Unmanned aerial vehicles in airborne environmental monitoring

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1. Introduction

Airborne remote sensing is a very useful tool in environmental monitoring if information is needed on a large territory within a short period of time. The only limiting factor is the cost, which could be high. For conventional monitoring, a manned aircraft or helicopter is necessary, which needs fuel, well-trained pilot and an airbase, which could be far away from the working area.

The size (and weight) of the high-resolution cameras and other sensors have shown a significant decreasing trend in costs during the last decades, giving an opportunity to use them onboard of small, unmanned aerial vehicles (UAVs or drones) (Sauerbier et al. 2011). The costs are significantly lower (by about a magnitude), and the flexibility of the application is much higher than that of the big aircrafts, due to the lack of airbase need (Sauerbier et al. 2011, Watts et al. 2012).

Several types of airborne monitoring are known, which can be divided into three main types: photogrammetry (Turner et al. 2012, Laliberte et al. 2011, Kelcey et al. 2012, Suárez et al. 2010), sensor mapping (Watts et al. 2012, Rojas et al. 2012) and sampling (Pöllänen et al. 2009, Aylor et al. 2011). In photogrammetry the information is image-type. These images could be high-resolution conventional photos (Sauerbier et al. 2011, Turner et al. 2012) or lower-resolution photos but from a special, well-defined spectral range (multi/hyperspectral imaging, IR/UV imaging) (Laliberte et al. 2011, Kelcey et al. 2012, Suárez et al. 2010). In both cases, two perspectives are possible: perspective from bird's-eye view or from vertical angle. While the first one provides rapid information and it is very easy to use (e.g. in case of emergency operations such as floodings, forest fires, natural disasters), the latter one is often used in GIS systems by converting the photos into orthographic projection and using them as "map layers", e.g. if a pollutant identification and its distribution should be determined. Both of them are usable in different types of environmental monitoring; from disaster emergency actions to the monitoring of pollutants or natural reserve areas.

The protection of natural reserve areas is our primary task to keep the planet for the next generations. Aerial photographs can be used as well for monitoring the wildlife or vegetation (Figure 1), in the latter case multispectral imaging is very informative (Kelcey et al. 2012, Gademer et al. 2010).

In pollution monitoring both conventional and hyperspectral types of imaging are usable. In case of conventional photographs only the visible pollutants (colours) or the impacts of the pollution (foaming, algae growth, etc.) are detectable (Figure 2), while using hyperspectral, especially UV/IR remote sensing other pollutants are transformed into "visible" range (e.g. oil spills) and the concentration of the pollutants can be evaluated (Long, 2012). The previously mentioned sensor remote sensing or sampling methods are also widely utilizable technologies in pollution monitoring (Watts et al. 2012, Rojas et al. 2012, Pöllänen et al. 2009, Aylor et al. 2011).

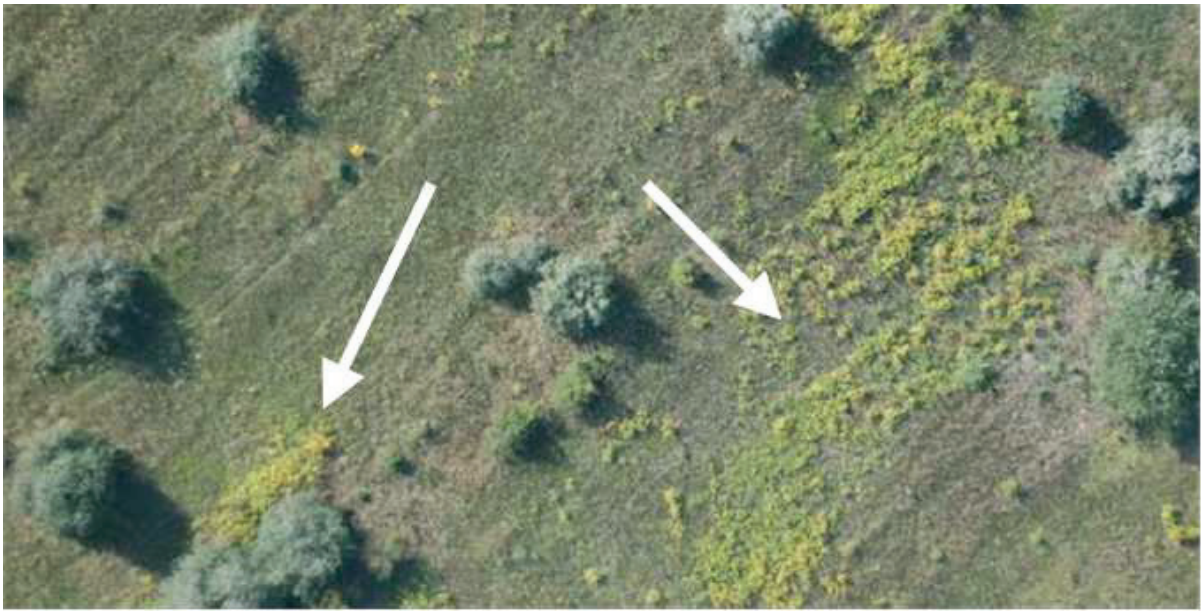

Figure 1: Monitoring of the population of a special plant species via aerial photogrammetry

Figure 2: Monitoring of water pollution from air

2. Experimental

In our survey, two UAVs were used: a MULTIPLEX Easy Star and a STYROMAN Smile (Figure 3). These UAVs were equipped with electric motors (TURNIGY and BLUE RAY types) and were controlled by a 2.4 GHz RC remote control system (FUTABA). A lightweight full-HD (1280×720) camera (FLIP) was used for imaging. The camera was normally positioned in the nose section of the UAV as seen on photos. The angle of down looking was alterable between 2°and 10°. Alternatively, the camera mount could be fixed on the belly of the plane: using this set up vertical angle photographs were taken.

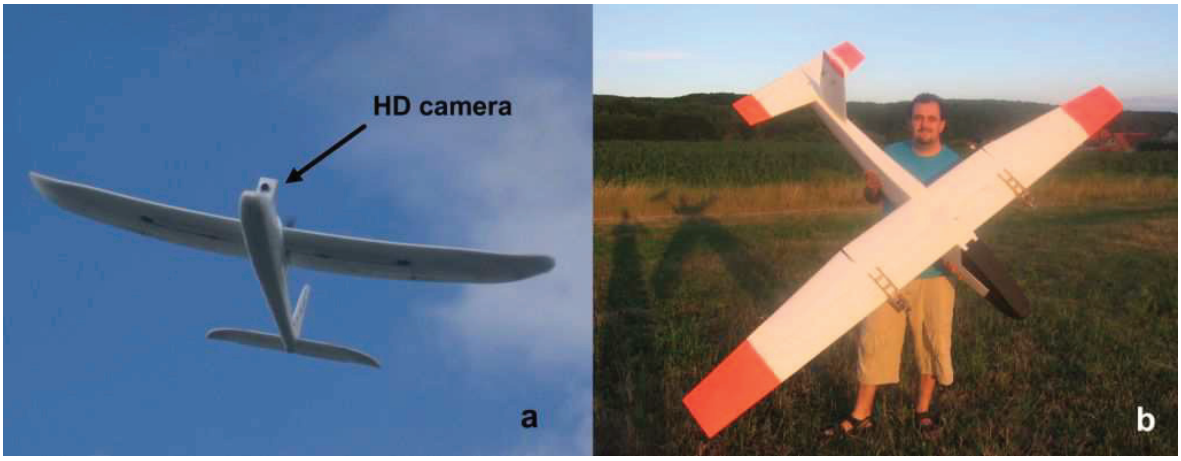

Figure 3: The UAVs used by the authors:
a Multiplex Easy Star (a) and the Styroman Smile (b)

3. Results

The flights were carried out in the area of Bakony Mountains, in Hungary. Several aerial photographs were taken on forests, agricultural fields and on ecological important territories, like wetlands. One of the investigated wetlands (a lake near to Csehbánya) was found rather interesting, since a significant part of the lake exhibited the signs of eutrophication. The growth of algae is hardly detectable from the shore of the lake (ground view), however, it is clearly visible from the air (Figure 4). Since this algae growth has only been detected very recently, further investigations are necessary in different seasons to study the ecology of the lakes and to devise a solution for this problem, if necessary.

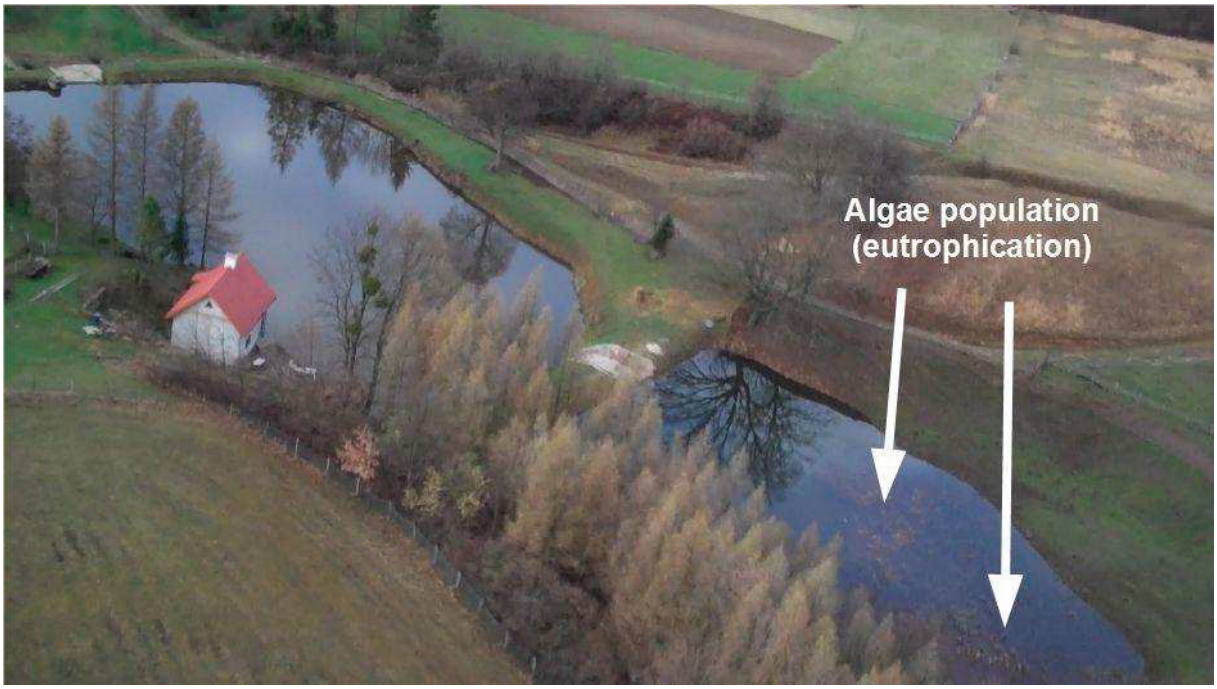

Figure 4: Image made by the authors on a lake
in the neighbourhood of Csehbánya village in Bakony Mountains

Using vertical option the UAV was used successfully in orthographic photos as well. Figure 5 shows an orthophoto made in Bakony Mountains, in the area of Csehbánya Village. This photo is a good example, since buildings, grassy areas and different agricultural fields can be seen in a relative small area.

Figure 5: Orthophoto made in the area of Csehbánya village in Bakony Mountains

As it can be seen, these photos are very informative and utilizable e.g. in agricultural monitoring of land use as well as in this program, in monitoring of natural reserve areas.

By studying the photos our UAVs are found to be very useful for this work; it is one of our future objectives to carry out an air monitoring project for the lakes in Bakony Mountains in collaboration with specialists. It was concluded that both UAVs are suitable for taking orthophotos as well. The noise level of both UAVs was found to be very low due to the electric motors, making those applicable over nature conservation areas as well.

4. Conclusions and future plans

Based on the successful results with this technique using single HD camera the photogrammetric survey will be continued in the area of the investigated lake and it is planned to extend this work to other wetlands and natural reserve areas as well. In addition to the HD photographing the project is planned to be continued with other high performance cameras and sensors to build up a complete “environmental sensing package” for our unmanned aerial vehicles.

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