CNS SG/24 – **IP/02**
Agenda Item 5.5
30/11/20 – 04/12/20

International Civil Aviation Organization

Twenty Fourth Meeting of the Communications/ Navigation and Surveillance Sub-group (CNS SG/24) of APANPIRG

Web-conference, 30 November – 4 December 2020

Agenda Item 5: Navigation

5.5 Other navigation related issues

RPAS-BASED FLIGHT INSPECTION PROGRAM PROGRESS IN CHINA

(Presented by China)

SUMMARY

Since the last project brief on flight inspection based on Remotely Piloted Aircraft Systems (RPAS) program in China which was launched as early as in 2017, the R&D group under the guidance of CAAC has been dedicating the continuous system optimization with a couple of laboratory test and trial flights. After the first trial in June 2019, a hybrid VTOL (Vertical Take-Off and Landing) Fixed-Wing RPAS was adopted to load the multitask flight inspection units instead of the conventional Fixed-Wing RPAS employed before. In 2019 and 2020, ten more flights were performed to validate the flight inspection system further, as well as investigating the minimum operational performance requirement for RPAS developed to carry flight inspection equipment and perform missions in civil aerodrome. From these trial flights which complied with CAAC Advisory Circular (AC-92-2019-01, Specific Type of UAS Trial Operation Administration), both the technical feasibility and inspection data creditability of RPAS-based flight inspection system are proved solidly meanwhile more valuable information has been obtained to direct the flight inspection RPAS development. In 2020, an equally important progress is that a standard system for RPAS-based flight inspection has been proposed by CAAC, covering the aircraft, mission system, crew, flight inspection specification, etc. The technical specification for the RPAS-based flight inspection system has been published as CAAC Information Bulletin (IB-TM-2020-005) in September 2020.

1. INTRODUCTION

In June 2019, the joint research and development team of RPAS-based flight inspection technology in China completed the first trail flight in Dongying airport, a commercial airport in Shandong Province, which validated the feasibility and suitability from both technical and operational aspects at the first time. Whereafter, based on the experience and data obtained from the first trial flight and dozens of following lab experiments plus dynamic ground field tests, a hybrid VTOL (Vertical Take-Off and Landing) Fixed-Wing RPAS was selected as the new unmanned aerial platform to borne the improved flight inspection mission payload. The subsequent trial flights were conducted from the late of 2019 and 2020 in general aviation

airports and Dongying airport. Though the Covid-19 epidemic outbreak caused serve delays since early of 2020, significant progress has been achieved in this state-of-art technology.

2. DISCUSSION

2.1 VTOL Fixed-Wing RPAS application in flight inspection mission

Different with conventional fixed wing RPAS, a hybrid VTOL Fixed-Wing RPAS has some unique advantages in take-off and landing space, safety, transportation and deployment. The RPAS applied in this project is summarized as follows.

- The RPAS is take-off and landing vertically with the lift provided by four electric driving rotor wings. After rising to a certain height, the fixed wing engine powers the aircraft while the rotor wings are off. While the aircraft descends to a certain height ready for landing, the rotor wings will take over from the fixed wings.

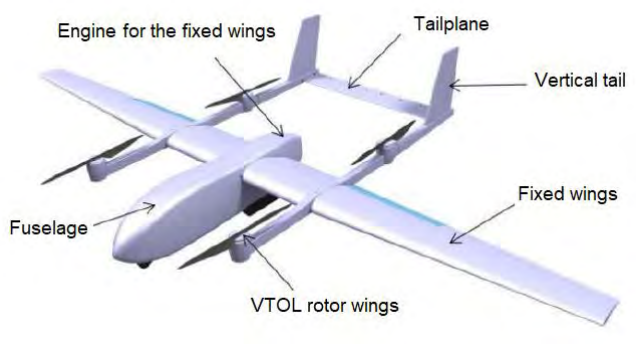

Figure 1 VTOL RPAS layout

- The RPAS used has a 5.2-meter wingspan and a 2.9-meter fuselage, with a maximum takeoff weight of 90 kg, a maximum payload of 50 kg.

Figure 2 VTOL RPAS used in the project

- The telecontrol and telemetry station is portable and easy to be programmed for expect flight route.

Figure 3 Telecontrol and telemetry station

- The RPAS is much easier for transportation via a classical van after disassembly. The flight inspection unit is integrated with the RPAS, no extra space required almost.

Figure 4 A Van for transportation

- The flight inspection payload, including the antennas, nav receiver, GNSS receiver, data link receiver, signal processing unit, ADS-B unit etc. They are assembled with the RPAS precisely and powered by batteries.
- After a couple optimizations, the flight inspection system is much more durable and compatible with different RPAS platform.

Figure 5 Integration testing of the flight inspection system

2.2 Trial flights and conclusions

The further ten trial flights were perform from December 14, 2019 to October 13, 2020 in total, including seven flights evaluating the flight inspection capability: ILS, VOR/DME, NDB, ADS-B and preliminary GBAS testing in commercial airport, Dongying airport as well as three flights for RPAS engine testing in general aviation airports. The flights in Dongying airport were implemented after the end of all the commercial flights.

Figure 6 Before take-off of the trial flight

Figure 7 The RPAS in flight

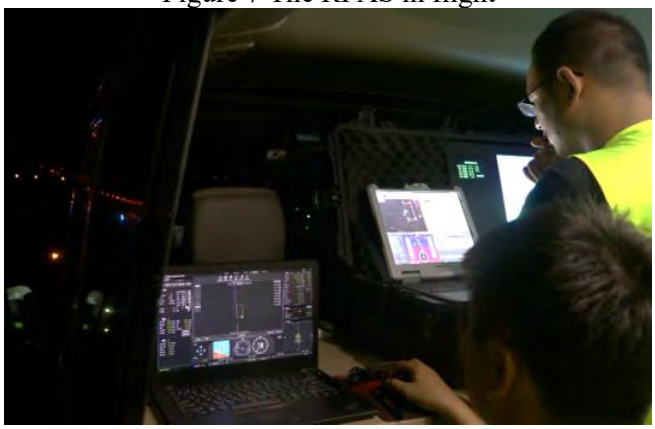

Figure 8 Realtime inspection and flight control

Based on amount of testing data, the trial flights provide convincing conclusion that the RPAS-based flight inspection payload developed by the joint team in China can support most of the navaid inspection in civil airport. The validated parameters in the past trial flights are listed in the following tables and figures, which covered the key ones interested in flight inspection mission.

Table 1 The validated inspection parameters in trial flights

Facility	Scheduled Inspection Parameters	Complete
Localizer	Course Alignment	√
	Course Structure	√
	Mean Width	√
	Coverage	√
	Width	√
	Symmetry	√
	Clearance	√
Glideslope	Structure	√
	Angle	√
	Width	√
	Symmetry	√
	Clearance	√
	Coverage	√
	Reference Datum Height	√
Marker	Width	√
VOR	Bearing Error	√
	30Hz AM	√
	9960Hz AM	√
	30Hz FM	√
	Coverage	√
	Roughness	√
	Bend	√
DME	Range Error	√
	Coverage	√
NDB	Bearing Error	√
	Coverage	√
	Indication	√
ADS-B	Identification	√
	Positioning	√

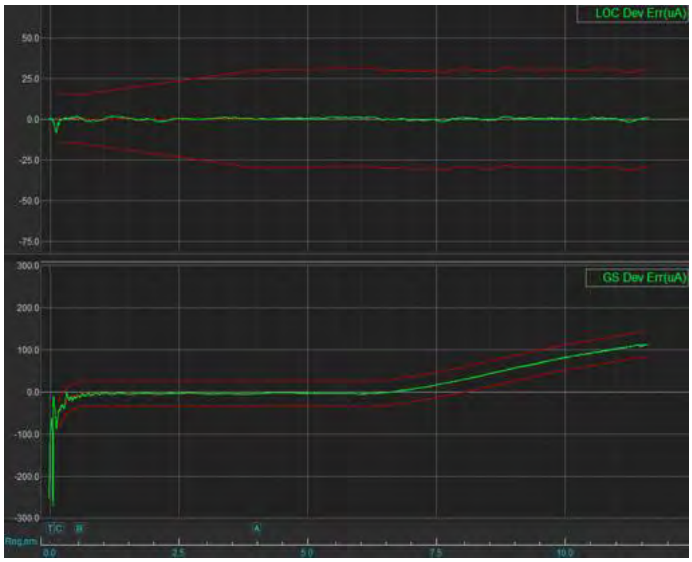

Figure 9 ILS Inspection

Figure 10 VOR/DME Inspection

Besides the proved performance of flight inspection mission payload, some points about the RPAS have been drawn: with no doubt, the ability of the RPAS can limit actual inspection function, for example polarization was not evaluated since the unmanned aircraft cannot incline to desired degree in flight for safety consideration. Taking both technical and economic

factors into account, no COTS RPAS is found which meets inspection flight requirements. A special RPAS should be developed with the following extra features at least:

1) Multi-mode highly accurate reference technology with well-control ability of low-altitude pass.
2) Bank with certain degree left and right
3) Descend tracking glide signal
4) Be rain-proof and wind-proof
5) Aero-class engine
6) Enough service ceiling, speed, range, climb rate

2.3 Standard system establishment

In 2020, CAAC proposed to establish a standard system for RPAS-based flight inspection, covering the aircraft, mission system, crew qualification, flight inspection specification, etc. The first one: Technical Specification for the RPAS-based Flight Inspection System has been published as CAAC Information Bulletin (IB-TM-2020-005) in September 2020.

信 息 通 告

中国民用航空局空管行业管理办公室

编　　号：IB-TM-2020-005

下发日期：2020 年 9 月 27 日

基于固定翼/混合翼无人机的
民用航空飞行校验系统技术要求
（试行）

Figure 11 Technical Specification for the RPAS-based Flight Inspection System

2.4 Standards and regulations

The work is carried out referencing to the following standards and regulations:

- ICAO Doc 8071 Volume I (Fifth Edition-2018)
- ICAO Annex 10 (Sixth Edition-2006)
- ICAO Annex 14 (Seventh Edition-2016)
- ICAO Doc 10019 (First Edition-2015)
- CAAC AC-92-2019-01 (2019)
- CAAC AC-115-TM-2018-01 (2018)

- CAAC AC-86-TM-2016-01 (2016)
- FAA 8200.1D 2015

2.5 Next Step

The joint research team will continue to work on the following:

a) Improve RPAS aircraft performance.
b) Pilot RPAS-based flight inspection technology in certain commercial airport.
c) Continue standard system establishment.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper.

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