REAL TIME DUAL CAMERA SPECTRAL IMAGING
BASED ON NVIDIA TEGRA SOC TO ASSESS UAV MISSIONS

Michele Moscaritolo, Alessandro Della Villa, Giacomo Benelli
San Jose (CA) - 07 April 2016
PRESENTATION
OVERVIEW

› Introduction
› Requirements
› Proposed solution
› Development assessment
› Discussion
UAV (Unmanned Aerial Vehicle) known as a drone (Dynamic Remotely Operated Navigation Equipment). An aircraft without a human pilot aboard.
DRONE APPLICATIONS

- Inspection
- Survey & mapping
- Safety & Security
- Agriculture
- Creative

- Energy
- Mining
- Fire fighting
- Farming
- Videography

- Telecom
- Construction
- SAR
- Vegetation management
- Photography

- Infrastructure
- Infrastructure
- Surveillance
- Research

- Farming
- Vegetation management
- Photography

- Surveillance
- Research

- Fire fighting
- SAR
- Vegetation management

- Energy
- Mining
- Construction

- Inspection
- Survey & mapping
- Safety & Security
DRONE APPLICATIONS POSE A CHALLENGES

ASSESSMENT OF PAYLOAD FOR:

- Data acquisition & Analysis
- Computational power
- Real time onboard processing
- Multi spectral sensor
PRESENTATION OVERVIEW

› Introduction
› Requirements
› Proposed solution
› Development assessment
› Discussion
BASIC REQUIREMENTS

1. Data acquisition & Analysis
2. Computational power
3. Real time on board processing
4. Multi spectral sensor
5. Light and small sensor
6. Reduce cost
7. Scalable and modular
8. User/Developer friendly
Multispectral camera ideal “tool” to capture data in different scenario but:

- Expensive Cost!
- Processing power hungry!

To satisfy this requirement we must find an alternative solution.
PRESENTATION
OVERVIEW

› Introduction
› Requirements
› **Proposed solution**
› Development assessment
› Discussion
IR+Visible image sensors coupled with high processing power of Jetson Tegra can be the ideal solution since Tegra can real time associate to each pixel Visible and IR Spectrum.
GOAL: ADVANCED UAVs

Library of functions real-time computer vision and image acquisition and processing

Software - SDK

PROCESS UNIT
Nvidia Tegra Family K1, X1, ...

Daylight Camera
Sony optical zoom

Thermal Camera
Flir Digital
Performance compare for Embedded Computer Vision and Image Processing

Costs

WATTS

GFLOPS

SMARTPHONES

FPGA

X1 NVIDIA 2016 oOCCHI II

K1 NVIDIA oOCCHI I

MULTISPECTRAL SOLUTION
Introduction

Requirements

Proposed solution

Development assessment

Discussion
### ARCHITECTURE

<table>
<thead>
<tr>
<th>Custom Algorithms for UAV applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metadata, Communication Protocol, Data Storage, Video Output</td>
</tr>
<tr>
<td>Software + SDK</td>
</tr>
<tr>
<td>Tegra SoC GPU</td>
</tr>
<tr>
<td>Sensor interface</td>
</tr>
<tr>
<td>Camera Sensors</td>
</tr>
<tr>
<td>Visible and Infrared (LWIR)</td>
</tr>
</tbody>
</table>

- HDMI
- SD
- OpenCV tegra
- Qt
- V4L
- NVIDIA CUDA
- USB
In order to meet requirements we need a software capable to:

1. Receive commands from remote and provide output (HDMI or SD)
2. Efficiently capture from generic USB cameras
3. Deliver a constant frame rate for UAV fly operations
4. Take benefit of GPU to combine sensor data
Capture and Master have been isolated in separate threads attached to dedicated cores.

Capture and Master have fixed pulse interval in order to deliver fixed frame rate (8.33 fps or 25 fps).

To respect time processing constrain GPU is used.

GPU processing pipelines can be configured setting up wanted transformations to extend and customize functionalities.
SOFTWARE ARCHITECTURE
FEATURES

video replacement
TYPICAL SCENARIO

Typical scenario Based on previous requirement roof inspection
MEASUREMENT & ANALYSIS
Typical scenario Based on previous requirement Body signature detection
IMAGE PROCESSING

IMAGE REGISTRATION
PRESENTATION
OVERVIEW

› Introduction
› Requirements
› Proposed solution
› Development assessment
› Discussion
Dual head camera with overlay solution is possible:

1. To adopt in different applications and drone missions
2. To get relevant spectral information
3. To have real time on board processing with Nvidia Tegra
4. Scalar and modular platform has been developed for UAV Multi Spectral applications

It offers less spectral information with respect to hyperspectral but it is 3-4 times cheaper.
REAL TIME DUAL CAMERA SPECTRAL IMAGING
BASED ON NVIDIA TEGRA SOC TO ASSESS UAV MISSIONS

Michele Moscaritolo, Alessandro Della Villa, Giacomo Benelli
San Jose (CA) - 07 April 2016