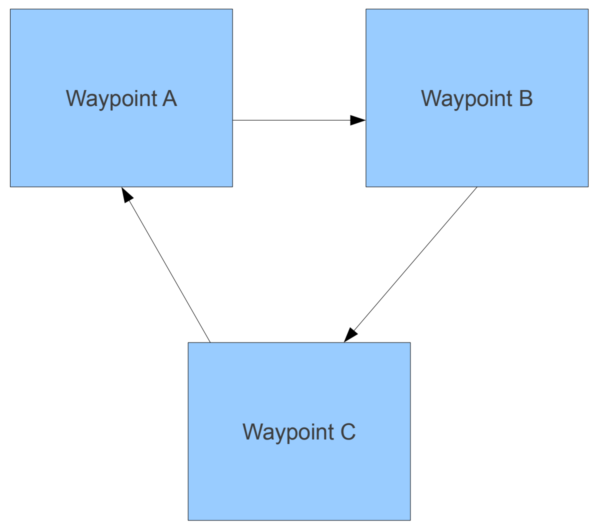

Figure 4: Flying Waypoints

2 Background

A robot can perform many tasks, but those tasks must be preprogrammed. Different physical architectures give robots the ability to change what tasks are physically possible. In addition, the architecture of a robot can affect how well a robot can preform specific tasks. Essentially, a robot is a device that uses sensor information to preform specified actions given that certain programmed circumstances are met.

2.1 Sensors

In order for any robot to function to a particular degree of accuracy, it must have sensors. Without sensor feedback, a robot could be thought of as being blind, as a result of no data being available to navigate its environment. In general there are many different type

Figure 5: Inferred Crop Imaging [1]

of sensors, each type of sensor has its own uses and weaknesses. The sensors that will be used in this proposal will fall into categories such as distance, speed, and location.

In order to fully utilize sensors, the programmer must have knowledge of how those sensors work. For example, the Braitenberg Vehicle is a simple way of conveying fundamental information about the light sensor.

This vehicles basic function is to move towards the brightest spot it can find. In Figure 6 each of the wires from the light sensors attach to a motor on the opposite side of the robot. Lets assume that the larger the feedback value from the light sensor, the faster the motor linked to it will run. At first the wiring may seem contradictory to the robots goal. However, think about the leftmost sensor. The greater the feedback value, the greater the signal output, which in turn causes that motor to run faster. So suppose that in this case the light value is stronger in the left most sensor. This will cause the right motor to

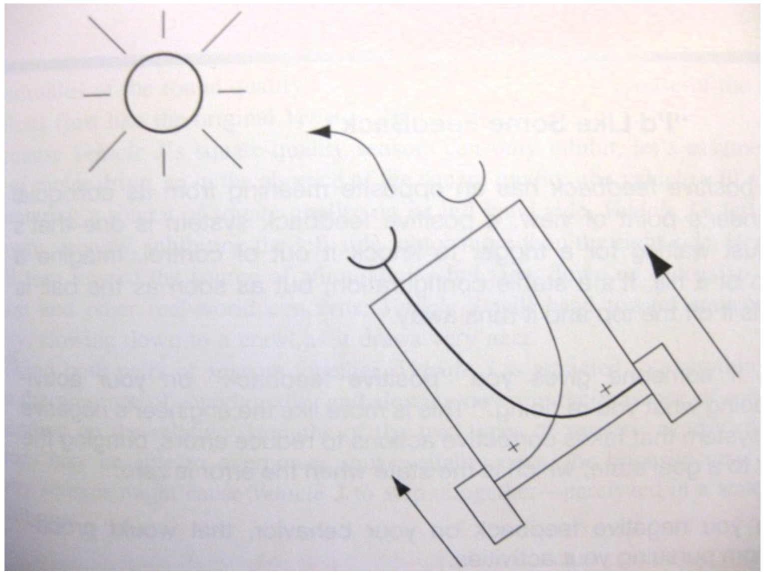

Figure 6: Braitenberg's Light Finder [2]

increase its speed proportionately to the light feedback value. Remember, the right most sensor is not receiving as strong of a light value from the sensor. This will cause the left motor to run, but it will not run as fast as the right motor. Due to the difference in speed between the motors, the robot will turn left towards the stronger light source. Overall, using a single sensor to preform actions is relatively simple. However, using multiple types of sensors used in conjunction can make this much more complicated.

3 Evaluation Strategy

Logically, some parts of evaluating whether or not the project works will be clear (such as if the airplane fell out of the sky during a turn). The most challenging part is ensuring that the GPS navigation works correctly every time. For crop imaging to be successful, we must be able to take a picture of the same location reliably. It is a given that our accuracy has a limit due to the resolution of the GPS sensor. However, giving leeway

for that limit we can compare dozens of photos and see how accurately they match up. This will allow us to evaluate the effectiveness of our airplanes ability to follow and take pictures of a preset path.
get

4 Research Schedule

- 1 week to research how the gps works
- 2-3 weeks test and build general direction based routing algorithm
- 1 weekend to test gps and pitot tube walking.
- 1 weekend to test gps and pitot tube while in car.
- 1 weekend to capture raw data during remote control flight of plain.
- 4-7 weeks program plane and test.
- 2 weeks write proposal.
- **Future Work:** Implement the third dimension axis.

5 Conclusion

Auto-piloted model planes are uncommon, and exceedingly expensive. Creating a simple plain that can fly to pre-selected destinations can have many uses. Crop imaging is a prime area in which work is being done. However, taking pictures of the same place is too costly and expensive to implement long term. The creation of this airplane will give experience to the programmer and allow for future work to evolve the usability of the system.

References

[1] *Crop Identification*, May 2011. www.seos-project.eu/modules/agriculture/agriculture-c03-p03.html.

[2] Fred G. Martin. *Robotic Explorations: A Hands-on Introduction to Engineering*. Prentice Hall PTR, Upper Saddle River, NJ, USA, 1st edition, 2000.

[3] sensorwiki.org. Gyroscope, 2011. http://sensorwiki.org/doku.php/sensors/gyroscope.