Infrared (IR) Drone for Quick and Cheap PV Inspection

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Motivation

Thermographic examination can be time-consuming and labour-intensive

- WHAT:
  - Relatively cheap IR-Drone for quick monitoring of big PV installations

- WHY:
  - To identify PV modules that work at reduced power
  - To document the quality of the PV modules
  - To ensure the safety of PV modules
  - To maximize the energy yields from PV

- HOW:
  - Remote controlled drone with thermal imaging camera
Institution

- Bern University of Applied Sciences (BFH)
- SCCER-FURIES
  - Swiss Competence Center for Energy Research
- Bachelor Thesis Manuel Lanz (2014)
Institution

- Photovoltaic Laboratory (PV LAB)
  - Five Competence Groups

- PV long-term measurement & quality control
- PV inverter tests
- Photovoltaic-oriented buildings (PVOB)
- PV2X/EV2X: PV and smart consumers (electric vehicles)
- International/Education/Outreach
Content

1. Technology
2. Application
3. Experiences
4. Conclusions
5. Outlook 2016
1. Technology - Multicopter

- Company: DJI China / Model S1000
  - 8 motors, max. 500W each

- Two cameras
  - Compact camera
  - IR-camera

- Live videostream

- Max. flight time: 20 min

Model S1000 octocopter with installed camera-system
1. Technology - Cameras

**OPTRIS PI Leightweight + PI400**
- Full radiometric IR-video
- Exposure time: 1/80 s
- Video: 35 Hz
- Spectral range: 7.5 to 13 µm

**GoPro Hero 3+**
- Resolution:
- Video: 60 Hz
1. Technology - Tests

- On-site PV-installation
- Roof mounted, monocristalline
  - Siemens M55HO, 53Wp
- Installed power: 60kW
- Operational since 1994
- Required time to IR-map: 2 minutes
2. Application

Stade de Suisse, Bern

- Largest stadium-integrated PV-plant in the world (until July 2015)
2. Application

Stade de Suisse, Bern

- Roof mounted, polycrystalline
  - Kyocera KC167GH-2
    - 5122 modules
  - Kyocera KC175GHT-2
    - 2808 modules

- Installed power: 1‘347 kWp

- Operational since 2007

- Required time to IR map entire installation: 30 minutes

- No permissions needed
2. Application

- Damaged PV Modules found
- They will be examined by the PV-LAB
3. Lessons Learned

- Drone:
  - Requires expertise and practice in controlling the drone

- Thermal pictures:
  - Allow rapid detection and localization of defects
  - Analysis of the data requires time and experience

- Effects of cleaning:
  - By cleaning the PV modules some thermal abnormalities could be corrected
  - Extra power yield gained from cleaning is about 4 percent
Mont Soleil (Jura Mountains, 1’270 m asl)

- Free field, monocristalline
  - Siemens M55, 53Wp

- Installed power: 554.5kWp

- Operational since 1992

- Required time to IR map: 16 minutes
4. Conclusions

1. IR Multicopter Drone is well suited to quickly and precisely screen PV systems at low costs
2. Contactless examination
3. The power loss of the modules can be directly derived from the thermal images
4. No further auxiliary devices needed
5. Allows area-wide inspection of PV installations
6. Only minimal safety precautions needed
7. Precision: Identification of defective modules
6. Outlook 2016

- **Applications**
  - Retrofitted skyscraper Zurich (PV-envelope)
  - Alpine PV-installation at Jungfraujoch (3,454 m asl), Switzerland

- **Research & Development**
  - Thermal image databank with typical defects
  - Software for automated hot-spot detection
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