International Civil Aviation Organization

Twenty Fifth Meeting of the Communications/ Navigation and Surveillance Sub-group (CNS SG/25) of APANPIRG

Video Tele-Conference, 18 – 22 October 2021

Agenda Item 12: Discuss and share experience and application of new technologies, including big data analysis, artificial intelligence, Digital Tower, counter UAS detection and identification system, UTM, etc.

UAS-BASED PAPI INSPECTION TECHNOLOGY IN CHINA

(Presented by China)

SUMMARY

The UAS application research team in China has been developing a leading and practical PAPI flight inspection technology based on the proven multi-rotor UAS and high-end image payload. The technology was tested within trial flights at both plain and plateau airports. Its advantages were shown clearly in pro-environment, safety, economy, efficiency, and labor saving. Despite there is still room for improvement, the UAS-based PAPI inspection technology has great potential to benefit both the flight inspection service provider and the airports when applied.

1. INTRODUCTION

1.1 Unmmaned Aerial System (UAS) has potential technological superiority for aviation application, especially in some certain scenarios, such as airport lighting flight inspection, electromagnetic environment protection, obstacle detection, foreign object debris monitoring, etc.

1.2 The proven COTS UAS products, such DJI M300 series drones and high-end image payloads, such as DJI Zen muse series cameras, provide great choices of research and developing platforms for UAS-based PAPI flight inspection technology and complete frontier, practical solutions.

1.3 The joint team in China has been committing to this field since 2017. The prototype is optimized iteratively to second generation with machine learning technology involved to support smart color identification.

1.4 The latest trial flight in Nyingchi Mainling airport, a typical, windy plateau airport in China with high mountains and narrow canyons, validated the technology further and demonstrated the advantages particularly at the airport like Mainling counting on RNAV RNP operation.

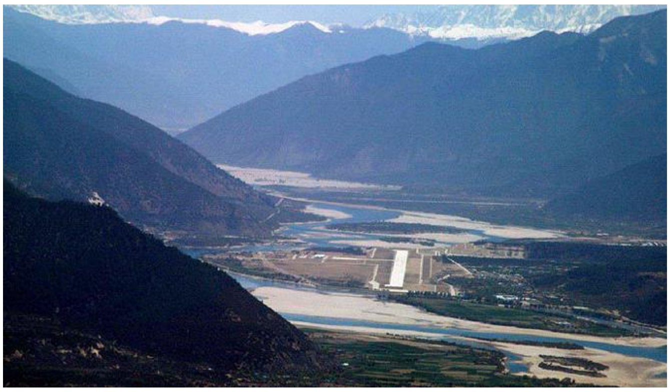

Figure 1 Mainling Airport, Nyingchi, Tibet, China
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2. UAS-BASED PAPI FLIGHT INSPECTION TECHNOLOGY

2.1 System Introduction

2.1.1 The UAS-Based PAPI Flight Inspection System consists of multi-rotor UAV with image payload in the air, one main remote controller, one inspection module plus spare controller, and one GNSS RTK station. A training platform is developed to create smart image recognition model-based machine learning structure.

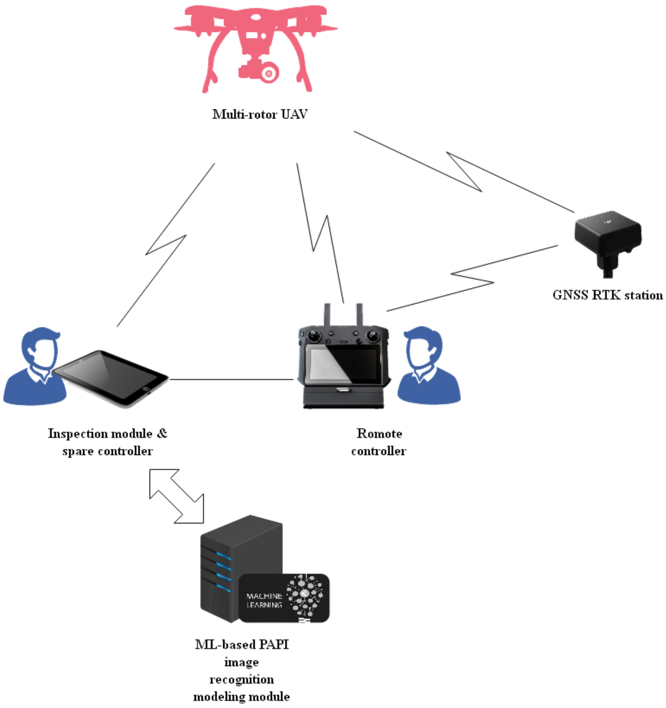

Figure 2 UAS-Based Flight Inspection System

2.1.2 In the prototype system, DJI M300 RTK UAS is selected as the unmanned flying platform with Zen muse Z30 camera as the image payload. Though DJI has embedded differential positioning technology via cellular network, it is recommended to set up a GNSS RTK station for reliable, stable correction data, especially taking the remote airports into account.

2.1.3 A special inspection module is developed to be the mission core, which has the abilities of route planning, uploading commands, calculation, etc. In addition, the module has the function of controlling the UAV when necessary. During the flight, Inspector can monitor all the status, to work as a safety observer, besides inspection mission.

2.2 Trial Flights and Outcomes

2.2.1 The team carried out thirteen trial flights to test the UAS plus the payload's functions and performance, evaluate the technology concept, verify the mission module and integrated system.

2.2.2 The trails were completed in different terrains, weather conditions, and light conditions. The latest flights were carried out at Nyingchi Mainling airport, at dawn, early morning, nightfall, and night in June 2021.

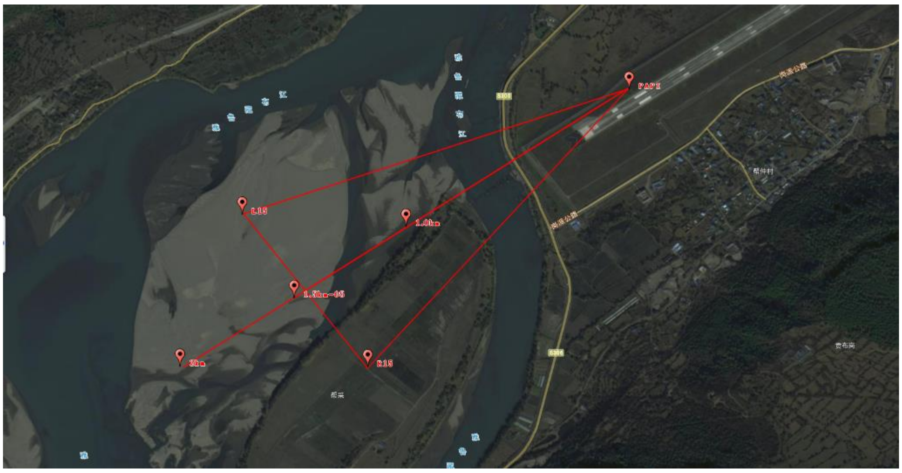

Figure 3 Flight Route at Nyingchi Mainling Airport

2.2.3 In the trials, the system recorded the PAPI color changes, calculated the azimuth, elevation, range online as expected along with UAV moving horizontally and vertically. The angle when color changes of each light was captured, and the coverage was evaluated by cross over flight.

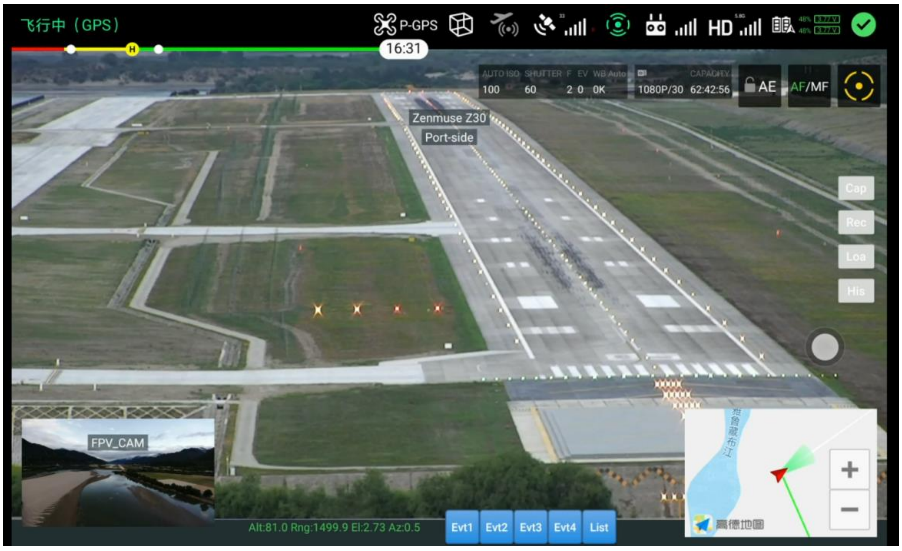

Figure 4 Online PAPI Evaluation and Calculation

2.3 Limits and Path Forward

2.3.1 As a tradeoff between cost and performance, the system may not support a further distance and higher altitude flight, taking the flight duration of the UAS and color recognition ability of the payload into account.

2.3.2 The possible difference in color changes sensing between the camera and human eyes may bring bias to final PAPI evaluation. This leads two further directions: investigate the difference and the way to correct, set a reasonable tolerance when using camera-based technology.

2.3.3 The team will design an optimal flight route based on conventional PAPI flight inspection experience, data, and requirements.

3. CONCLUSIONS

3.1 UAS-Based system with proper payload and specially developed mission module is feasible technically to complete PAPI inspection and potential to undertake all the airport lights routine check.

3.2 There are still some limits in the prototype which guides the team to refine the system.

4. ACTION BY THE MEETING

4.1 The meeting is invited to:

a) Note the material provided.

b) Provide feedback on the methodology presented in this working paper.

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