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Real Time Embedded Image Processing for Autonomous Unmanned Aerial Vehicles

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Agenda

- Introduction
- Methods and Tools
- Experiments and Results
- Additional Results
- Conclusion

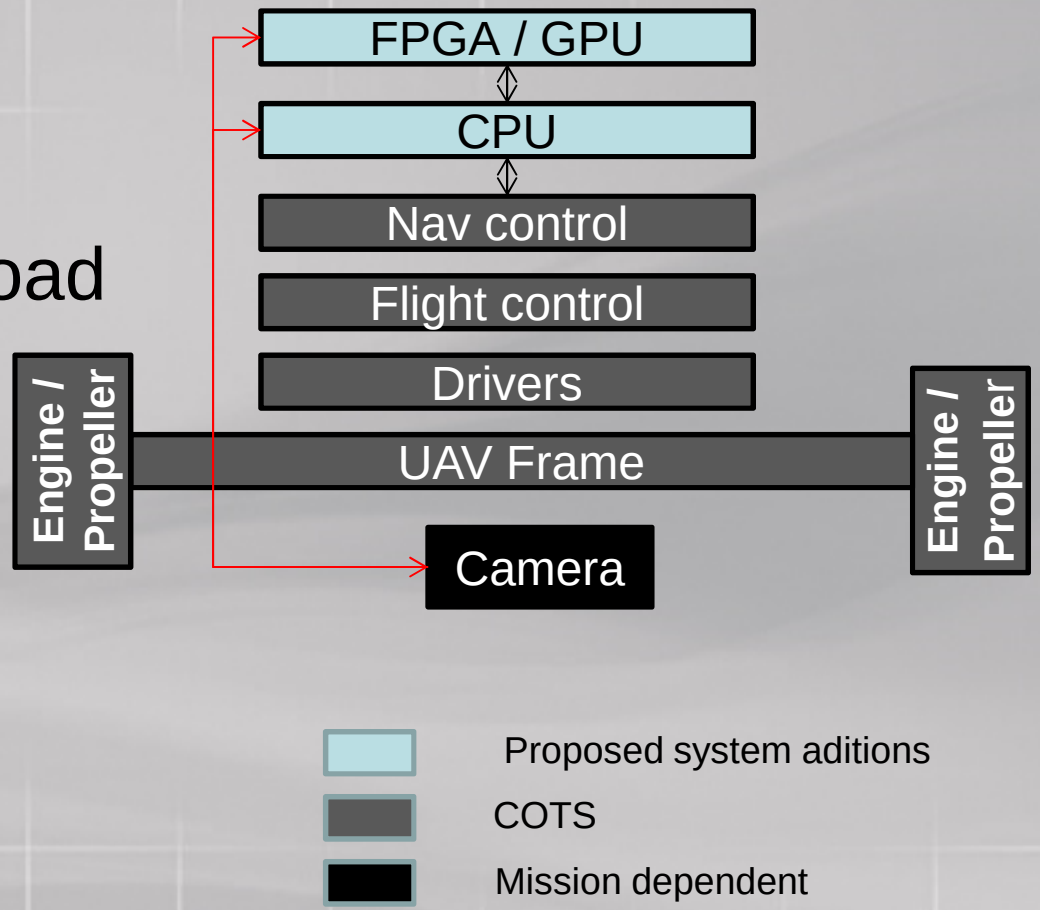
Introduction

Introduction

- Increasely demand for new UAVs in surveillance and inspection applications
  - Time reduction
  - Cost reduction
  - Risk reduction
  - 3D Missions (Dull, Dirty and Dangerous)
- Necessity of embedded computing power to process payload data while in mission

Introduction

- Small UAVs
- Additional hardware to process payload data



Introduction

- No big deal for large UAV platforms
- Big problem for small UAV platforms
  - Limited energy resources
  - Limited payload
  - Cost-benefit trade off

Introduction

Goal

- Evaluate the usage of COTS embedded computer in small UAVs
  - Raspberry Pi 2
  - Ordinary UAV mission: detecting points of interest

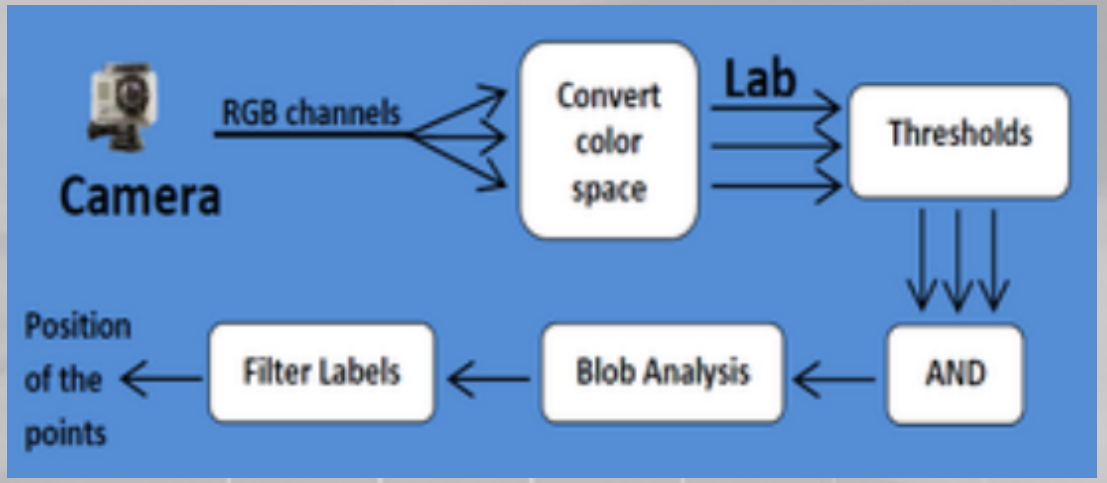
Methods and Tools

Methods

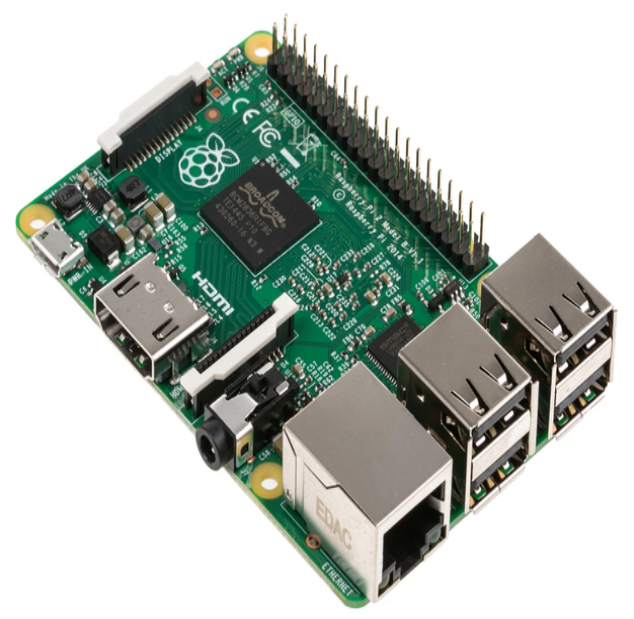
- Study about the behavior of image processing algorithms used in POIs detection – timing requirements
- Configurated a set of experiments to stress the chosen COTS hardware
- Indentification of the bottlenecks

Methods

- Detection of points of interest (POIs)
  - Image acquisition
  - Filtering
  - Predetermined pattern of interest



Tools



- Raspberry Pi 2
  - 900MHz quad-core ARM Cortex-A7 CPU
  - 1GB RAM
  - Cheap
  - Easily available on the market
  - Lightweighted to be added on a COTS small UAVs

Tools

- Real-time operating system
- Open source with Large community support
- Easy port to RBP

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Experiments and Results

Experiments

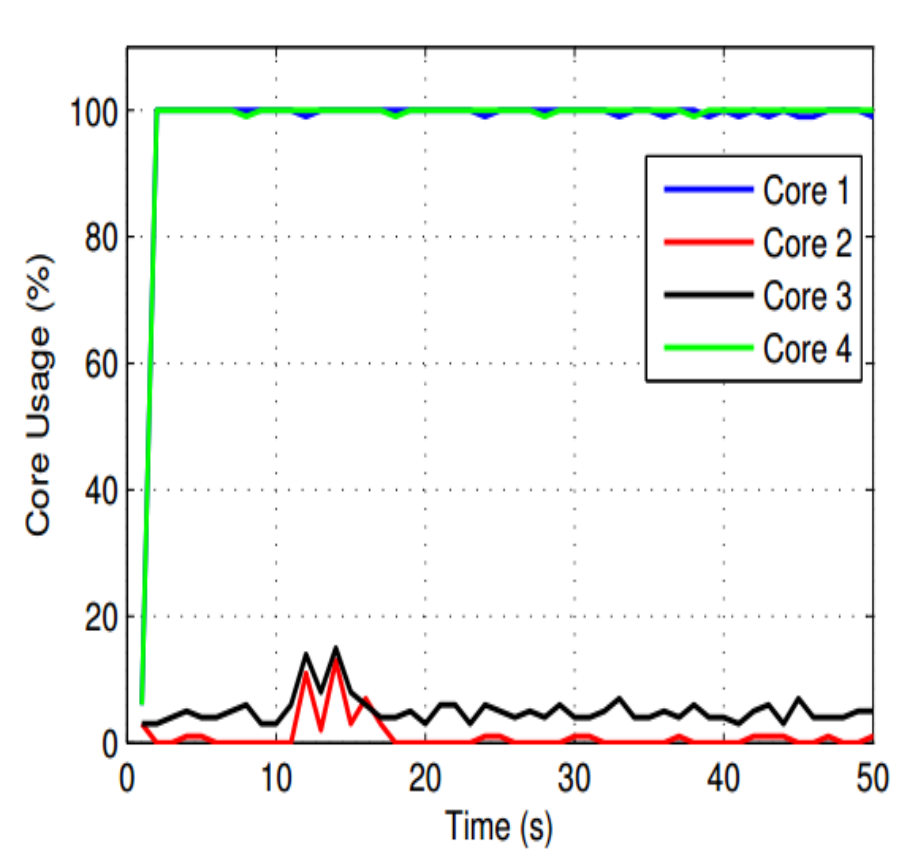
- The chosen application was executed in 4 different scenarios to analyze the hardware's behavior

N^0	# tasks	Description
1	2	Two tasks Real Time
2	4	Two tasks Real Time and two simple tasks
3	8	Two tasks Real Time and six simple tasks
4	12	Two tasks Real Time and ten simple tasks

Results

Nº	# tasks	Description
1	2	Two tasks Real Time
2	4	Two tasks Real Time and two simple tasks
3	8	Two tasks Real Time and six simple tasks
4	12	Two tasks Real Time and ten simple tasks

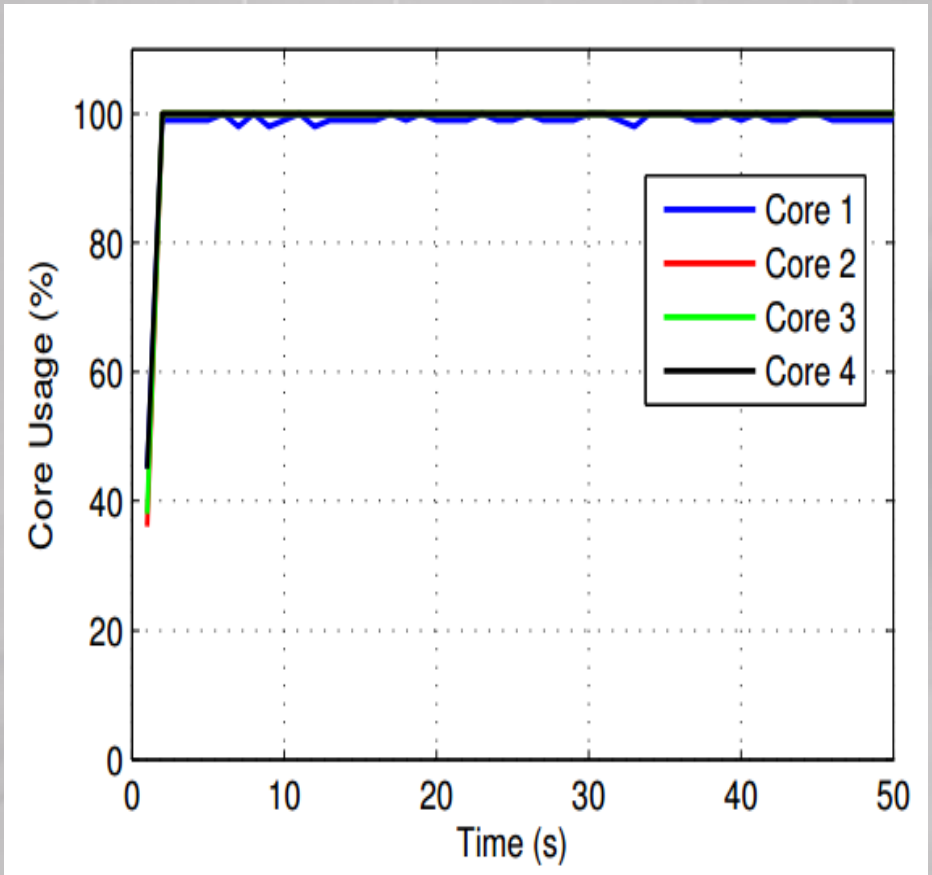
- Cores Usage - scenario 1



Results

Nº	# tasks	Description
1	2	Two tasks Real Time
2	4	Two tasks Real Time and two simple tasks
3	8	Two tasks Real Time and six simple tasks
4	12	Two tasks Real Time and ten simple tasks

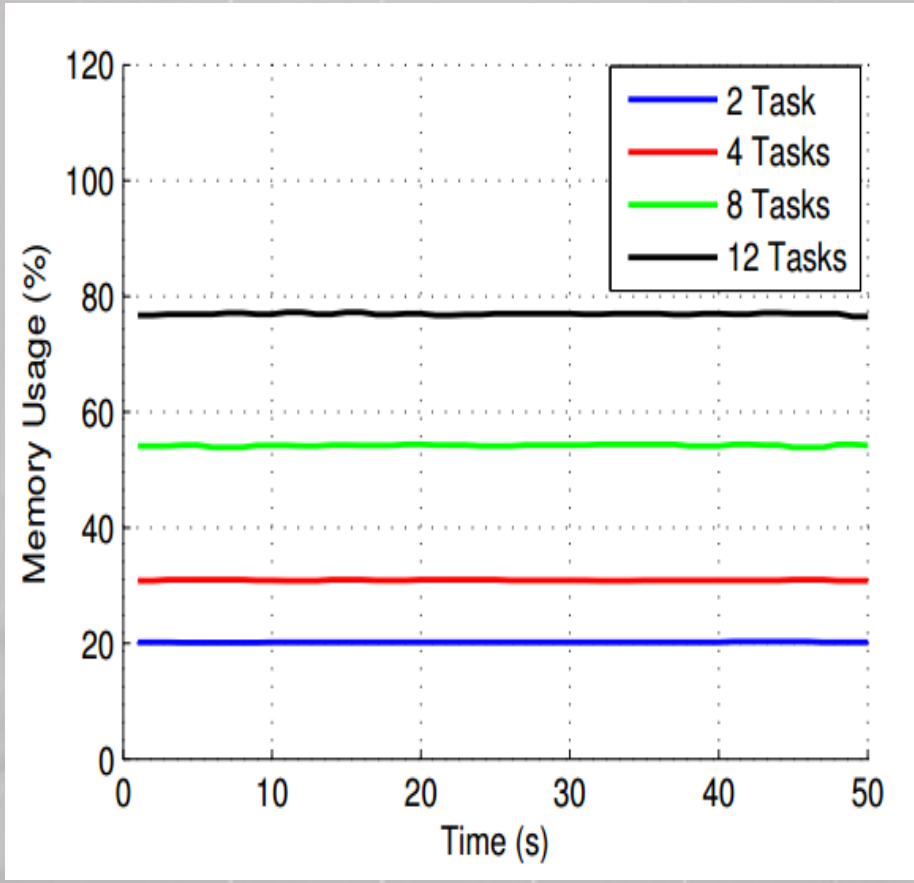
- Cores Usage – scenario 4



Results

Nº	# tasks	Description
1	2	Two tasks Real Time
2	4	Two tasks Real Time and two simple tasks
3	8	Two tasks Real Time and six simple tasks
4	12	Two tasks Real Time and ten simple tasks

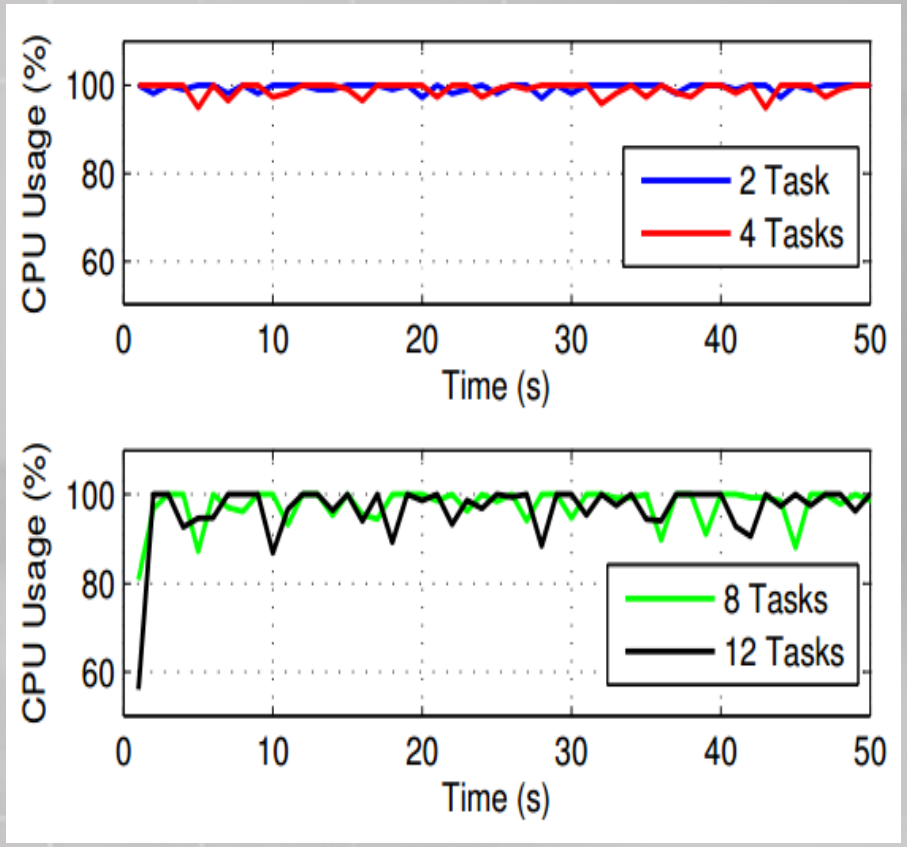
- Memory Usage



Results

Nº	# tasks	Description
1	2	Two tasks Real Time
2	4	Two tasks Real Time and two simple tasks
3	8	Two tasks Real Time and six simple tasks
4	12	Two tasks Real Time and ten simple tasks

- Behavior of the RT tasks in each scenario



Results

Nº	# tasks	Description
1	2	Two tasks Real Time
2	4	Two tasks Real Time and two simple tasks
3	8	Two tasks Real Time and six simple tasks
4	12	Two tasks Real Time and ten simple tasks

- Missed deadlines assuming 0.3309s (worst execution time in scenario 1) as threshold

Nº	# tasks	# Deadline not respected
1	2 tasks	0
2	4 tasks	737
3	8 tasks	896
4	12 tasks	977

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Additional Preliminary Results

Payload and Mission Control Processing Integration Design for Electric Power Lines Inspection

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Payload and Mission Control Processing Integration Design

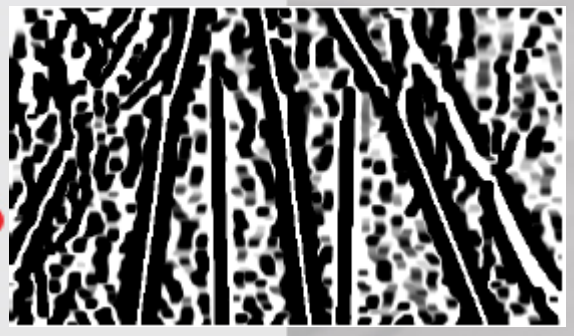
Electric Power Lines Inspection

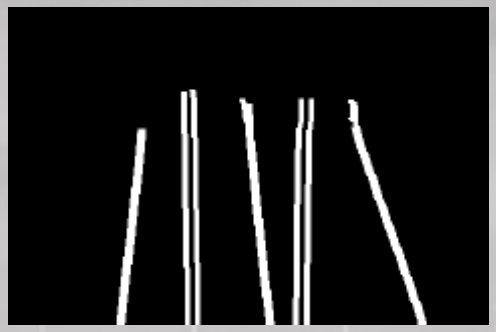
- Autonomouns navigation and control
- Refining GPS data
- Embedded Video Processing

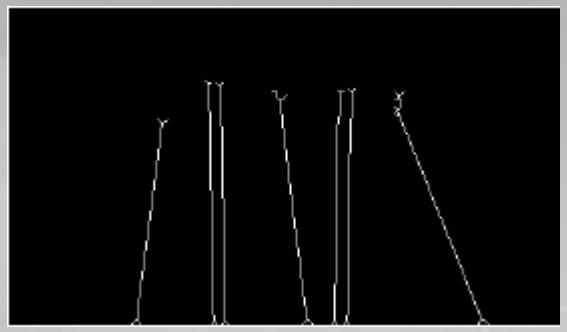
Payload and Mission Control Processing Integration Design

Electric Power Lines Inspection

”Well Behaved Scenarios...”







Payload and Mission Control Processing Integration Design

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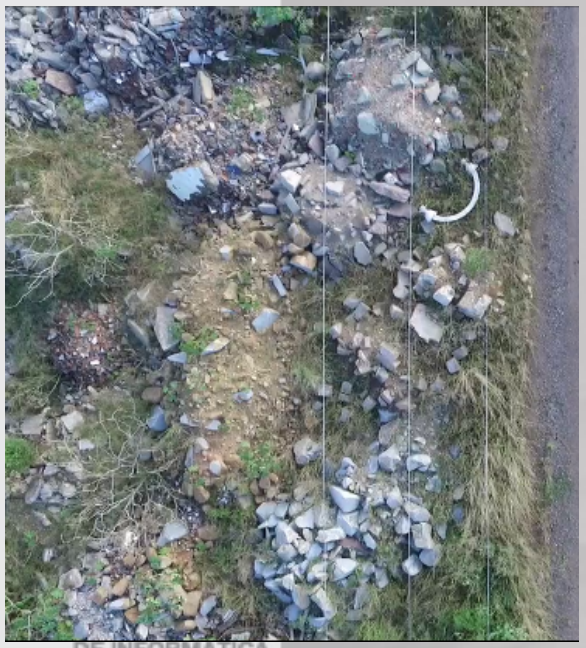
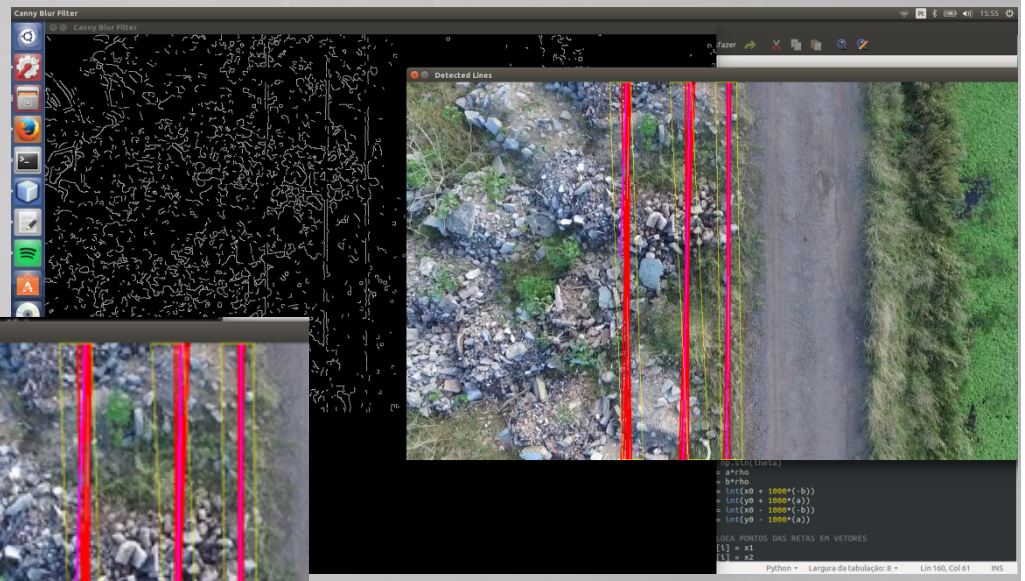
Electric Power Lines Inspection
... but life is not so easy!





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Conclusions

Conclusions

- The RBP
  - Inexpensive hardware
  - Easily accessible
- Possible to be used in real time applications, but with serious restrictions
- Optimizations in the software need to be done to make this usage more successful

Thank you!

Questions?!

This work is been performend under a cooperation between Federal University of Rio Grande do Sul and the company SKYDRONES in Brazil and the Halmstad University in Sweden

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