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RESEARCH ARTICLE

Use of Unmanned Aerial Vehicles in Runway Control

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HIGHLIGHTS

- The results obtained from the images in the controls made with the UAV showed that the desired findings will be determined to a large extent in the controls made with traditional methods.
- The UAV will provide instant video images about the runway status and these images will be recorded in an external memory on the UAV.
- The images obtained by the UAV allow to watch these images online and later.

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ABSTRACT

In this study, an Unmanned Aerial Vehicle (UAV) has been developed in order to ensure that the runway control routinely performed by an apron vehicle is performed in a shorter time, with less cost and more safely experimental studies have been carried out for runway control with this developed UAV. With the developed UAV, test flights were carried out at an airport determined by obtaining the necessary permits in the runway control study, and necessary data were obtained. In the region where the test flight was made, the necessary routine checks were made in the presence of experts who made observations with traditional methods, and the points that would pose problems were determined, and the applicability of the UAV in the runway control was concluded by comparing it with the test flight data.

Contents

1. Introduction

Air transport is of great importance all over the world. Today, air transportation is growing day by day. As the demands for air transportation increase, airline companies expand their fleets. In addition, aircraft manufacturers have started to produce new aircraft in parallel with these developments. As a result of all these developments, serious increases have occurred in air traffic. The capacity of airports has started to increase significantly. After a certain period of time, the capacity of airports has reached a level that cannot meet the demands. Therefore, in order to increase the capacity of airports, expansion processes have been initiated or new airports have been established [1, 2].

Runway controls, which usually have to be carried out quickly at airports with very heavy air traffic, must be carried

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out within the visual possibility provided by the car headlights in night conditions. Depending on the circumstances, a continuous surveillance or control situation is not possible [3].

A foreign object that may be present on the pollution caused by aircraft tire tracks on a runway, especially in daytime conditions; If it is not of a size that can be easily seen with the eye, there is very little chance of being detected by an apron vehicle doing routine runway checks on the runway and traveling at 20-50 km/h and the apron mechanic using it. In night conditions, this rate is much lower [4, 5].

In this study, an Unmanned Aerial Vehicle (UAV) has been developed in order to ensure that the runway control is routinely performed by an apron vehicle and the apron mechanic using it is performed in a shorter time, with less cost and more safely. and experimental studies have been carried out for runway control with this developed UAV.

When the literature is examined, UAVs are successfully applied in many civilian applications such as primarily military applications, forest fire, atmosphere research, ocean observations, geological surveys, weather forecasting,

2. Unmanned Aerial Vehicle (UAV)

UAV is an unmanned vehicle which can be used either by a person from the ground through a remote control or it can fly automatically with a flight plan which is planned beforehand [6].

UAV was first used in the 19th century. UAV gain its popularity in the last decade and many scientists focused on UAV. Generally, UAV is used in military purposes but in previous years we are witnessing the use of UAV for academic research and sometimes for civil purposes. In the beginning, a few countries could use UAV, but now many countries have access to the use of UAV [7].

In literature, UAV is generally used for military purposes and sometimes it can be used for environmental issues such as weather forecasts, forest fires, atmospheric research, ocean observations and geological surveys, but until today, their use in runway control applications has not been found [6–11].

2.1. The Advantages of Using UAV

UAV is more beneficial in war zone especially when it is risky for soldiers to get to the zone. Long flights are tiring for a pilot and a pilot may lose his / her concentration, but by using UAV this will not be a problem [12].

The following points are the pros of UAV compared with a normal aircraft [8, 13].

- UAV is more environmentally friendly
- UAV is more economical in terms of manufacturing, maintenance and fuel consumption.
- UAV cannot be easily detected by enemies in the war zone because of its small size.
- If an UAV is shot down it won't cause as much loss as a normal aircraft does because we don't want to lose our pilots.

3. Materials and Methods

In this study, the investigation of the effectiveness of the use of UAV in the runway control study was carried out using a modified 4-engine helicopter model as a platform. The UAV system used in the runway control study consists of an air platform and a ground control station. It provides ease of operation thanks to the sufficient thrust it receives from the model engines, which have sufficient carrying force for the Electric-Electronic (avionic) system and parts.

3.1. UAV Aerial Platform

A rotary-wing 4-engine (quadrotor) mini helicopter was used as an aerial platform. The model used has a suitable place for mounting electrical - electronic (avionic) systems and camera systems such as camera, video transmitter and standard radio transmitter. Figure 1 shows the UAV used as an aerial platform.

Figure 1 UAV

In the runway control studies, a camera system that provides simultaneous image transmission for the detection of foreign objects that may be on the runway has been developed and mounted on the UAV in the most appropriate way without disturbing its aerodynamic structure.

3.2. Ground Control Station (GCS)

In addition to the visual use of the UAV, it is also controlled by transferring the images taken from the camera on the UAV to the monitor with a video receiver in GCS during its use at long distances. By using this system, as mentioned before, the video and audio information coming from the UAV can be taken and the aircraft can be directed and runway control can be done with the help of the images on the screen. GCS consists of a 6-channel standard transmitter (control unit), a monitoring unit (monitor) and a video receiver.

3.3. Autopilot Mode

Thanks to the software adapted to the developed UAV, the runway control can be done with autopilot mode by entering the coordinates of the runway to be controlled.

This is the main control problem of holding a UAV over a specified time period for the desired flight on a predetermined route. During this process, the dynamic status of the UAV could be affected by disruptive impacts created by its own system or caused by the external environment. In the cases of deviation from equilibrium, the desired stability and performance will not be realized during manual control of the UAV from the ground [13].

Holding an aircraft continuously horizontal and fixed on predetermined coordinates and serial control mechanisms designed to generate the commands returning it to its former position in the case of necessary status changes is known as “Automatic Pilot” or “Auto Pilot” [8].

Directing the model to the operation area where manual operation is inadequate, taking images, making exploration and providing more a stabilized flight and facilitating the return of an aircraft which is out of range of the GPS coordinates noted at the beginning can all be carried out by the autopilot system thanks to the software installed into autopilot system. Figure 2 shows the input screen of GPS coordinates in the NAZA-M V2 software which is used by the GCS of the UAV.

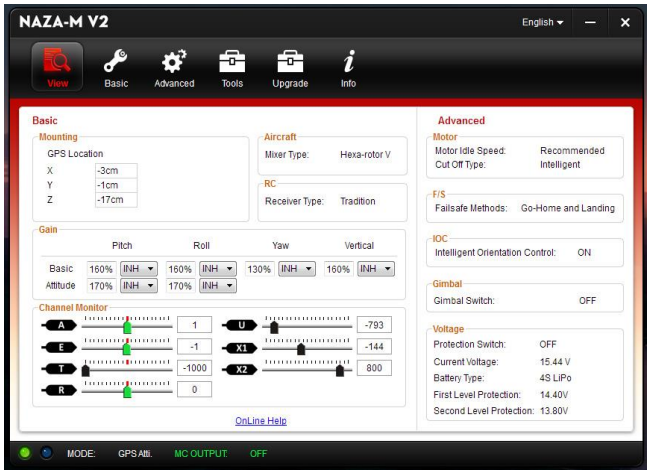

Figure 2 GPS position information input screen

4. Results and Discussion

Test flights were carried out at different flight levels, and the weather conditions on the day of the flight are given in Table 1.

Table 1 Weather conditions on the day of the test flight

	Temperature	Wind speed	Wind direction
Weather Condition	25 °C	7,4 m/s (10 meters height)	From the north

In the study, the following foreign object was observed on the runway in the images sent online by the UAV, which was watched by the experts at the ground control station:

As seen in Figure 3 at 01:31 minutes of the flight, a foreign object (bag) was detected on the runway.

Figure 3 Foreign object (bag) detected on the runway

At 01:37 minutes of the flight, a foreign object (bush) was detected on the runway as seen in Figure 4.

Figure 4 Foreign object (bush) detected on the runway

At 02:47 minutes of the flight, a foreign object (bush) was detected on the runway as seen in Figure 5.

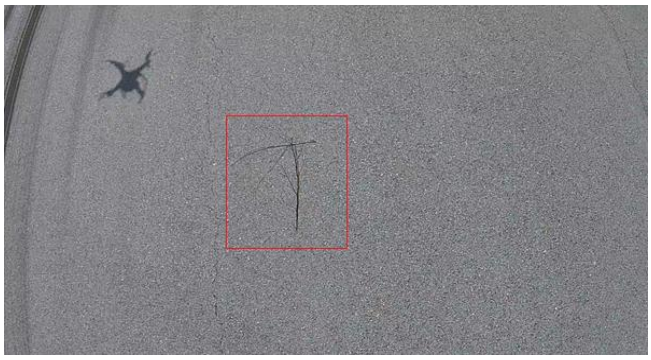

Figure 5 Foreign object (bush) detected on the runway

5. Conclusion

With the realized project, the unmanned aerial vehicle has been made available for reconnaissance, surveillance and operational purposes, and uninterrupted control will be possible using the camera with day and night vision system. With the developed UAV, test flights were carried out at an airport determined by obtaining the necessary permits in the runway control study, and necessary data were obtained. In the region where the test flight was made, the necessary routine checks were made in the presence of experts who made observations with traditional methods, and the points that would pose problems were determined, and the applicability of the UAV in the runway control was concluded by comparing it with the test flight data.

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