ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 3, Issue 9, September 2016

Drones in the Field of Agriculture

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***Abstract*—This paper describes the use of Unmanned Aerial Vehicle in the field of Agriculture. Drones, or unmanned aerial vehicles (UAVs), have been used by the military since WWI for remote surveillance. In the last decade, farmers have begun using them to monitor their fields as well as aiding precision agriculture programs. There are estimates that 80 to 90% of the growth in the drone market in the next decade will come from agriculture. The ease of use and ability to specialize each system means there will be a UAV for every situation. UAVs can monitor fields more often than satellites, take more detailed pictures, and are not obstructed by clouds. The different types of cameras can monitor data like photosynthesis rates or find where patches of weeds are in a field.**

***Keywords*—Drones, Agriculture, Digital image processing, Autonomus, Flight control**

I. INTRODUCTION

An Un-Manned Aerial Vehicle is an aircraft with no human to control instead it is controlled by autonomus flight control. Unmanned Aerial Vehicles (UAVs) have been referred to variously as drones, robot planes, pilotless aircraft, Remotely Piloted Vehicles (RPVs), Remotely Piloted Aircrafts (RPAs), and other terms which describe aircraft that fly under the control of an operator with no person aboard. They are most often called UAVs, and when combined with ground control stations and data links, form unmanned aerial systems (UAS). UAVs vary widely in size and capacity.Though often associated with military activity, there is also keen interest in UAVs by domestic law enforcement, the private sector, and amateur enthusiasts. This is largely due to the decreasing cost of UAV technology, and to the fact that UAVs have distinct functional advantages. Quad copter and wing aircraft drone are best suited for theagriculture industry. Drone is well equipped with an autopilot using GPS and a point to shoot camera that is also controlled by GPS. Importance of Drone can be understood from the fact that it can provide farmers with three detailed views. First, keeping eye on crop from the air can help reveal patterns that show a problem related to irrigation, soil variation and fungal infestations. Secondly, drone uses Satellite remote sensing method which is used to identify the crop growth by comparing multiple images taken by the satellite. Third, airborne cameras can take multispectral images, capturing data using visual spectrum as well as infrared, which shows the difference between the distressed and healthy plants which can't be viewed with naked eyes.

A. Autonomous flight control in drones

Drones are controlled autonomous control, the relay on the feedback from the sensor and a particular feedbackperforms certain operation in the drone. Drones such as quadcopter consist of are a multirotor helicopter that is lifted and propelled by four rotors. Quadcopters generally use two pairs of identical fixed pitched propellers; two clockwise (CW) and two counter-clockwise (CCW). A quad copter may contain a small flight control along with accrlerometers(IMU), Global Positioning System and cameras the autonomous control system runs on the BBB, a linux-based single-board computer. The developed atonomus software will be loaded onto the BBB where a route for the aircraft will be automatically generated based on the user input. Google Earth path input data will be sent to the BBB to process and establish navigational waypoints. The aircraft will follow its set path autonomously, driven by the autopilot system. If emergency remote control is necessary, manual operation can be enabled at any point during flight. A standard R/C transmitter will initiate a signal to the BBB to shut down, and the aircraft will respond only to manual control. The transmitter's signals will manipulate the servos and electronic speed control on the aircraft to direct flight. During flight, The IMU will communicate information from the gyroscope, compass, accelerometer, and barometer to the Beagle Bone Black. The GPS will determine current location at the rate of 1Hz.The autopilot PID control software will automatically adjust the ailerons, elevator and rudder to maintain flight stability and GPS route navigation. The switch between manual control and autonomous control may be made at any time using the RC transmitter.

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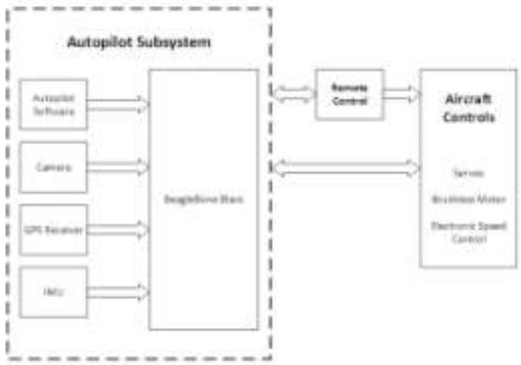

Fig.1 Autopilot Block Diagram

A. Sensors used in Drones

Drones relay on the sensor for their autonomous control . Drones consist of vast range of sensors .RGB camera is used for visual inspection, elevation modeling, plant counting. NIR (near-infrared) sensor is used to soil property & moisture analysis, crop health stress analysis, water management, erosion analysis, plant counting .RE (red-edge) sensor is used to analysis crop health, plant counting, water management. Multi SPEC 4C (multispectral) sensor combines both NIR & RE applications. Multispectral remote sensing provides radically new perspectives on the health and vigor of crops. It allows growers and agronomists to detect areas of stress in a crop and manage these issues immediately. It enables precise application of nutrient inputs and disease preventative actions based on the actual field conditions. The colors we see in light are defined by the wavelength of that light. Plants absorb and reflect light differently depending on this wavelength. Plants typically absorb blue light and red light, while reflecting some green light. They also reflect a much larger amount of near-infrared (NIR) light, which is not visible to the human eye but is visible to multispectral cameras like Red Edge and Sequoia. The reflectance curve of a typical plant is shown below. Reflectance is the percent of light that is reflected by the plant. By measuring the reflectance of a plant at different wavelengths, multispectral imaging enables identification of areas of stress in a crop, and provides a quantitative metric for the vigor of a plant .Multispectral cameras work by imaging different wavelengths of light. Multispectral cameras have multiple imagers, each with a special optical filter that allows only a precise set of light wavelengths to be captured by that imager. The output of the camera is a set of images for that particular wavelength. These sets of images are then stitched together to create geographically accurate mosaics, with multiple layers for each wavelength. Mathematically combining these layers yields vegetation indices. There are many types of vegetation indices that measure different characteristics of a plant. Some indices are useful for measuring chlorophyll content of plant leaves, which can provide a reliable indicator of nitrogen status and help inform fertilizer management decisions. Other indices can be used to estimate the amount of leaf area per unit ground area (leaf area index) and help identify within-field differences in crop development or vigor. One popular index is the Normalized Differential Vegetation Index (NDVI), created by combining the reflectance from red and NIR light. A single-imager multispectral camera uses a blocking filter combined with the standard camera's built-in filter to capture information in 3 wavelengths of light. Because these imagers aren't optimized for remote sensing, the built-in filters are wideband and suffer from data contamination from neighboring bands. This figure shows a comparison of narrowband optical filters and the filters used in a typical single-imager camera. A professional multispectral camera like Red Edge or Sequoia uses narrowband filters with known characteristics combined with factory calibration parameters, enabling accurate measurements of reflectance that a converted camera simply cannot match.

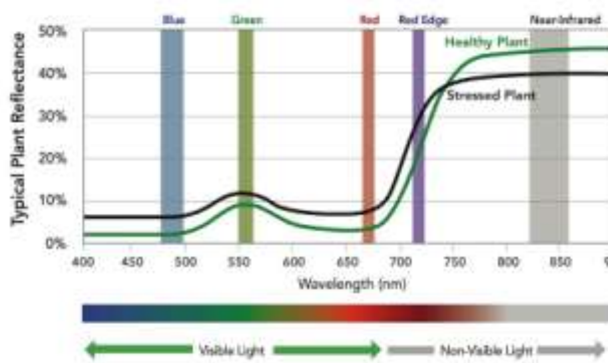

Fig.2 Common Reflectance Profiles of Crops

IFERP
ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
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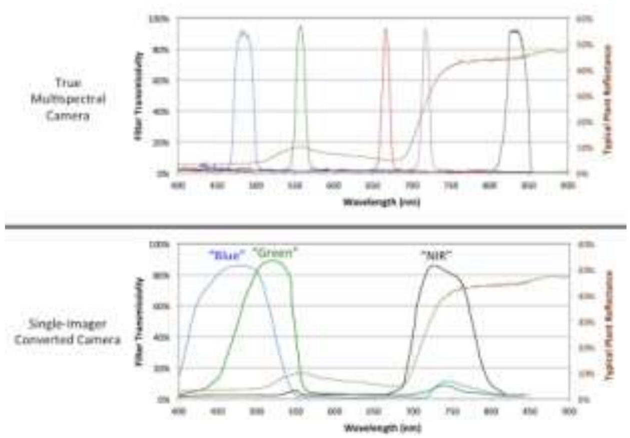

Fig.3 Narrowband Filters

II. IMAGE PROCESSING SYSTEM AND GPS NAVIGATION FO DRONE

As the drone passes over the selected area, the down facing camera will collect overlapping images that cover the entire area. As each image is taken, the BBB will store location data from the GPS receiver. After flight, these images will be assembled into one image of the entire user selected area based on overlap and GPS location if necessary. This camera will also have optical filter capabilities to allow specialized imaging applications. The camera will use an "infrablue" filter. This filter allows a near infrared image to be captured in the red channel of the camera, while still capturing the visible spectrum in the blue channel. After all the GPS data and images have been stored in the BBB, the image processing software will create a single large image of the surveyed area. After the images have been stitched together, further filtering will be done to provide an image that may be used to analyze crop health according the Normalized Difference Vegetation Index. The Normalized Difference Vegetation Index, or NDVI, is a simple indicator used by NASA to determine if there is live plant life. The index ranges from -1 to 1, with 1 appearing as a bright green. The scale is calculated using the equation, NDVI = (NIR VIS)/(NIR + VIS), where NIR is the near infrared channel, and the VIS, is the visible channel. This works on the fact that plants absorb red and blue light, while reflecting the infrared.

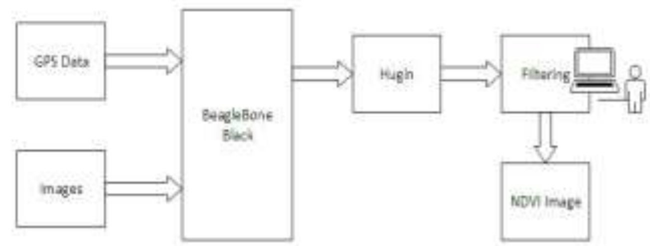

Fig.4Image Processing Software and Final Filtering

A. Sensors used in Drones

The GPS Navigation system software flowchart is shown in Figure. First the user inputs a waypoint path in the Google Earth "GUI." The steps for using Google Earth to save .kmz path files are listed below:

1. Open Google Earth.
2. Locate survey area.
3. Draw path of waypoints.
4. Save path as a .kmz file.
5. Transfer file to Beagle Bone Black.
6. Input file name to navigation program.

Once the path is input to the program, user interface is complete. The code parses the file, computes the waypoints, calculates distance and bearing, and adjusts flight course if necessary by position the rudder with pwm signals. Once the last waypoint is reached manual control will be resumed and the user will land the plane.

The PID servo control software flowchart is shown in Figure. All servos are initialized to center positions, the sensor buses are set up, and PID control sensor set points are initialized to level flight values. During flight, the sensors will provide readings about once per 80ms period. If adjustment is needed for stable flight, the current accelerometer values will be offset from the accelerometer set points. This error will be calculated and weighed with previous error to calculate the amount of servo position adjustment (to the corresponding ailerons, elevator, and rudder) needed to maintain stable flight. The process will be repeated in the loop for the entire autonomous portion of the flight.

When the complete code is executed, the GPS navigation system and PID servo control loop are run in

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)

Vol 3, Issue 9, September 2016

separate threads so timing is not an issue. The “take picture” script is also run in a separate thread, which prompts the camera to take a picture every few seconds.

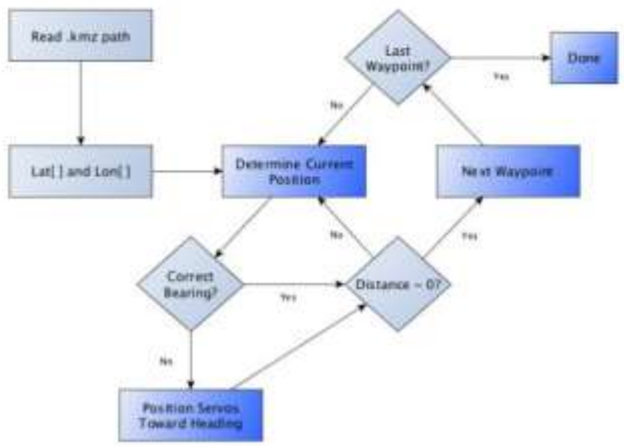

Fig.5GPS Navigation System Flowchart

III. ADVANTAGES AND DISADVANTAGES

Agricultural drone has successfully paved a new means of increasing productivity by the farmers. These drone are becoming popular tools similar to any other consumer device. The Drone will play a crucial role in agriculture in the next decade, which will help the farmer to transform the agriculture industry with little technical knowledge. Drone can help farmers in various aspects such as soil fertilizing, spraying pesticides and seeding. It will also help cattle farmer to keep count of their livestock gone astray or stolen. Disadvantages: Drones are best suitable for large farms compared to the smaller one as they cover larger area, which is not the case with smaller farm. One of the major disadvantages of using drone is linked with the privacy concerns. Majority of Countries follows loose guideline to govern the use of drones. Another disadvantage of using drone in agriculture is that it has limited access to carry the load. Most of the farmers believe in adopting traditional means of crop care compared to the agriculture drone as use of these drones requires technological know-how.

CONCLUSSION

Agricultural drone have the potential to improve the crops and helps in providing an insight about the disease management technique through imaging and sensors. It will also provide help in the monitoring of irrigation and water supply by predicting the availability of water through glaciers. Agricultural drone can help the farmers to transform the agriculture industry.

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