Near Real-Time Common Operational Picture (COP) for Natural Disaster Management Support

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Abstract

This work gives an overview of the development of a multi-functional airborne management support system within the frame of the Austrian national safety and security research programme. The objective was to assist crisis management tasks of emergency teams and armed forces in disaster management by providing multi spectral, near real-time airborne image data products and a resulting common operational picture (COP). As time, flexibility and reliability as well as objective information are crucial aspects in emergency management, the work shows the used components which are tailored to meet these requirements.

Keywords: Natural Disaster; Near-Real-Time Management; Common Operational Picture; Image Processing; Multi-Sensor Platform.

1 Introduction

The airborne multi-functional management support system ARGUS [2], developed as part of the national research project AIRWATCH enables near real-time monitoring of natural disasters (forest fires, earthquakes, floods, etc.) based on optical and thermal images and follows the demand of emergency teams to react quickly when natural disasters like forest fires, flooding, earthquakes, landslides, etc. occur and can provide flexible and significant assistance for in-situ analysis as well as management activities.

Geo-referenced, high quality multi-sensor image data as well as proper scenario and thematic tailored analysis are provided to dedicated target groups, such as civil protection agencies, fire brigades or national defence agencies acting in support missions, in order to enhance decision making processed and control task forces in an efficient way. Intelligent image analysis algorithms allow situation and thematic specific value added products.

2 ARGUS System

ARGUS is an airborne multi-functional management support system which enables near real-time assessment of natural disasters based on optical and thermal images as well as rapid mapping capabilities. It enables airborne image acquisition in near real-time and the capability to provide an up-to-date operational picture [1] of an effected area in order to increase awareness. As shown in figure 1, it consists of three segments.

2.1 Multi Sensor Platform

The multi-sensor platform provides optical (RGB) as well as thermal infrared (TIR) cameras in combination with a highly precise GPS/IMU solution [3]. The fusion of images with synchronized position and orientation data allows the following processing chain to provide near real-time ortho-rectified images which build the basis of a common operational picture to support decision making and management processes. By using a panning mirror technology, TIR covers the same area as RGB with an improved ground sample distance (GSD). The integrated sensor equipment on the platform includes a 30 MPixel

Figure 1: Proposed system concept.

Source: JOANNEUM RESEARCH ForschungsgmbH.

camera (Prosilica GE 6600C), a thermal camera (Infratec InfraTEC VarioCAM hr head 600) on a swinging mount and a GPS/IMU combination (Novatel Span IGM) to support the direct geocoding process. Tailored for the usage on different carriers (Pilatus Porter PC6, DA42MPP, etc.), the platform offers a flexible usage within different scenarios. Table 1 shows the data acquisition capabilities of the used components. The cited post-processing accuracy is highly dependent on the available quality of reference information.

Table 1: Performance indicators of the sensor platform at a flight height of 1000m above ground level per capture cycle.

Sensor	RGB	TIR
GSD [m/px]	0.11	0.50
Ground coverage[m]	730	320 / image 750 / swipe
Real-time accuracy [m]	< 2.0	
Post-processing accuracy [m]	< 0.2	< 1.0

2.2 Communication Segment

The system provides a broadband (8Mbit/s) line-of-sight solution with an effective range of up to 50km to transmit recorded images to the ground station in real-time.

2.3 Processing and Management Segment

The ground modules include the geo-processing services for near real time processing, so that ortho-rectified products are available in the command centre within one minute after image acquisition. Furthermore, modules for the generation of situation related value added products like hot spot maps and risk maps offer a valuable input for a common operational picture (COP).

An important focus of the ground segment lies on the management application. It supports:

- mission flight planning and controlling;
- visualization and interactive analysis of common operational picture;
- triggering value added products;
- preparation and analysis of reference geo-data sets;
- definition and documentation of relevant geo-data, like points, polygons or areas of interest;
- standardized interfaces to attain compatibility to existing expert systems.

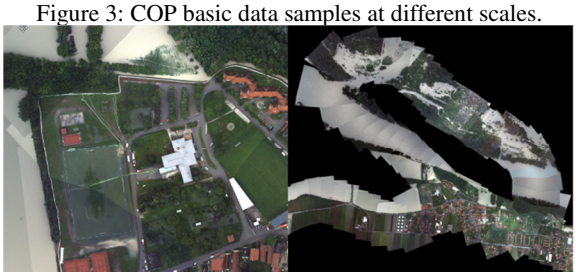
The following figure shows a sample of the ARGUS management application.

Figure 2: Ground segment – management application.

Source: JOANNEUM RESEARCH ForschungsgmbH.

It was used within different scenarios, mainly focussing flooding and forest fire situations, e.g. [4]. Figure 3 shows samples of image products gathered within these missions. Thereby, the ground resolution and geo-accuracy was optimal to support time critical decision making processes like resource allocation and command of ground units

Figure 3: COP basic data samples at different scales.



Source: JOANNEUM RESEARCH ForschungsgmbH.

ARGUS is able to cover large regions (100-200km²/hr) on demand. Over multiple time periods, the resulting material is used for a time evolving common operational picture. In addition to the geo-referenced multi-sensor images, also thematic analysis e.g. hot spot maps and flood masks can be provided for a COP. ARGUS includes modules for processing optical and thermal data to provide scenario tailored products. As an example, for the generation of hot spot masks, relevant temperature ranges can be provided and masks as well as colour coded images are generated to provide heat maps.

3 Conclusion and Outlook

The presented system for providing essential information for a near-realtime COP decision within natural disaster scenarios yields promising results and helps to provide important information for the involved management staff. Experience gained from the deployment of ARGUS during real world scenarios shows that information derived from near-realtime available multi-spectral sensors meets the major requirements of rapid support for decision making processes in time critical situations. The content gathered from image analyses employing the used sensors is sufficient for most disaster management scenarios. The modular concept and flexible design allows simple adjustment to different quality requirements like higher image quality, adapted sensor modalities or different data processing workflows. The used cameras can be equipped with different lenses which result in either high area coverage or in more details on hot spots. The flexibility and modular configuration also strengthens the usability, which is essential for a solution that needs to be practically oriented.

The next step is to integrate ARGUS into a permanent operational disaster management service on a national level in a close cooperation between the Ministry of Defence, the Ministry of Interior and the regional governments. Especially in the field of wildland fires and the management of firefighting actions, the proposed solution is of high interest. The main objective is to provide accurate information on the situation as well as to be the basis for the coordination of the available resources within different hierarchies as well as extended interaction with fire fighters in the field.

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