Monitoring extreme hydrological events and their effects using lightweight unmanned aircraft for remote sensing

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Introduction

How can we acquire spatial measurements?

- **Terrestrial surveying**
  - Disadvantages: time and labour-consuming, susceptibility to mistakes, topographic restrictions

- **Aerial and satellite photogrammetry**
  - Advantages: high resolution, large area imagery available
  - Disadvantages: time and labour-consuming, susceptibility to mistakes, topographic restrictions
  - Topographic restrictions (airport needed)

- **Remote sensing**
  - Advantages: advanced technology, high resolution, large area imagery available
  - Disadvantages: time and labour-consuming, susceptibility to mistakes, topographic restrictions
  - Topographic restrictions (airport needed)
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Introduction

incorporating the UAV into the HydroProg to test a new concept of combining spatial prediction with its aerial verification
Comprehensive UAV system swinglet CAM

a. Fixed-wing UAV
   - endurance: 1 flight ≈ 30 min
   - ultra-light: 0,5 kg
   - wingspan: 80 cm

b. ground control station
   - notebook with
     a dedicated software

c. radiomodem
d. remote control
e. on-board 12MP camera

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Close range oblique aerial imagery

- No vertical photographs
- No metric camera

Terrestrial and aerial photographs and digital images:
- Vertical
  - True
  - Tilted
- Oblique
  - High
  - Low
Ortophotomap generation (1)

**AERIAL PHOTOGRAPHS**

geometry not eligible for quantitative **measurements** (topographic displacement, tilt and sometimes camera lens distortion)

**ORTHORECTIFICATION PROCESS**

changing the perspective projection of a photo into the orthographic position

**FINAL PRODUCT**

Geometric correctness of the orthophotomap (can be treated as cartometric material)

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Kłodzko County is located in the Central and Eastern Sudetes, in the SW Poland. The rivers of the region are the Nysa Kłodzka and its key tributaries, which contribute to rapid and catastrophic floods. The data recorded by the Local System for Flood Monitoring, which was created in this county, are transmitted every 15 minutes.

Study area
Results (1)

**Missions**
- Multiple missions over chosen gauges,
- Frequency weather-dependent

**Products of geoprocessing**
- Orthophotomaps: resolution $\approx 3 \text{ cm/px}$
- Digital Surface Models: resolution $\approx 11 \text{ cm/px}$
Results (2)

- **Fluvial changes**
- **Orthophotomap sequence**

Raw images (aerial photos)

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Conclusions

- Unmanned aerial vehicles allow us to acquire high temporal and spatial resolution data, appropriate for hydrologic analysis.

**ADVANTAGES**
- Flexibility in deployment
- Low cost of survey
- Short time of mission arrangement (quick reaction if needed)
- Extremely high resolution – up to 3 cm/px

**DISADVANTAGES**
- Strong dependency on weather conditions
- Requirements of post-flight imagery processing in order to make the final product cartometric and free of geometric distortion

The UAV-based remote sensing fills the void between high-cost, time-consuming terrestrial measurements and high-cost, high-range aerial photo acquisition, which provides lower resolution products.
Further research

- carrying out additional surveys during periods of high flood risk,
- evaluating the quality of the DSM,
- transferring the prediction for single points into the spatial prognosis,
- automation of flood warnings sent by email/SMS to the UAV operating team so that they are able to immediately organize a field trip and conduct multiple aerial missions in the vicinity of the selected gauges.
Thank you for your attention

I will be happy to answer any questions

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