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Multicopter platform prototype for environmental monitoring

Stanisław Anweiler [a, *], Dawid Piwowarski [b]

[a] Faculty of Mechanical Engineering, Department of Environmental Engineering, Opole University of Technology, Poland
[b] OK Strojservis, Polska Sp. z o.o, Poland

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ABSTRACT

Due to the ecological devastation of the natural environment, there is a constant need for monitoring the environmental features changes. Airborne engineering is now rapidly developing, enabling the construction of small automatic flying vehicles, so called multicopters or flying drones. The main objective of this study is to design and manufacture the low cost and low weight quadcopter platform prototype for the purpose of the environmental monitoring and research. A multirotor concept was created, which assumed some executive functions i.e. hovering, environmental data acquisition or Global Positioning System movement. On the basis of these assumptions, platform components were chosen. They include: the frame, drives, electronics and software. Also the presentation of the environmental measurement capabilities, with the use of multicopters was done along with the discussion on application capabilities, advantages and disadvantages of Unmanned Aerial Vechicles for analytical agriculture. On the basis of the project, a prototype quadcopter platform was built. During the tests some corrections to specific components were made. As a result of the whole process, a platform that is able to accomplish the tasks was created. All components of the multicopter have been described, materials used, mounting and connecting them, as well as the presentation of the specific device problems. The manufacturing cost of the drone prototype was lower than EUR 500, weight of less than 750 g and the drone performed all assumed tasks, which was considered a success of the project. Scientific value of the paper includes the guidance of cheap and efficient setup along with the applications.

1. Introduction

The quest for environmental sustainability is inextricably linked to the monitoring service. Monitoring is critical for environmental management. Environmental management decisions are dependent on monitoring; the same holds for reporting for legal purposes and reporting the environmental performance (Verschoor and Reijnders, 2001). Companies, life cycles, footprints, indicators, systems even whole cities and countries are subject of various monitoring activities according to achieve and maintain sustainable development (Kostevšek et al., 2015). Increasing efforts and resources have been devoted to research during environmental studies, including the assessment of various harmful impacts (Čuček et al., 2012). But environmental monitoring is not only limited to those impacts. Sustainability must be addressed from interdisciplinary and multi-cultural perspectives (Duić et al., 2015). It is capable to reach much more innovative achievements like for example automated registration of potential locations for solar energy production (Szabó et al., 2016), integrate various indicators into "families" (Galli et al., 2012) or recently developed interesting and promising cities' sustainability benchmarking index (Kılkıs, 2015).

All of this requires gathering great amount of various data. Availability of the updated data is becoming increasingly important in order to allow a rigorous analysis (Allouhi et al., 2015).

The issue of multirotor flying devices was taken up at the beginning of the twentieth century. As reported by Leishman (2006), one of the first documented prototypes, able to take off was Jeromede Bothezat's *Flying Octopus*. Multicopters are similar to helicopters but should be treated as a separate group of flying objects. They have higher maneuverability due to engines with fixed pitch propeller. Each motor is controlled independently by the flight controller. What allowed to resign from the precise helicopter rotor standard mechanics.

The impulse for the dynamic development in the multirotor area at the present time was the concept of Alexandre Dubus. It

* Corresponding author.
E-mail addresses: s.anweiler@po.opole.pl (S. Anweiler), piwowarskidawid@o2.pl (D. Piwowarski).

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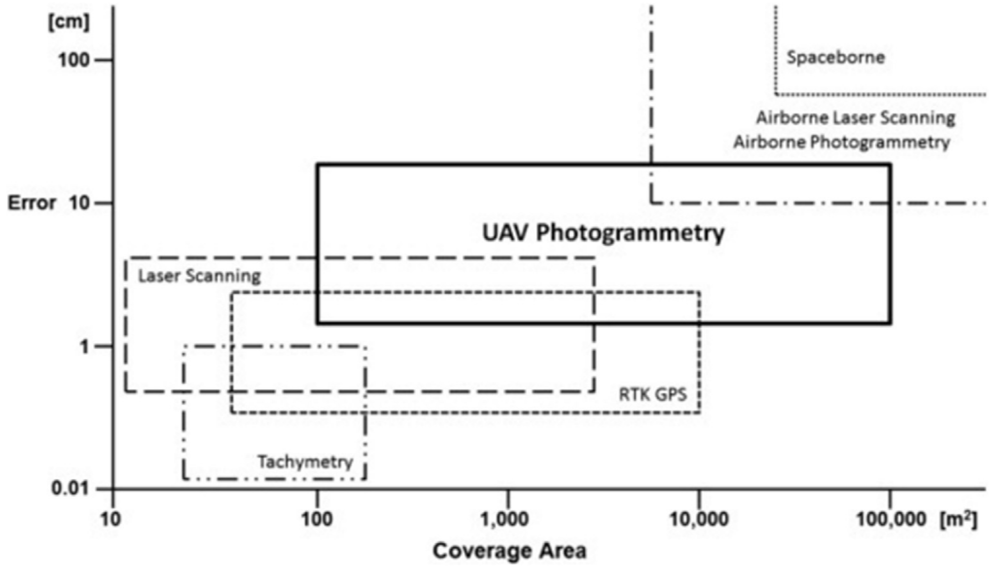

Fig. 1. Potential UAV system application areas in surveying tasks (Siebert and Teizer, 2014).

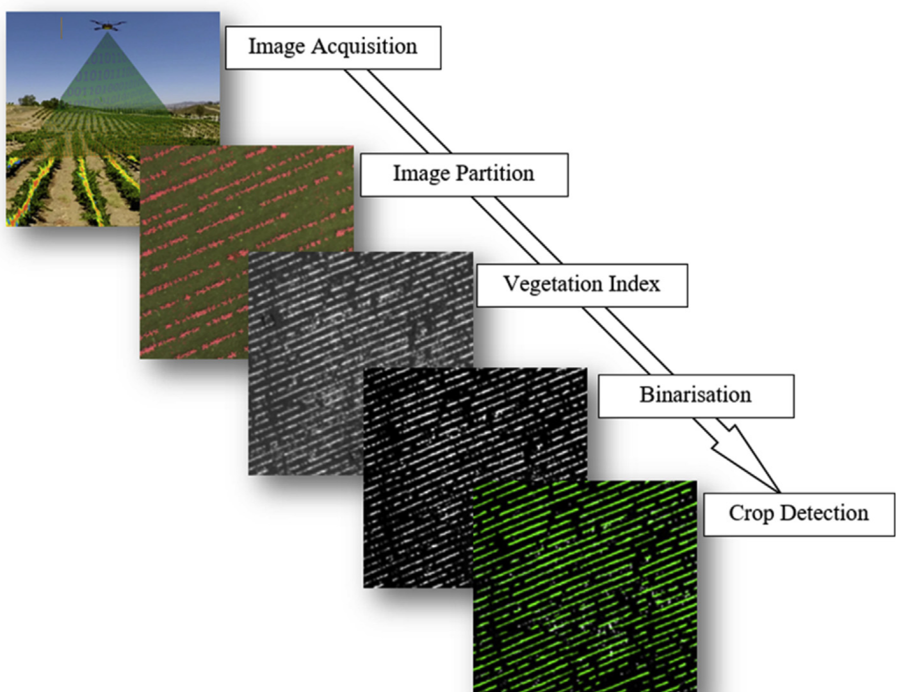

Fig. 2. Steps of the weed mapping system case study proposed by Pérez-Ortiz et al. (2015).

consisted of gyroscopes and accelerometers included in the keypad to the popular game console and the Arduino microcontroller. He is also the author of the program, the code for the microcontroller and the graphical interface. The entire project was called *MultiWii* (Banzi, 2008).

Typical multirotor aerial robots encounter several obstacles in the design and control. They have to be overcome to cater for expected industry demands that push the boundaries of existing multicopter performance. Research and experimentation in this field is now vastly developing. Many UAV prototypes are being constructed now and the performance of these systems is demonstrated in indoor and outdoor flight (Banzi, 2008; Buchi, 2011; Pounds et al., 2010).

Although environmental research with airborne equipment is becoming very popular, professional literature on small multirotor devices subject is still extremely scarce, and is still on a hobbyist grade (Dandois and Ellis, 2013; Nicol et al., 2011).

In this research authors give guidance on Small Unmanned Aerial Vechicles design and assembly. The novelty is pointed by extremely low cost while delivering fully operational features. System shows many innovative application possibilities, including newly spotted opportunity for analytical agriculture. All these

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