Real Time Drone Video to Support First Responders

UAV Flight Testing Convention

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DLR

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Setting the scene

- Activities within the European IN-PREP project
- Project aimed at building a system to improve preparedness and response phases of urgent natural and manmade crises

- Here: Provision of aerial images to contribute to a common operational picture in the response phase

IN-PREP

IN-PREP has received funding from the European Union's Horizon 2020 innovation programme under the Grant Agreement No 740627.

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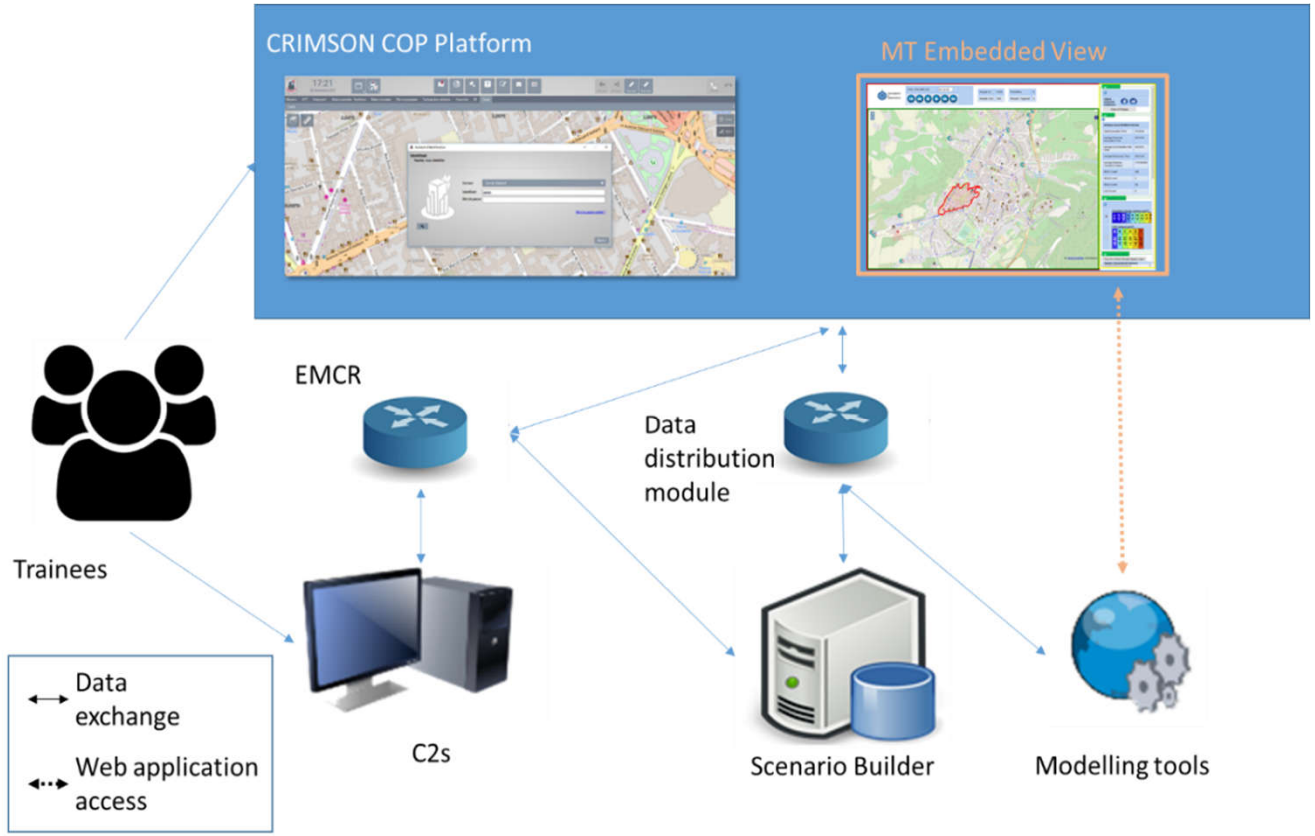
Objectives

- The objectives of the flight test were:
  - To demonstrate that aerial video footage is an excellent means to enhance situation awareness in the operations center and for the units in the field
  - To show the integration of drone and camera control and real-time video streaming to multiple users into Command and Control (C2) systems
  - To show the functionality of the in-house developed Ground Control Station (GCS) “U-FLY”, in particular the interaction with C2 systems, drone connection via mobile internet
  - To demonstrate the functionality and assess the latency of the multi-user real-time video stream system

System Architecture

- Investigated system embedded into an extensive infrastructure created for the project
- The mixed reality preparedness platform (MRPP) comprises different command and control (C2) systems and modelling tools, complemented with (remote) sensor modules and scenario execution tools
- Drone mission requests as well as real-time drone video integrated



Roles

Trainee

Decides which area to investigate
Sends mission request

Mission Planning

Remote pilot

Trajectory Generation

Checks request
Modifies route (if required)
Pre-calculates flight path
Enables mission
Monitors flight execution
Adapts mission (if required)

Sensor Simulation

Real sensors

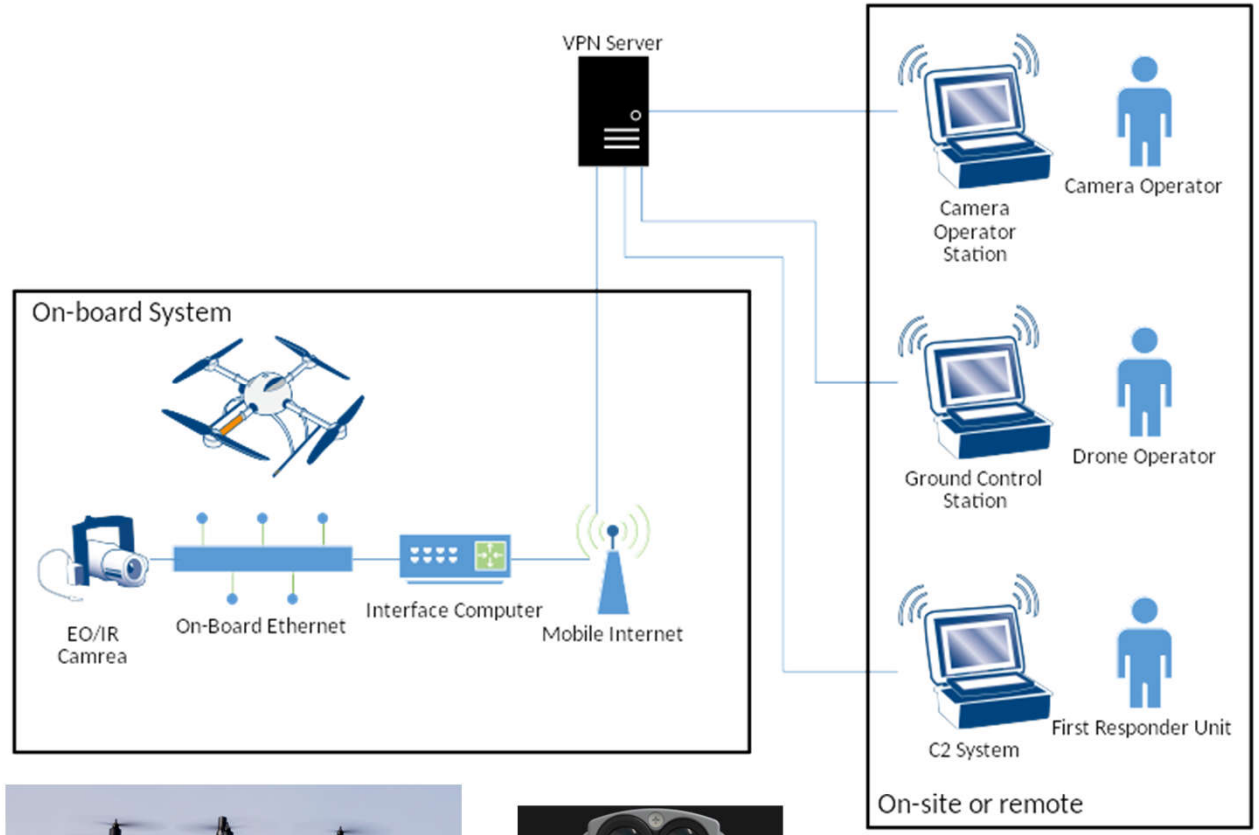
Flight status

Drone (sim. or real)

Sensor data

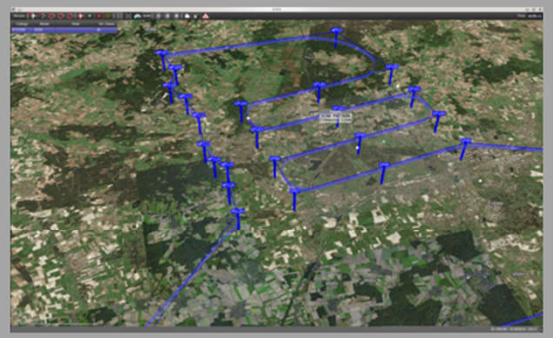
System Architecture

- System under test was a real-time video distribution system that can supply multiple users at the same time
- Drone used „Mikrokopter MK Okto XL 6S12“
- Camera used „Nextvision Nighthawk 2“
- Connected to an on-board interface computer (Raspberry Pi 4)
- Connected to a VPN via a LTE stick
- Camera video is streamed as multicast via mobile internet and VPN

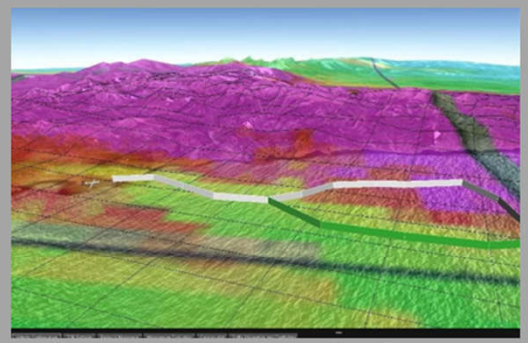


Validation Tool UAS Ground Control Station (U-FLY)

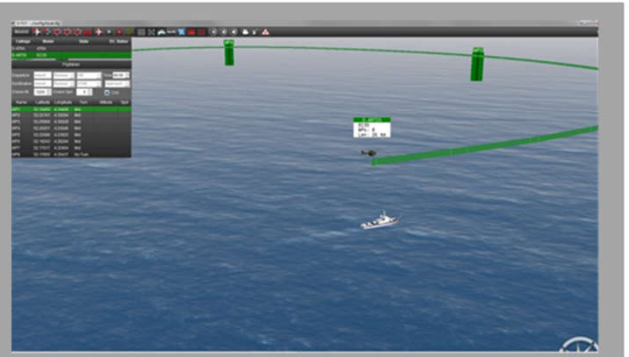
GCS U-FLY



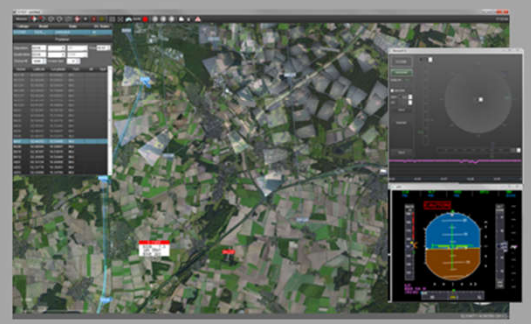
Mission Planning



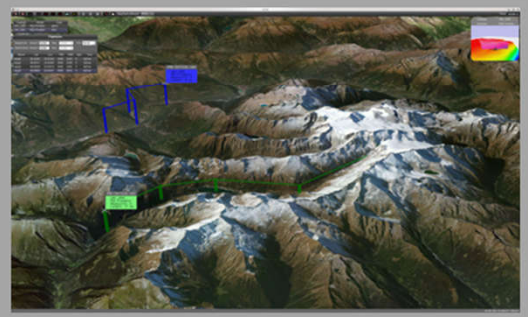
Sensor data visualization and processing



Modelling & Simulation



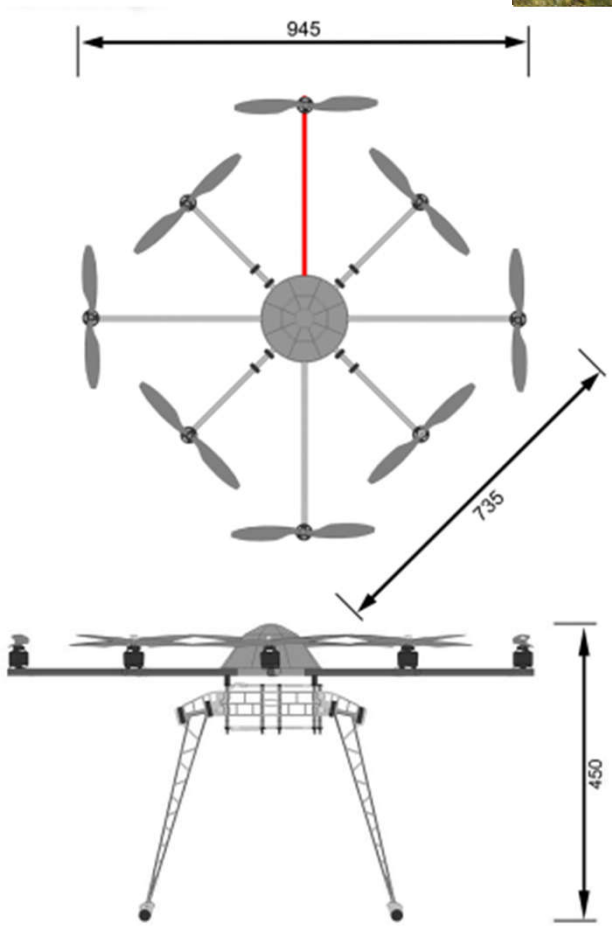
Mission Execution and Flight Control



3D Terrain Visualization

Mikrokopter OktoXL

- Frame diam.: ~ 1 m
- MTOW: 6,6 kg
- Payload: 2,5 kg
- Propeller: 12“ (30,5 cm)
- Recommended max. wind speed: 2-3 Beaufort
- Copter is airworthy up to 6 Beaufort (requires advanced flight skills)
- Use of parachute possible



Next Vision Camera Option

- Dual camera (Night Hawk 2)
- Optical, infrared
- Own gimbal
- Interfaced with TRIP2

- TRIP2:
- Main interface
- Can be connected via serial port or ethernet
- Serial connection can be used for 433MHz telemetry to control the camera; range approx. 300-500m
- Video server via IP

Or

HDMI

RJ 45 or serial

Connectivity

- Raspberry Pi 4 via USB LTE stick
- Can be used as video server (with Raspi cam or HDMI input card)
- Raspi is connected to VPN (via LTE Stick)
- Can be connected to on-board system via LAN and relay the connection
- Therefore, it can relay the Nextvision TRIP2 video via IP
- Video stream can be connected AND camera can be controlled
- Quality of the available mobile internet is key

Or/and

VPN IP
(via anything)

VPN IP
(via LTE)

LAN on-board

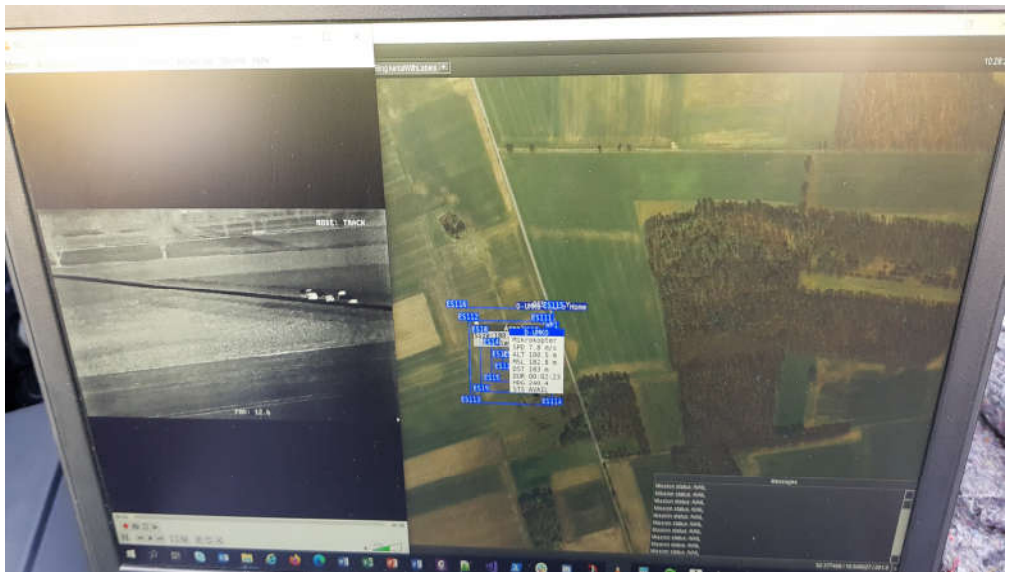
LAN on-board

Flight Test Setup

- C2 operator requests a mission
- Remote pilot validates trajectory
- Trajectory displayed in U-FLY including actual flight data
- Different pre-defined search patterns available or individual positioning of waypoints possible

Flight Test Setup

- Next to the U-FLY display, the transmitted video can be viewed by multiple users in real time
- Possibility to set up an individual camera operator station
- Full control of the camera while other users are still able to see the video

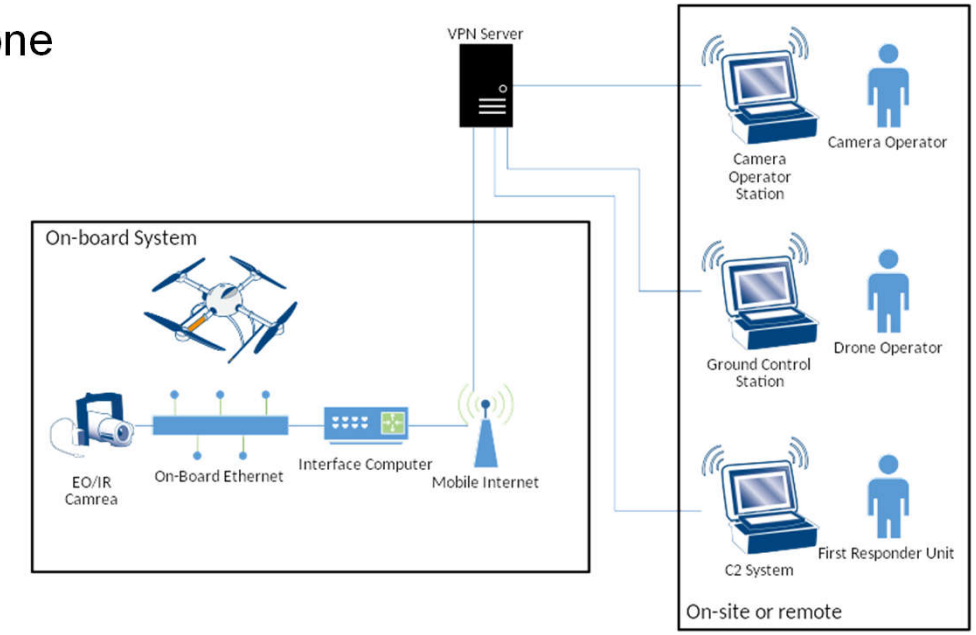


Flight Test Setup

- Flights conducted as VLOS flights in open subcategory A3 (drone class C4)
- Safety pilot present to take over control if required
  → “Simulated BVLOS“
- Flights conducted automatically through C2 system and U-Fly
- Additional camera control station to focus on usability and video latency aspects

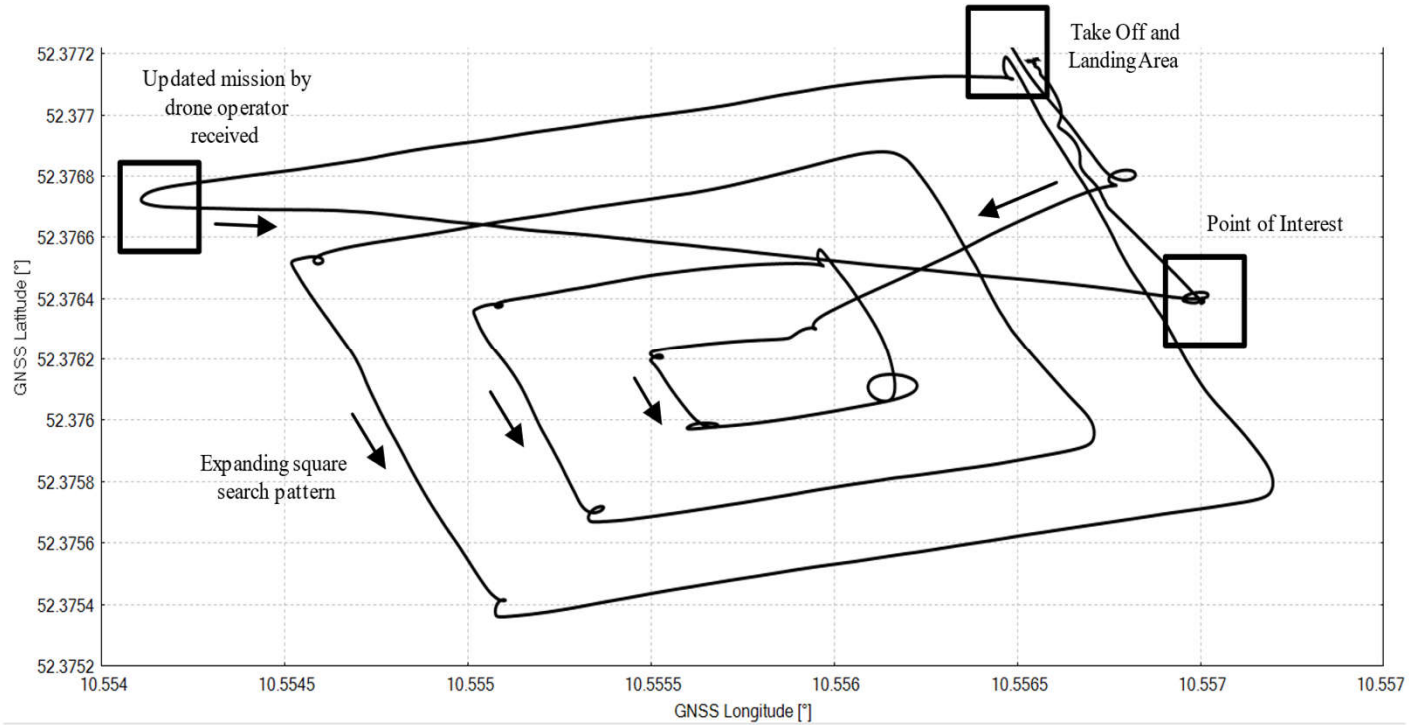
Results

- Within the command center, an AOI is defined within the C2 system, and a drone mission is requested
- Drone operator receives and verifies the mission using the ground control station U-FLY. The pattern is selected depending on the type of request.
- Drone operator sends the mission via mobile internet to the drone
- Drone starts the mission and transmits position and video data
- Camera operator monitors the video stream and is able to control the camera via mobile internet
- If a POI is identified, the camera operator can notify the drone operator and/or the command center in order to update the drone mission



Results

- Flights conducted in February 2021
- Three different missions were flown
- Example mission shown in the figure with mission update received
- Drone status information transmitted via mobile internet with 1Hz
- Observed video latency well below 1s on average



- C2 operator feedback indicated that frame rate of the video stream was experienced to vary, but it did not have negative impact on the possibility to get an overview of the situation
- The resolution of the video stream was perceived to be sufficient


MODE: RATE
FOV: 57.0

Conclusions

- System setup presented is a solution that enables the broadcast of an **aerial video stream to multiple users**
- This allows to **enhance situational awareness** of multiple first responder units while performing missions during a crisis
- Possibility to control the camera as well as the drone **remotely in BVLOS operations with no additional ground infrastructure** (other than for the mobile internet) required
- The **latency** found during the flight tests was **small enough** so that the drone and the camera operator were able to perform their tasks successfully
- The setup presented here, enables crisis managers to receive **first sensor data within minutes** and act accordingly
- Generally, C2 operators were **supportive** of the concept
- This functionality is **already integrated** in their respective system according to one C2 operator

Thank you for your attention!