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APPLICATION OF UNMANNED AERIAL VEHICLE IN EXTREME INTERVENTION CONDITIONS

Abstract

Along with the purchase of the drones, The Fire and Rescue Corps members started to be trained as the drone pilots. The pilots can encounter different dangers and limitations during their intervention flight. We have decided to analyse the possibilities of the drone use in extreme intervention conditions within the F&RS. Slovak fire departments are gradually modernizing their equipment. Currently, the drones able to monitor the area quickly and effectively are emerging. Slovak Fire and Rescue Corps (HaZZ) started to update their equipment and purchased first drones from DJI Mavic 2 Pro company. Pilots can encounter different undesirable circumstances which influence the functionality of drone. The main goal of the research was to experimentally test the unmanned aerial vehicle in particular extreme intervention conditions.

Keywords: Unnamed aerial vehicle, extreme intervention conditions, fire department

PILÓTA NÉLKÜLI LÉGI JÁRMŰ ALKALMAZÁSA EXTRÉM KÖRÜLMÉNYEK KÖZÖTT

Absztrakt

A drónok megjelenésével megkezdődött a drónpilóták kiképzése is. Ezek a pilóták különböző veszélyekkel és korlátozásokkal találkozhatnak repülésük során. A szerzők elemzik a drónok extrém intervenciók körülmények közötti felhasználásának lehetőségeit az F&RS-n belül. A szlovák tűzoltóságok fokozatosan korszerűsítik felszerelésüket. Ennek eredményeként megvásárolták az első drónokat a DJI Mavic 2 Pro cégtől. A drónpilóták olyan nemkívánatos körülményekkel találkozhatnak, amelyek befolyásolhatják a drónok működését. A kutatás fő



célja a pilóta nélküli légi jármű kísérleti tesztelése volt, különösen extrém beavatkozási körülmények között.

Kulcsszavak: pilóta nélküli légi jármű, extrém beavatkozási körülmény, tűzoltóság

1. METHODS OF RESEARCH

The main methods of research were the experiments applied in different difficult conditions during the intervention. The necessary items for the experiments were: GPS, camera of the drone, radio altimeter, anti-plugging sensors, camera documenting the experiment, military smoke bomb, combustible substance, radio communication with the airport to obtain the information about weather conditions such as wind, humidity and air pressure. Drone pilot and drone flying instructor were also included in the experiment [1].



Picture 1. First drones from DJI Mavic 2 Pro company.

Specific methods of the experiments

We have tested the drone for his ability to resist to icing. The drone was placed in the refrigeration box in the AeroREST restaurant where we performed two independent measurements to observe the temperature by the thermostat and the thermometer inside the box. We have also measured the time of battery life needed only to be able to fly using the anti-



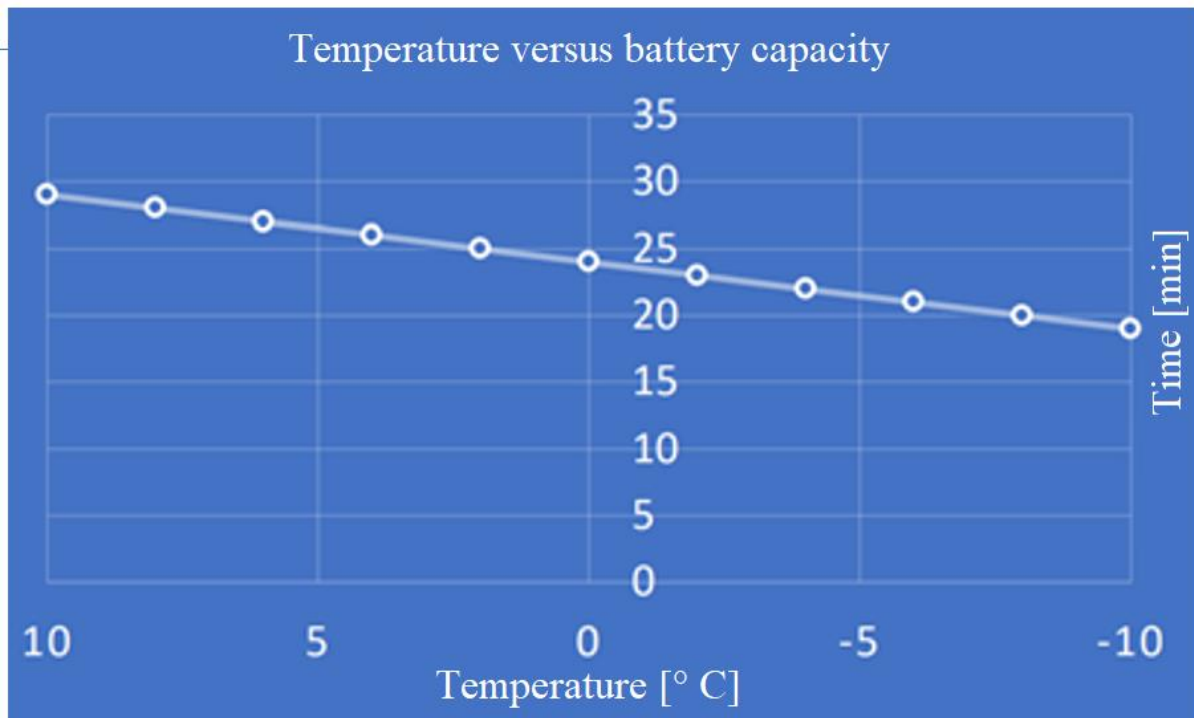
plugging functions. In the next experiment, we focused on the influence of the heat, the smoke, the ability to fly over the water area and the range of visibility for monitoring of the surroundings. The following equipment was used during the experiments: the GPS, drone camera, altimeter radio, anti-plugging sensors, camera for documenting the experiment, military smoke bomb, flammable liquids, radio communication with the airport to obtain the information about weather conditions such as wind, humidity and air pressure. The following information were documented, evaluated and represented in the charts and graphs [2,3].

The methodology was as follows:

- resource and information collection and analysis regarding the given issue;
- consulting and comparing the information related to the topic;
- analysis of the external influences on the drone;
- application of the experimental flight to define the behaviour of the drone during the extreme intervention conditions;
- proposing the method of drone flying in difficult condition of intervention (low temperatures, freeze, smoke in the air, flight over water area).

Experiment no. 1: The influence of low temperature on battery life

Flying in lower temperature can cause the decrease of battery capacity which influences not only the flying range but also the characteristics of the quadcopter itself. Low temperature can also form the icing on the leading edge of the propeller which influences the extrusion force of the propeller. Low temperature can also form the cover of frost on the construction which will influence the take-off weight [4].



Picture 2. Influence of temperature on battery life

Experiment no. 2: Influence of freeze on the flying qualities

The icing might be formed due to multiples influences such as humidity, the temperature and the height we have set [5,6].





Picture 3. Frost formed on the leading edge of the propeller during flight in cold and humid air [7].

Experiment no. 3: The functionality of radio altimeter over the water area

The quadcopter is equipped with altimeter radio, which is situated in the bottom part of the drone. Altimeter radio sends the signal to the area below the drone which is reflected and based on this information the drone is able to set the propriate height.



Pictures 4. and 5 - The positioning of radio altimeter on quadcopter and experimental tank [7].

Experiment no. 4: The influence of smoke on drone functionality

During the fire, the enviroment is smoky which is the obstacle not only because of the visibility restriction but can cause also another possible dangers. Fire smoke contains the ash which can enter the rotors and cause the malfunctioning. These problems will be common for pilots as the drones should be used for forest fires and fires of bigger buildings. The direction of the smoke can change due to the wind which will worsen the flight in given environment. The pilot should therefore anticipate and foresee the weather change [6].



Pictures 6. and 7. The drone flying around the fire and through the smoke [7].

The closer to the heavy smoke and the longer time spend in such an environment, the more the drone increase its output. Although no failure has been noted. Afterwards, the drone has landed and we have checked the condition of the rotors. There was a small particles of ash nearby the electric motors. Flight in heavily smoked environment with high contain of ash and fire fumes can cause the malfunction or damage to the electric motors. Therefore, it is important that pilots avoid a heavily smoked area [6].

2. RESULTS OF THE EXPERIMENT MEASUREMENTS

1. Experiment - drone copes with the low temperature quite well and the battery life is degrading gradually and not very fast. The lower the temperature, the shorter the battery life.
2. Experiment was unsuccessful due to the low humidity in refrigeration box in which we tried to make the frost cover on the leading edges.
3. Experiment showed that the radio altimeter on quadcopter reflects the signal from the pool bottom during the flight over the pool, and therefore the quadcopter started to lose the altitude.
4. Experiment showed that the drone loses the stability due to the heat release. The turbulence occurred nearby the fire. The quadcopter engines were slightly clogged with fly ash.



3. DISCUSSION

Unnamed aerial vehicles can be used effectively in any field of defense system. It can be in the field of the disaster management [8][9], economy [10], safety system [11] or in the crisis management [12].

When flying a drone, it is essential to considerate civilian security and pilot's abilities. Since the drone can cause the fall of the rescue helicopter in case of accident, it is crucial to think about the potential danger. The abilities of the drones influenced by the extreme conditions of intervention are limited.

We found out that the battery life shorter with the lowering temperature.

If the frost covers the leading edges of the propeller, the compressive force of propeller will decline and prevent the capability of flight.

We also discovered that while flying over the water area, the drone should have meters in attitude to spare.

We need to avoid the heavily smoked area during the exploratory flight.

4. CONCLUSION

Drone is equipped with the newest technology, which helps during the flight. It is highly recommended for pilots to fly in fully automated system using the sensors which might help to avoid the collision.

Although, it is necessary to have skills and knowledge to flight in manual mode in extreme condition of intervention and to be aware of potential risks.



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