THE QUESTION ABOUT THE RETURN OF AUTONOMOUS DRONES.

DOES AN AUTONOMOUS DRONE RETURN HOME AT ALL TIME?

Flight is as incredible as its past was. Soon there will be unmanned aerial vehicles patrolling the skies above our cities as Philip J. Jarret once stated.

In the past years, the rapid improvement of flight industry, IT and control technology enabled the quick development of unmanned aerial vehicles which is the most dynamic among aircrafts. Hardly a day goes by when we cannot read topics about their innovations and innovative possibilities of their application. Evolution of unmanned aerial vehicles has been continuous in the past decades too, we can say stormy. Fixed wing, rotary wing and even flapping-wing (ornithopters) have been created. One type can fly faster than the speed of sound, another one weighs only a few grams and a third is capable to depart with several tonnes of take-off mass. Some only fly few hundred meters from the base of its operation and there are types capable to fly across continents.

ORIGIN OF THE UAV

They can fly autonomously or can be remotely controlled by a human being, or these two can be combined. Common features of these constructions: the necessary presence of human factor during their planning and construction period and their operations in the air and also on the ground all along their life cycle. An ever decreasing size of control equipment, and construction costs made UAV/UAS technology available to all. Civilians and companies widely favour operations of UAV's to shoot pictures or videos or to deliver packages, not to mention military and disaster management tasks.

One can ask himself; do we need human control if ability of self control autonomy comes true? In other words in our perception it is a robot, but what do we know about them? Robots initially were intented to serve and protect life and to deploy them to avoid risks of human loss in dangerous situations. The idea of robotics came from Isaac Asimov and the word robot is rooted in Czech language. Intellectual work similar to human activities as basic principle for a robot requires perception, information processing, knowledge and memory, learning skills and communication-based activities.

ROBOT CONTROL

In case of an UAV, which is a mobile robot, control options differs by the intention to use it within visual range or not. In the first situation control exists with remote tele-operation under visual signs by an operator. Leaving the visual range the robot is applied with imaging and image transmission systems essential for safe control. Still it is not autonomously because it requires professional knowledge and attention of the operator. An operator provides management of the drone from a cockpit on the ground and needs continously information about its position from the parameters of the aerial vehicle.

A flight operator can be assisted by a sensor operator. Pre-programmed flight paths were useful where the UAV has to pass pre-programmed ground or three dimensional points in its duty environment. It occurs by point to point regulation or by path tracking method on pre-planned turning points. During the execution of these tasks it is required to apply a barrier detection system on the UAV such as ultrasound or proximity sensors to avoid without problem any

unforeseen barriers. Control-based on dynamic path planning essentially requires the exact coordinates of the target. Application of an on-board computer on the UAV significantly changes the control situation. During its path from the take-off point to the destination it identifies the terrain and sets up its own orbit. Camera, image processing, ultrasound or laser rangefinder, digital course meter, and currently measured GPS coordinates support its navigation and sensing. It is significant to program the take-off point just the same as the destination point. Target is just an intermediate location. In case we can dynamically upload target coordinates during the execution of the exercise, there is no need for concordant take-off and destination points. Evolution in IT, computers and production technologies made creation of miniaturisation feasible. In the same time the way of operation developed.

On-board flight data transmission between the UAV and the ground control are mostly to inform the operator and not to confirm the control itself. Orders of he operator consist of flight direction and desired target coordinates only acting as a flight controller and not as a pilot. Thanks to a stormy evolution of related technologies the UAV is now capable to execute take-off and landing procedures individually. Leaving the operator in the role of monitoring the execution of the mission only he can control the flight of several UAV's simoultaneously. On-board computers will be responsible for the security of the airborne UAV and will manage the correct maneuvers. It is essential to gain concordance among the ground sub-systems and the aerial sub-systems. To achieve this goal, continuous and standing communication is needed to ensure efficient cooperation.

DESIGN OF ON-BOARD SYSTEM

The design, number and quality of on-board instruments can differ significantly by category. Quality means system security established by redundant elements. During the planning phase and the construction phase of UAVs, regulations approved for the operation of conventional aircrafts must be fundamentally applied. In the general design system, electronic components responsible for the flight of a UAV can be divided into three main blocks. These are the equipment itself with the applied sensors and interveners, the flight control unit and the auto pilot. In the general design system, electronic components responsible for the flight of a UAV can be divided into three main blocks. These are the equipment itself with the applied sensors and interveners, the flight control unit and the auto pilot. The simplified system consists of two tied circuits as highlighted in picture 6.

The inner tied circuit ensures the stability of flight characteristics like altitude and flight positions like pitch angle. This circle is responsible for flight control. Furthermore, its task is to avoid the consequences of disturbances which appear during the flight like, turbulence, gusts and shifts in density. Flight data, like speed and altitude is measured by sensors and transmitted as electronic signal to the electronic process circuit. The flight control system transmits the setpoint generated by the auto pilot and the actual sensor data to the intervener units. After the shift in the course of the feedback, measurement result is provided by the intervener units. Reliable and persistent operations of the aerial vehicle are determined by many features such as its airframe, engine, certain interveners, on-board electronics and the reliability of electric supply circles.

Flight parameters and location of the UAV is measured by several sensors. Data received from the sensors are stored in the central control unit. This data is autonomously compared with the setpoint (desired basic flight data) and then considering the system`s characteristics the intervener sign will be calculated. According to their function, on-board electronics responsible for automatization can be divided into two groups. Flight control circles are responsible for the stability of the flight, for the desired altitude and its holding. They are also responsible for proper turning and angle. The signal transmitted to the interveners is produced by the auto-pilot module. At present, decisions are taken in accordance with the standing task and the data, mainly position coordinates, measured.

IS CONTROL ALWAYS SET ?

Limation of operation by malfunction of a component can cause the lost of the UAV and must be prevented. To minimize such an occurence some very important criteria in planning, construction and operation must be obeyed. Complete failure of sensors, detectors and auto-pilot is not permitted. On the other hand, reduced functionality is acceptable in case of a malfunction and certain functionalities have to be interchangeable. Flight safety shall not be violated, conditions must be harmonized accordingly. We cannot expect full functionality from the UAV in case of an unexpected malfunction. It may mean that the UAV is not capable to achieve its current task, but still capable to avoid crash. It also can perform emergency landing with maximum security and can activate the operator`s remote control option too. The establishment of a temporary security status may also be configured like circling in a given altitude.

RECOVERY MUST BE OBLIGATORY

The recovery of the UAV (or its data) is of high importance no matter what disturbance can occur even when it is enemy or allied interference or jamming. In this light, design only permits in such cases the handover of the control of the autonomous UAV to the ground control unit. The on-board computer can be prepared by pre-processed algorithms on how to act in case of an enduring loss of communication. Critical systems must be able to substitute each other making the UAV less vulnerable. An additional problem can occur in the security of terrain-following and low-altitude flights. Because of the much shorter reaction time, the possibility of an unexpected injury is much larger during the execution of these tasks. Nevertheless, in accordance with the stormy evolution of unmanned aerial systems their operation is in a shift in the direction of individual decision making. It does not only apply to the selection of their flight course, but also for their combat application.

MORE DEVELOPMENT TO COME

Yes, all advantages of improvements in the IT-field will be used in robotic appliances. So far the UAV has ‘grown up’, does not require permanent supervision and operating more examples in line has become routine. However exploring the possibilities is going as far to project what artificial intellingence (A.I.) might bring. When can we let it live its independent live and leave the control to itself? However there are progressive improvements in robotics and relating sciences the current status is that for the time being it is still not achieveable to create the robot UAV with individual thought and reasoning. The question remains; will it ever be possible? In the meanwhile the lack of analytic and assessment capabilities of the robot-UAV is expected to be solved rapidely, but only leaving the UAV in the position of a very advanced tool. Together with this more operational abilities will be found and developed.

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