Building an Agricultural UAV System for Aerial Field Surveys

The Problem
Currently, farmers with large farms tend to spray the entire field when problems arise. Blanket spraying of chemicals (including pesticides and fertilizers) is expensive, increases pesticide resistance, and harms the environment through run-off.

An Opportunity—Commercial UAVs
The FAA has indicated plans to allow commercial use of UAVs beginning September 30, 2015. Agriculture is a prime potential application, and AGCO would like to be prepared to take advantage of such an opportunity.

System Overview

Hardware
- Kestrel Autopilot—Navigates autonomously to waypoints and capable of autonomous takeoff and landing
- MAJA Fixed-Wing Plane—Chosen for durability, payload space, and long battery life
- Pentax Camera + Autopilot Interface Board—Allows correlation of photographs with autopilot-collected data
- Commbox—On-the-ground hardware for communication with the autopilot
- RC Controller—For manual flight control
- Laptop—Virtual Cockpit software for mission planning and monitoring

Software
- Image Stitching—Creates a single map of the aerial images taken by the UAV
- User Placed Fiducials—Creates a coordinate system for the field based on known locations
- Feature Detection—Outlines and returns contour coordinates for markers representing problem spots

Demo
The user interaction with the system is described below:
1. The flyover area is defined in advance.
2. The user launches Virtual Cockpit software, arms the plane’s motor, and manually takes off.
3. Plane takes overlapping images of the field, time-stamps them, and stores them on the SD card in the camera. The autopilot also sends time-stamped altitude, orientation, and GPS data back to the ground station.
4. Vital indicators (battery life and signal strength) are displayed to the user during flight.
5. At the end of the mission, the plane returns to a "home" point.
6. The user inserts the SD card into the laptop and launches the post-flight application.
7. The application stitches the collected images into a map and displays GPS coordinates of problem areas (markers).

Our Goals
As a part of the AGCO R&D team, the AGCO SCOPE team had 5 main goals:
- Explore potential uses for an agricultural UAV and develop a compelling use model
- Design a preliminary system architecture
- Create a demonstration prototype, documenting the process for AGCO’s future use
- Evaluate the potential financial benefits to farmers to determine whether a commercial agricultural UAV is a worthwhile pursuit for AGCO
- Identify problems that must be solved in order to create a fully functional, commercial product

Future Work
- Sensors and software to identify problems with crops
- Increased automation (i.e. takeoff and landing)
- More rigorous software testing with a multitude of data collected from a plane
- Integration of this system with a sprayer

SCOPE 2012—2013
Advisors: Andrew Bennett, Osa Fitch (Angel Advisor)
Liaisons: John Peterson, Jeffrey Zimmerman
Team members: David Gaynor, Geetanjali Gubba, Geoffrey Pleiss, Travis St. Onge, Ilana Walder-Biesanz

SCOPE Senior Capstone Program in Engineering

Franklin W. Olin College of Engineering