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The Aspects, Reasons and Outcomes of an Unmanned Air Vehicle Crash Caused By Engine Failure

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Abstract : The Unmanned Air Vehicle (UAV) systems are indispensable tools of air surveillance and reconnaissance nowadays. Via this systems, hazardous end risky intelligence gathering activities are handled easily. Although they are named as “Unmanned” the UAV systems are commanded by pilots/operators. So, because of weather conditions, enemy attacks etc. as well as pilot error it is possible to face with sudden Round per Minute (RPM) drops and subsequently engine cut/stop during a mission flight at high altitudes. In this case, there are some very urgent decisions to make and rapid “emergency procedure” steps to take in a very short time before Line of Sight (LOS) is lost. The time before crash and the distance to landing air base need to be calculated, the Return Home route need to be checked and the landing/crash side need to be determined. Therefore it is a vital necessity that UAV pilots have some extra qualifications like being determined, well instructed and trained, experienced apart from operating ability. Within this scope, for an education process of a UAV pilot experience sharing and lessons learned are as important as simulators even more. By means of lessons learned it is possible to find out the reasons, mistakes and prevent the likely UAV accidents. In this study it is told about a real UAV crash, experienced of the pilot, the dos and don'ts and the difficulties. Thus it is aimed to help the people who can experience the same or similar situations in future.

Key Words : UAV, reconnaissance, RPM, engine cut, emergency, LOS.

1.Introduction

UAVs, from quiet beginnings alongside manned aviation as targets and Remotely Piloted Vehicles, have been gradually growing in use. In particular, their use by military forces in operational areas such as the Balkans, Afghanistan and Iraq has started to catch the public eye. Now, with a drive for ‘homelands security’, and withincreasing environmental and financial pressure in carrying out ‘dull, dangerous and dirty’ tasks with larger, manned aircraft, interest is growing to expand the use of UAVs in military and civil applications. This requires that they be integrated into unsegregated airspace, alongside manned aircraft and over the general public [1]. It is foreseen

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that 30 thousands UAV will be in the air in 2030. Besides, for the first time, the trained UAV pilot number exceeds the number of Warcraft pilot number in USA in 2013 [2]. However, important questions remain over how they can be cleared to operate safely, in airspace infrastructures developed and regulated for safe manned flight.

2.Overview

UAV system is intended to provide imagery and intelligence (as well as target designation) for land and sea commanders, across the spectrum of conflict: Intelligence, Surveillance, Target Acquisition and Reconnaissance.

The system comprises as shown in Fig. 1: the UAV, the Ground Control Station(s) (GCS), the Tactical Units positioned with field commanders; the Field Teams for take-off and recovery other than from prepared airfields.

The system interfaces (on a mission basis) with the battlefield network provided through Network Enabled Capability (NEC). Other interfaces are envisioned to deal with training operations in a peacetime, civilian environment [1].

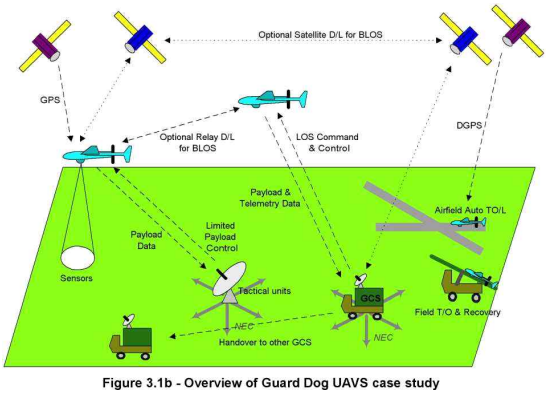

Fig. 1 Overview of UAV Systems [1]

3.Engine Failure as an Emergency

The engines (Fig. 2) on UAVs provide propulsion required for flight. The thrust generated by the engines allows the UAV to maintain a constant altitude or climb. Without the engine, UAVs are gliders and cannot fly at a constant altitude or climb.

Engine failure is a detectable safety risk in that there is usually a very clear indication that an engine has failed and is not providing propulsive thrust to the UAV. When this happens, the UAV can neither climb nor maintain a constant altitude and will start a gliding descent. In this instance the safety risk present is that of a collision potential with buildings, persons or vehicles

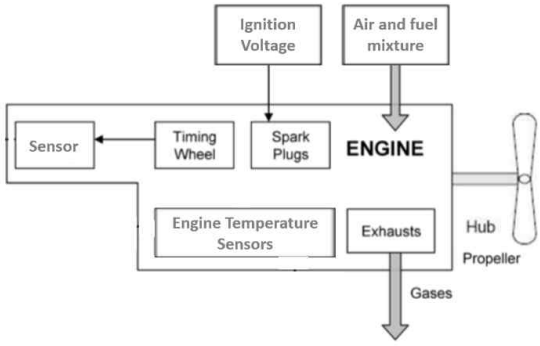

Fig. 2 General UAV Engine Block Diagram

The main mitigation strategy is that it will initiate a series of maneuvers that will guide the gliding UAV to a safe landing spot after an engine failure. Ensuring that the procedure can be executing safely will require constant monitoring of the aircraft's state to ensure that it is always in a position where it can glide to safety [3].

4.Real UAV Crash Caused by Engine Failure

Before reconnaissance mission flight, pre-flight briefing was conducted, meteorology, personnel, aircraft and GCS had been identified appropriate related to the requirements by the flight crew. On the morning of the same day, engine was started to determine whether any problems is with the engine, controls carried out, finished successfully and then stopped by technicians.

Started on the flight preparation at 14:00 hour and engine was started at 15:13. Motor and power tests and controls of the engine of UAV and checks were also made with the external pilot (who makes the UAV without automatic take-off and landing system take-off and land) in front of the hangar.

At 15.20; UAV started to taxi to the runway. The last checks were handled by technicians and two (Internal and external) pilots on the take-off position.

At 15.43; UAV took-off from main airbase runway and after reaching enough altitude directed to mission area. Over mission area, Air Traffic Control (ATC) commanded flight crew to change the altitude from 17.400 to 17.000 feet because of other air traffic. At 16.46; the internal pilot (who takes over the control from external pilot after take-off and hands over to external pilot after flight for landing) changed the throttle (gas) command and UAV began descent. RPM of the engine also decreased parallel to the altitude command. After reaching the desired altitude, although the throttle command was stable the RPM continued to decrease against the command and the engine stopped by itself.

After the engine failure, the internal pilot started to apply emergency procedure. According to the procedure; gliding range, gliding time and distance to the airbase were calculated and determined that the UAV would not be able to reach to the airbase. Thus UAV crash side was clarified by internal pilot.

Before losing the LOS, the route to the crash side which the UAV would follow automatically after losing the LOS was programmed and uploaded to UAV by the internal pilot. The north-south direction used for the route according to the terrestrial forms.

After a while the UAV descended to 8.600 feet and the LOS was lost. The UAV flight mode was changed to automatic flight mode and the plain began to follow north-south route uploaded before. The video records stopped at 16.59 with losing LOS.

Later on the UAV crash, an accident investigation team was formed; they investigated the telemeters, video and flight records, crash side photos, interrogated the eye witness and flight crew. They concluded that;

*All the flight preparations, controls, checks and test were made according to the procedure,

*Take-off and pilots hand overs were done properly,

*During the flight from beginning to the end all the parameters were within the limits,

*After engine stop, the emergency procedure was followed on time and properly,

*The crash side determination and uploaded route were appropriate,

*During the flight there were none of interference, electronic signal or impact, internal/external object damage, sabotage or any weapon fire,

As a result, the accident investigation team decide that;

*Every steps/commands before/during/after the flight were correct and appropriate with the procedures and limits,

*There were no errors and defects arising from

staff,

*The crash occurred because of the engine failure caused by an unknown technical defect.

5.Conclusion

Every day, there occurs a lot of engine failures as mentioned above, some caused by pilots/technicians faults, some others by technical defects. In order to hinder these accidents, primarily it is essential to avoid from men caused faults can be controlled / can be reduced. Although it is not possible to avoid from technically caused failures, the pilots and the other persons of flight crew have to implement the emergency procedure in order to keep the engine run for a duration enough to reach landing airbase.

Also in unmanned aircraft as in manned aircraft, it is very important that maintenance, repair and overhaul have to be done properly on time, and that before/during/after flight procedures have to be applied.

Despite all the precautions at the emergency situations may occur during flight pilot's attention, the dominance of the experience and emergency procedures comes to the fore. Constantly checking the flight data provide some signs of engine failure will occur and allows to take measures. Problem/fault's early detection gives some time for implementation of emergency procedures and operation of the engine till UAV's reaching to the runway.

In spite of the implementation of emergency procedures in the event of engine crash, the first thing to do is to calculate the flight time left and determine whether the UAV catch up with airbase and then if it will not reach the runway, secondly an appropriate (distance from the residential areas, easy to reach, etc.) crash side must be identified and the route for that side has to be formed, programmed and upload to the UAV. After engine stopped, within a short time like 5-15 minutes depending on the altitude (Above ground level / AGL) the data link will be lost. So all the steps above must be taken quickly and carefully.

In order to be able to take all these emergency and procedure steps described in the previous paragraph before LOS is lost, a second internal pilot must be included to the flight crew.

Despite the well-trained and experienced flight crew and actions taken it should not be forgotten that the UAV accidents caused by engine failures will continue as long as UAV flights keep on going. Therefore the flight crew always have to keep mentioned idea in their minds and be ready for all kind of emergency situation that may occur all the time during UAV flights.

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