Prediction of Payload Drop Point

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Abstract: ***This paper aims to predict the drop point of a payload attached to an unmanned aerial vehicle (UAV). The Data Acquisition System utilises two arduino boards, one present on the UAV and one present on ground. Both the arduinos communicate through RF modules. The one present on the UAV has various sensors whichcollect the wind speed, altitude, air pressure data and send them back to the arduino board on the ground which receives it and feeds it to a computer, which helps to evaluate the exact drop point coordinates for the payload. The system uses a FPV (first person view)camera attached on the UAV to give a live video feed back on the ground on a display unit (laptop screen).This FPV tells us where exactly the payload will be dropped according to the data collected by the sensors on board the UAV.***

Keywords: Payload drop, UAV, Umanned Aerial Vehicle, Humanitarian aid package

1. Introduction

UAVs (Unmanned Aerial Vehicles) are defined as aircrafts that can fly without the need of a pilot to sit in them. They are controlled through a ground based controller by either a human or completely autonomously with an on board computer.

They are usually used for reconnaissance, surveillance, payload delivery and have been adopted by governments across the globe to perform the same, in some cases rather aggressively. However, they are also used on a smaller scale in freelance photography and video recording.

Our paper aims to further the applications to include disaster relief projects such as finding and delivering food to those in need and that can't be reached through normal means. This will be achieved through our accurate payload drop point predicting system.

2. Data Acquisition System (DAS)

For our DAS the team incorporated an Arduino based wireless communication system and used a 915MHz antenna for transmission. A pair of NRF905 modules was used to establish a two way communication between the transmitter and receiver. The setup includes a barometer to provide a continuous feed of the current height of the plane, and a pitot tube and accelerometer are connected to get the relative wind speed and orientation of the plane.

3. First Person View (FPV) System

The FPV system operates on a 5.8 GHz band. It comprises of 5 main components:

1) FPV camera: The FPV camera used for the micro aerial vehicle is manufactured by Boscam andcan provide optimum video feed with 720p at 30/60 fps and 1080p at 30fps. The main reasonsfor selection of Boscam HD19 are (1) Low emissions in the 2.4 GHz, 915 MHz bands and (2)Cost compared to other cameras (approximately 1/3rd compared to other FPV cameras).
2) Transmitter: The system utilizes a 200mW 8-channel transmitter manufacture by Boscam.
   (Model no. TS-351)
3) Receiver: The system utilizes an 8-channel receiver manufactured by Boscam.
   (Model no. rc-805)
4) Display unit (laptop screen)
5) Antennas used: Clover leaved antennas are used to facilitate communications at all orientationsof the plane and for a longer range. This is due to the circular polarization of the antenna. Theuse of antennas was decided after a comparative simulation of dipole antennas and Clover leavedantennas using Ansoft HFSS simulation software.

4. MATLAB Interface

The visual input feed is given through the FPV which is then fed to the MATLAB Interface. The visual feed of camera interfaces with the user using a separate window. A circular projection overlaps the visual feed, as seen in figure 1 giving the user a specific idea about the relative distance.

Furthermore the accelerometer and the Pitot tube provide the user with a constant updates about the relative speed of the plane. Meticulous calculations, based on the basic working principles of mechanics and mathematics, done before hand provide the user with a visual alertness regarding the position of the plane with drop zone.

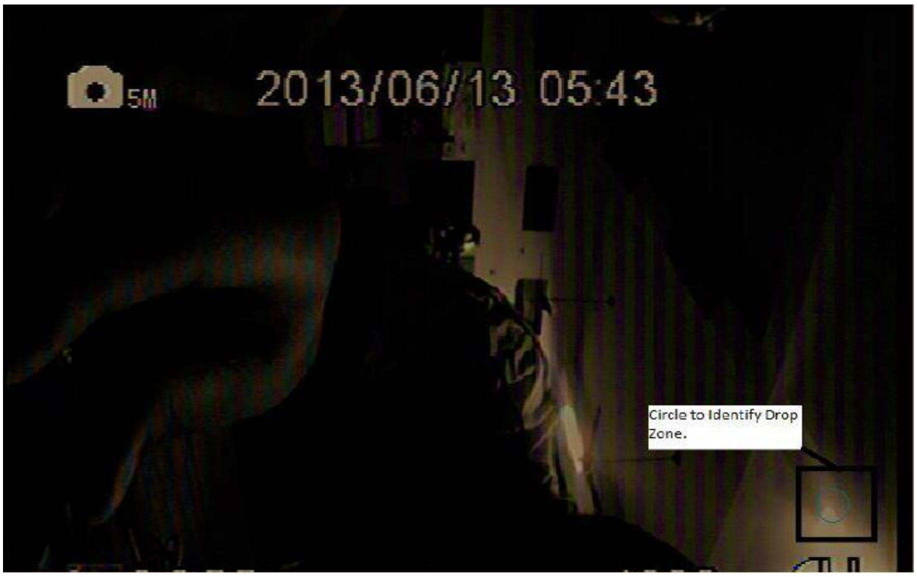

Figure 1: User Interface

The moment the circular projection overlaps with the actual drop zone the payload can be dropped. The circular projection will vary with the speed of the plane. For example if the speed of the plane is increased or the cross winds spontaneously vary then the projection will adjust itself accordingly using the algorithm provided in MATLAB, ergo the estimateddrop point dynamically shifts itself. The algorithm makes use of the data fed by the accelerometer, Pitot tube, barometer processing and accordingly projecting the image of the circle over the continuous video feed.

5. Execution

The speed, altitude and the direction of the UAV is calculated through the sensors on board.[The mass, drag coefficient of the payload is already inputted in] The software system consists of a few important parts

One of the functions is to deduce the vertical actions of payload upon release.This determines how long the payload would take to drop to the drop point and this is calculated using Runge-Kutta formula in MATLAB.

The Events Vertical function estimates the time of descent of the payload which is verified using a stop watch. Using various factors such as horizontal velocity, mass, drag, wind the event horizontal function deduces the horizontal distance travelled by the payload.

Once accurate estimates have been produced, the whole function is used to adjust drag coefficient with respect to side of the payload.

The drop point for the decided target is measured and its coefficient adjusted accordingly so that the deduced distance matches the actual horizontal distance travelled before impact.

6. Results

In our test flights, we achieved a 75% accuracy of the payload delivery through the UAV at hundred feet above ground. Theaccuracy gradually dropped as with the increase the UAV altitude. In result we reached to a conclusion that closer the UAV is to the ground the better the chances of the payload dropping on the intended drop point.

And hence our aim to carefully predict the drop point coordinates of payload through our system was successful. This system could be used during disasters for e.g. in future during disaster reliefs UAVs can deliver packets of food or utility items to those people who have been trapped in areas inaccessible through normal means. In future there could beother greater potentials of this system not be known to us right now.

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