SIBGRAPI '16

A Data Fusion Architecture Proposal for Visually Impaired People

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Summary

(1) Introduction

- Help the VIP to move around safely;
- Architecture that to contextualize environment elements;
- The proposed architecture is Composed of Computer Vision techniques **(CV)** and Data Fusion **(DF)**;

(1) Introduction

- Specific contexts;
- Offer some kind of danger to VIP;
- Kinect -> placed on the person;

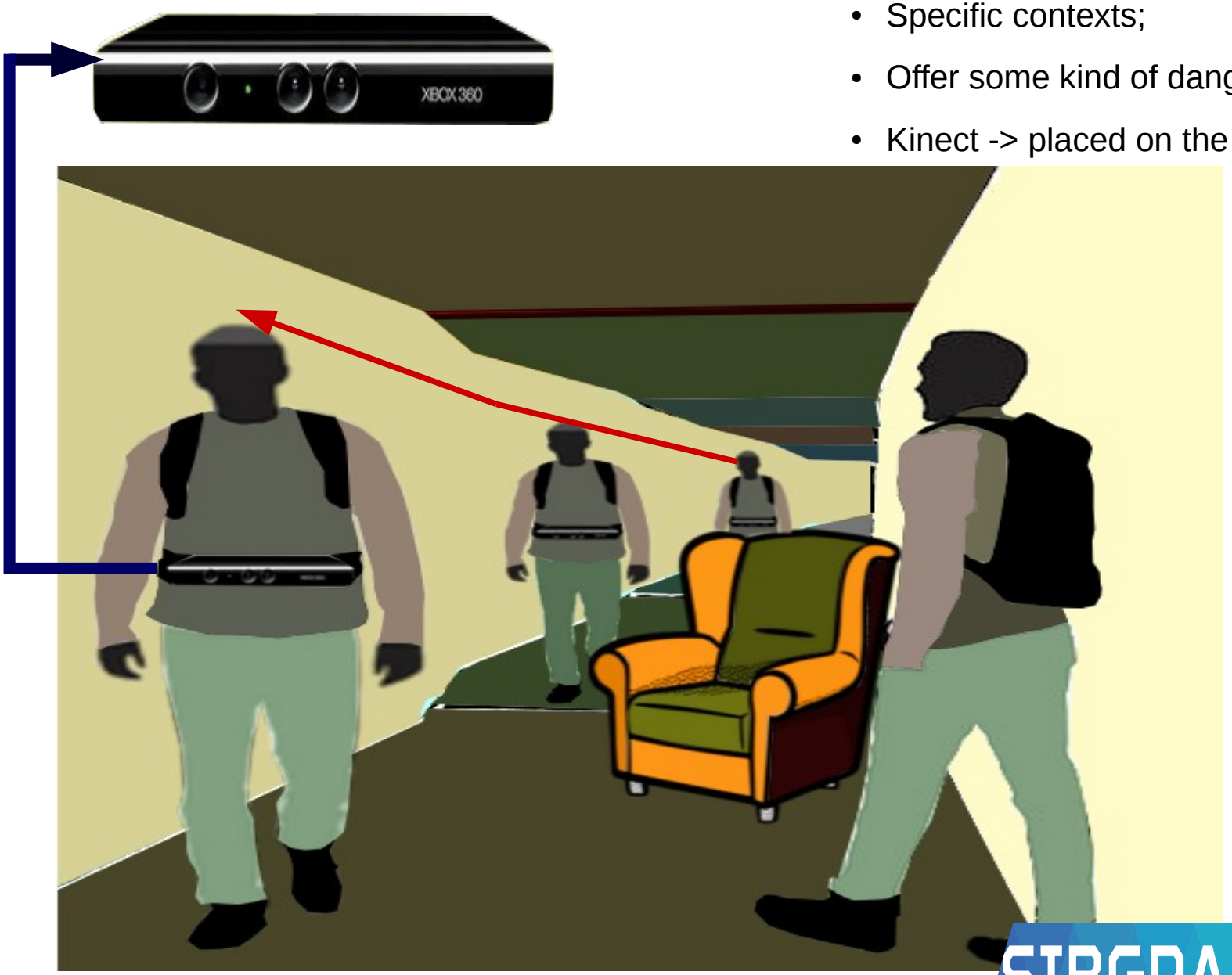


Figure 01: Indoor Environment

(2) Related Works

- **Ando et al [11]** -> provide continuous communication between the VIP and a Network of sensors distributed in the environment for locomotion without collisions;
- **Ando et al [11]** -> it needs to use a set of physical sensors around the environment;

- **Joseph et al [9]** → use of social sensors to provide data from sites and social networks that support VIP to find out if there is any danger to mobility in a given region;
- **Joseph et al [9] and Ando et al [11]** have a high dependence on external sensors in their systems for performing data fusion;
- In the **SAS-VIP** kinect device is carried by a person. Therefore, this project not depend of external sensors.

(2) Related Works

- **Angin et al [8]** → Proposes data extraction in a similar way to the structure used in this project;
- However, Angin's project **[8]** only presents the implementation of data fusion at the level of perception;
- The Angin's project is not executed inferences.
- **SAS-VIP** presents the implementation of data fusion at the level of **Projection (**where inferences are performed**)**;

(3) Contributions

- Integrate all information and make decisions based on the SAW level of projection (proposed by **Endsley et al [2003] and Liggins et al [2008]**);
  - The VIP Systems hardly address data fusion systems with SAW level;

- Generate decisions that a human being can trust;

- Reduce the number of physical sensors making the project cheaper;
  - It was possible with the use of CV techniques, image analysis and DF;

- Provide an arquitecture for dynamic objects analisys and context classification;

(4) (SAS-VIP)

Interviews with VIP were conducted to check their main difficulties.

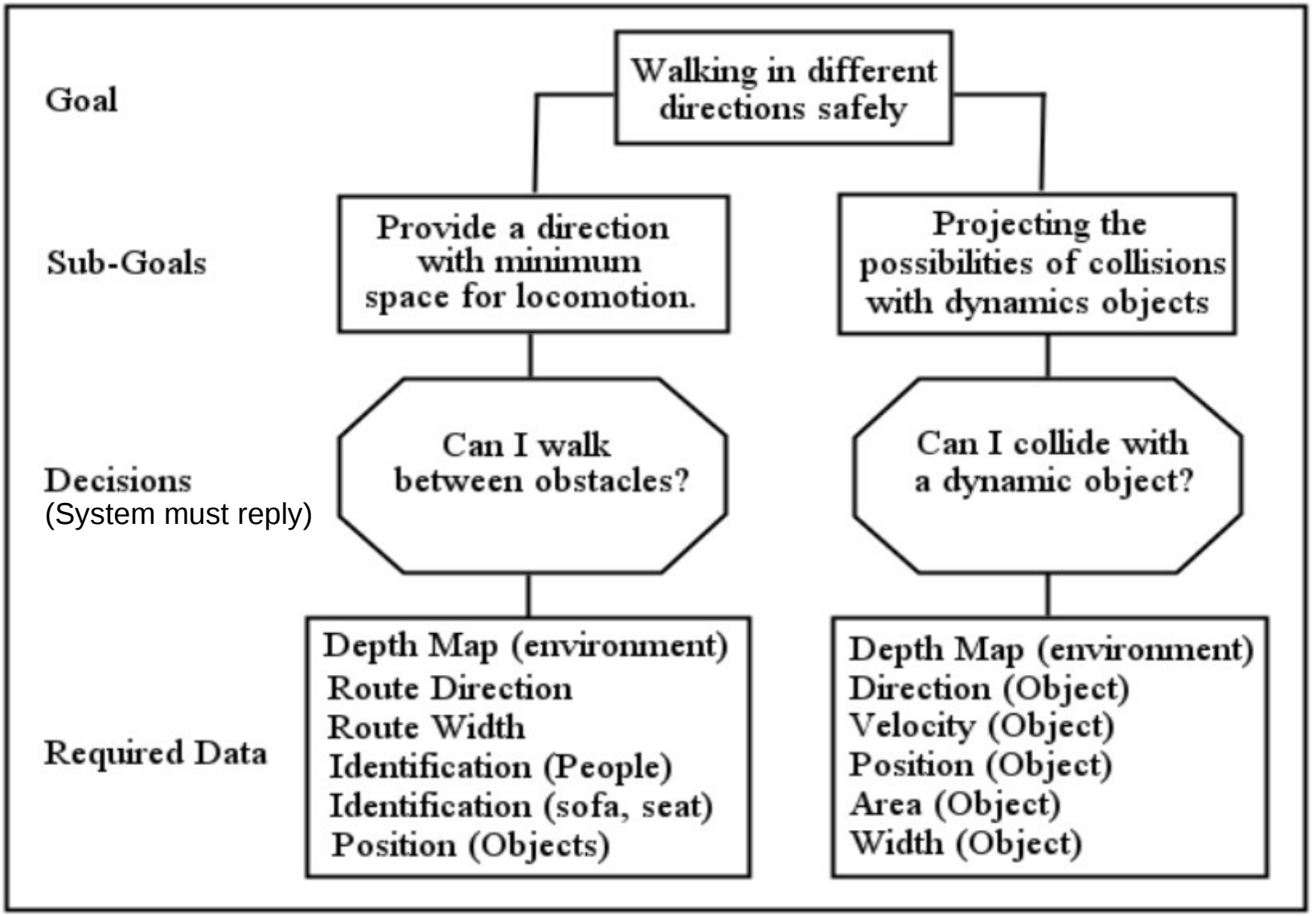


Figure 02: Analysis of user's goals using GDTA.

(4) (SAS-VIP)

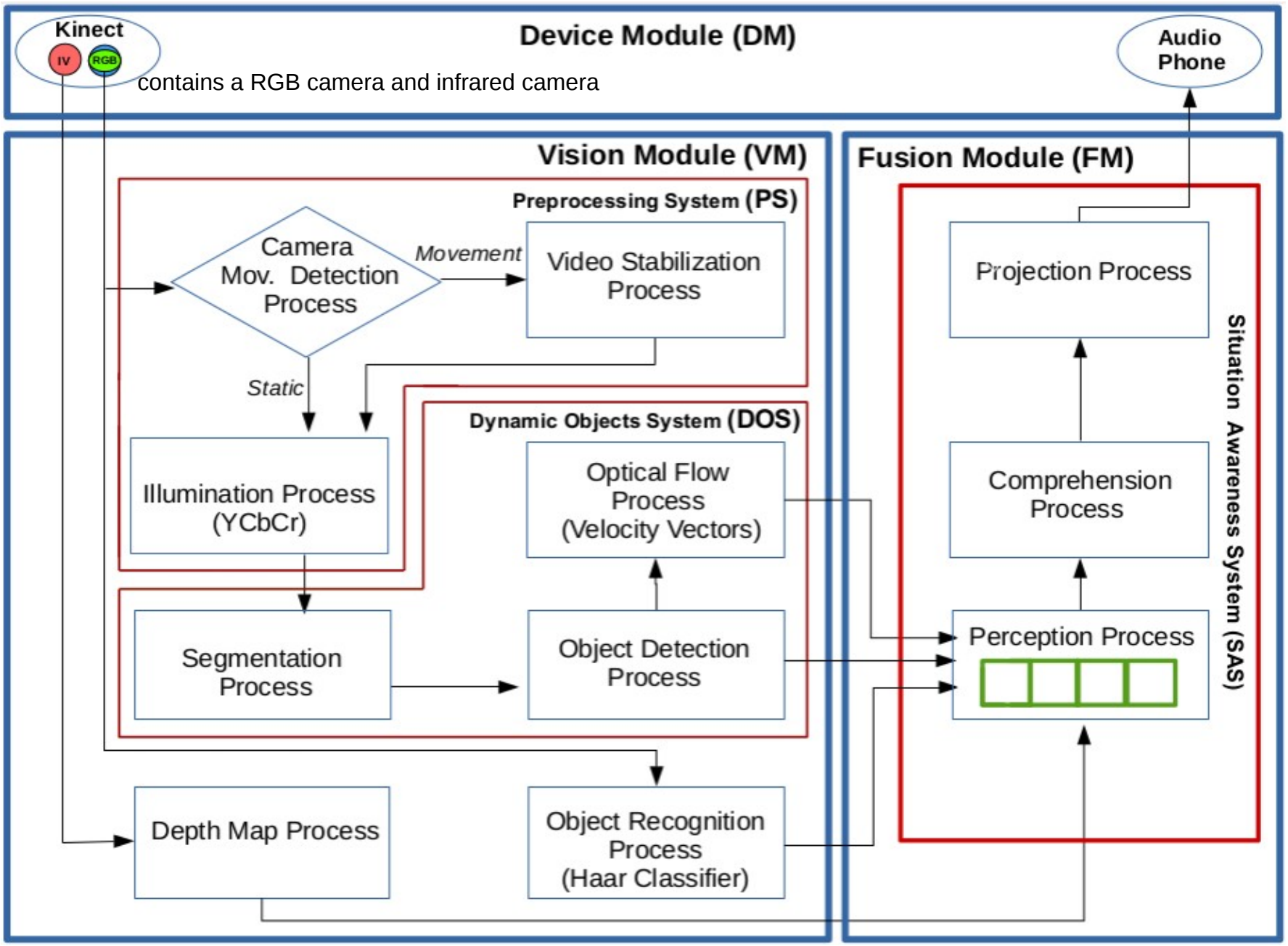


Figure 03: Architecture of SAS-VIP

(5) Results

Video Stabilization Process

The Stabilized image was obtained after application of Kalman filter on the affine transformation coefficients. (**Proposed by Bradski et al [16] and Raj et al [12]**)

(a) Previous image

(b) Current image

(c) Stabilized image

Figure 04: Preprocessing System

(5) Results
Illumination Process

After obtaining the intrinsic parameters of the camera, it was applied the following corrections. (**Proposed by Trucco [14]**)

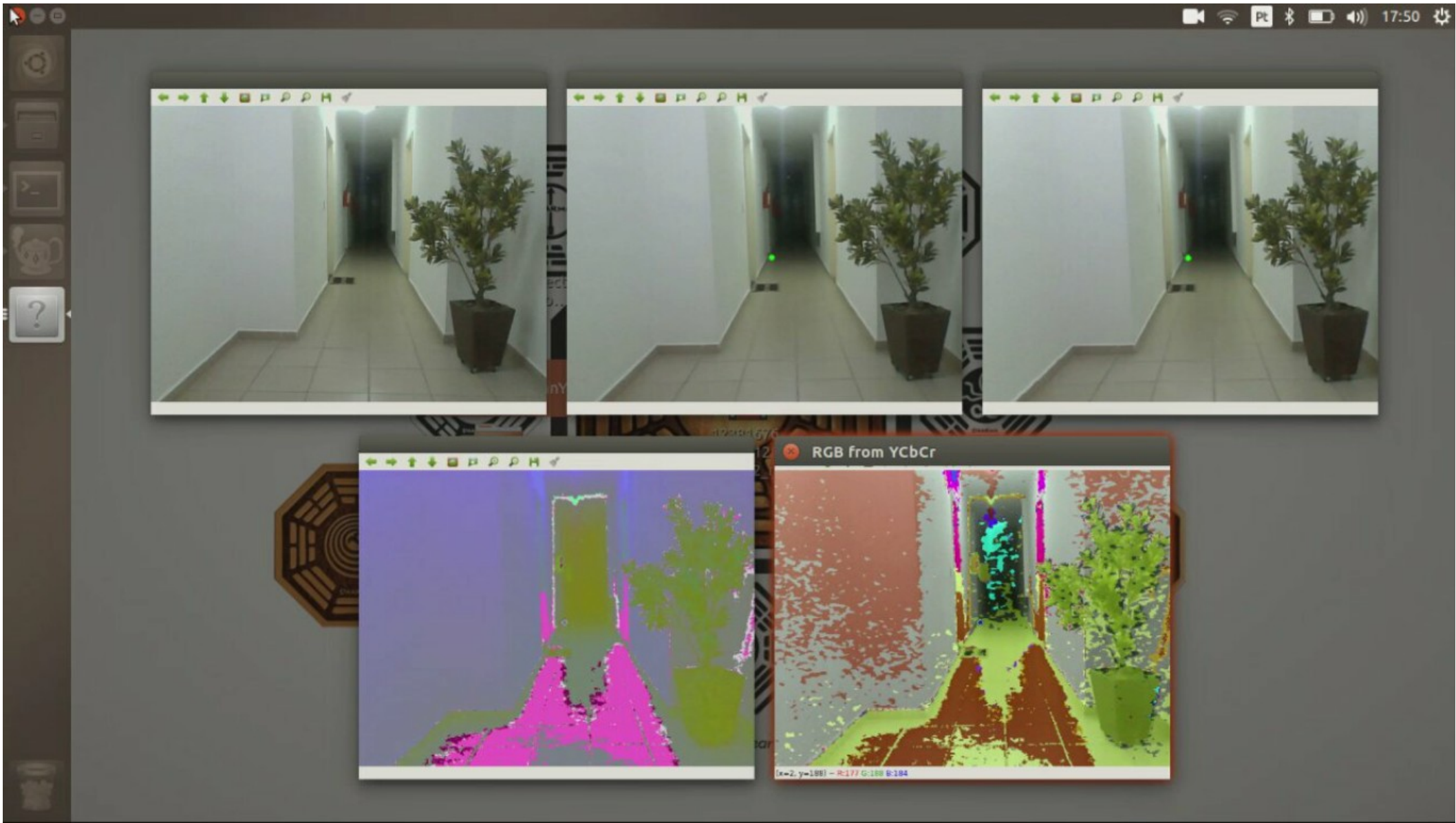
(a) Radial correction (b) Radiometric correction (c) YCbCr control

Figure 05: Preprocessing System

YcbCr Image provides illumination with higher quality for the segmentation process.

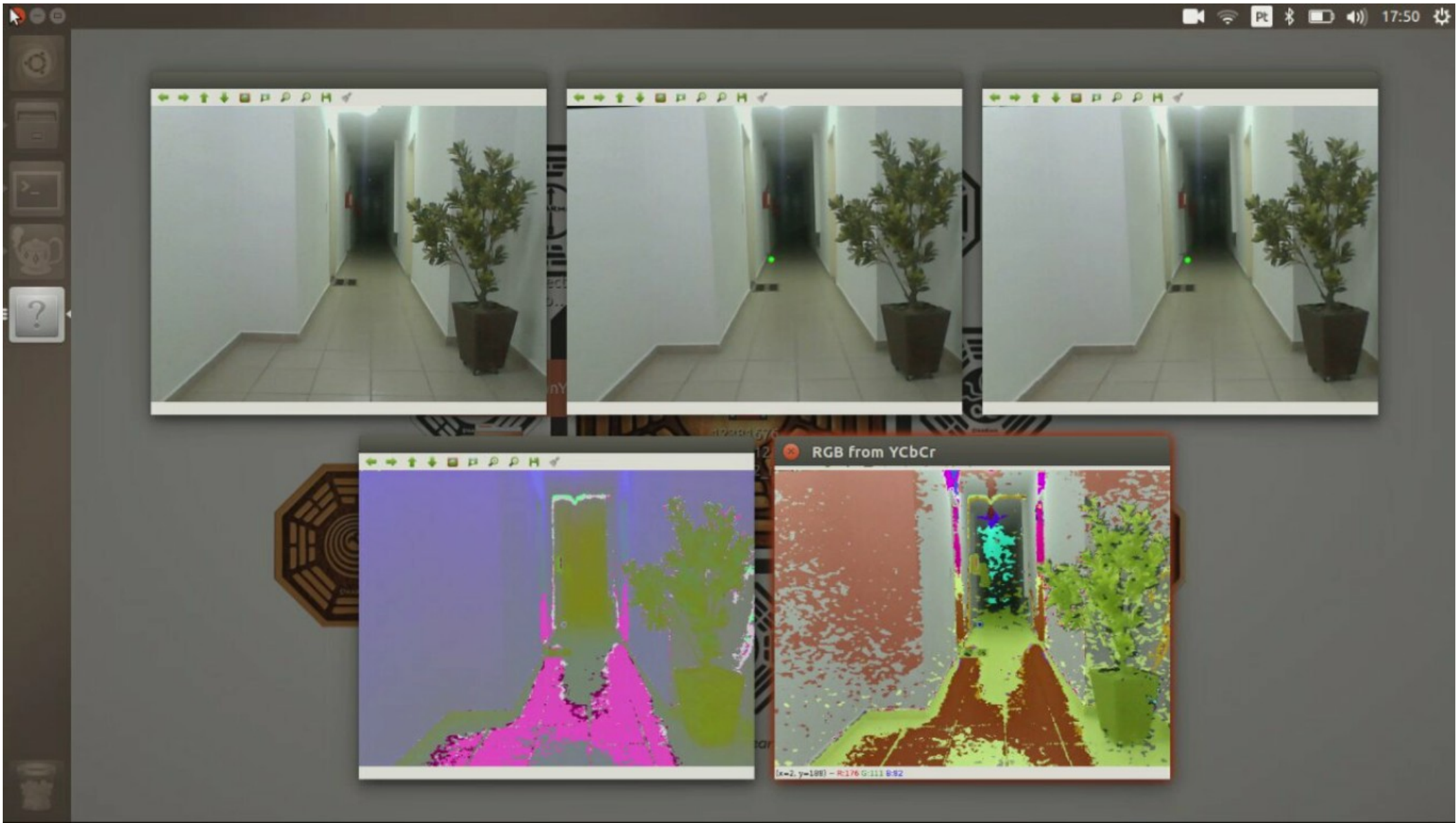
(5) Results

Video Stabilization Process (1)



(5) Results

Video Stabilization Process (2)



(5) Results

Video Stabilization Process (3)

(5) Results

Video Stabilization Process (4)

(5) Results
Dynamic Objects System

The segmentation algorithm performs the Background Subtraction **(Proposed by Kim et al [17] and Bradsky et al [16]).** So, applies the algorithm to compute the area and the center of mass of a moving object.

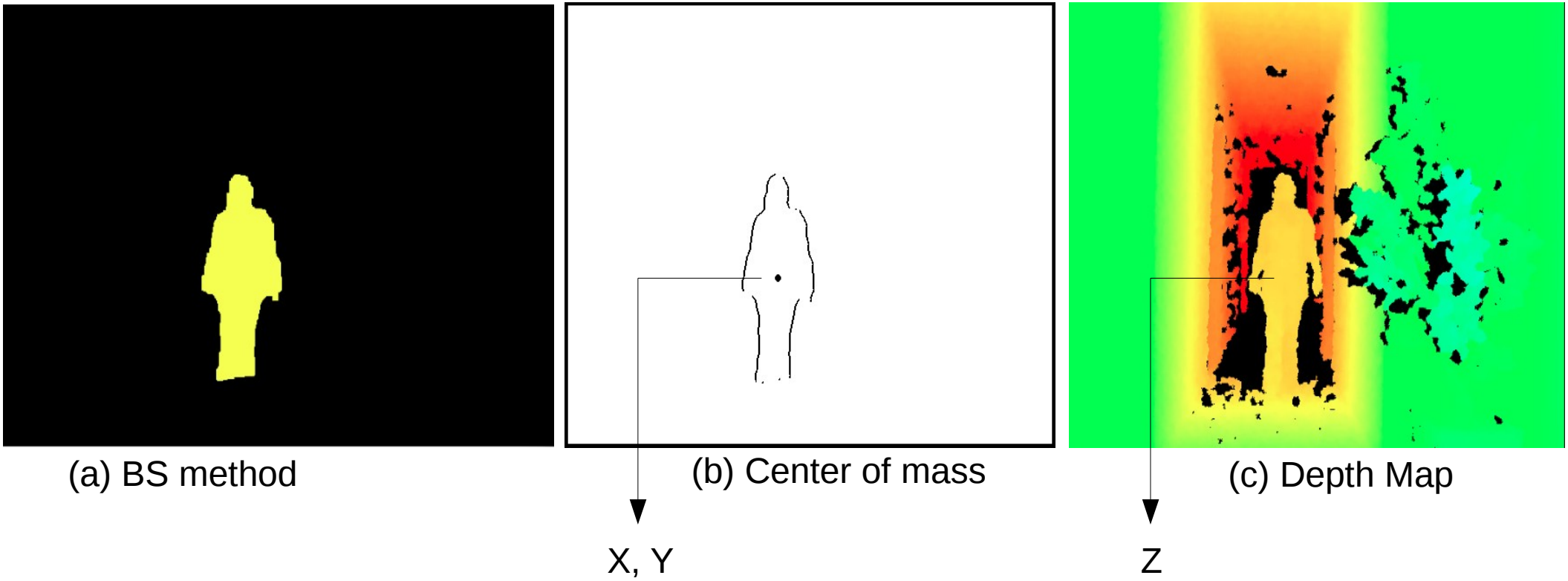
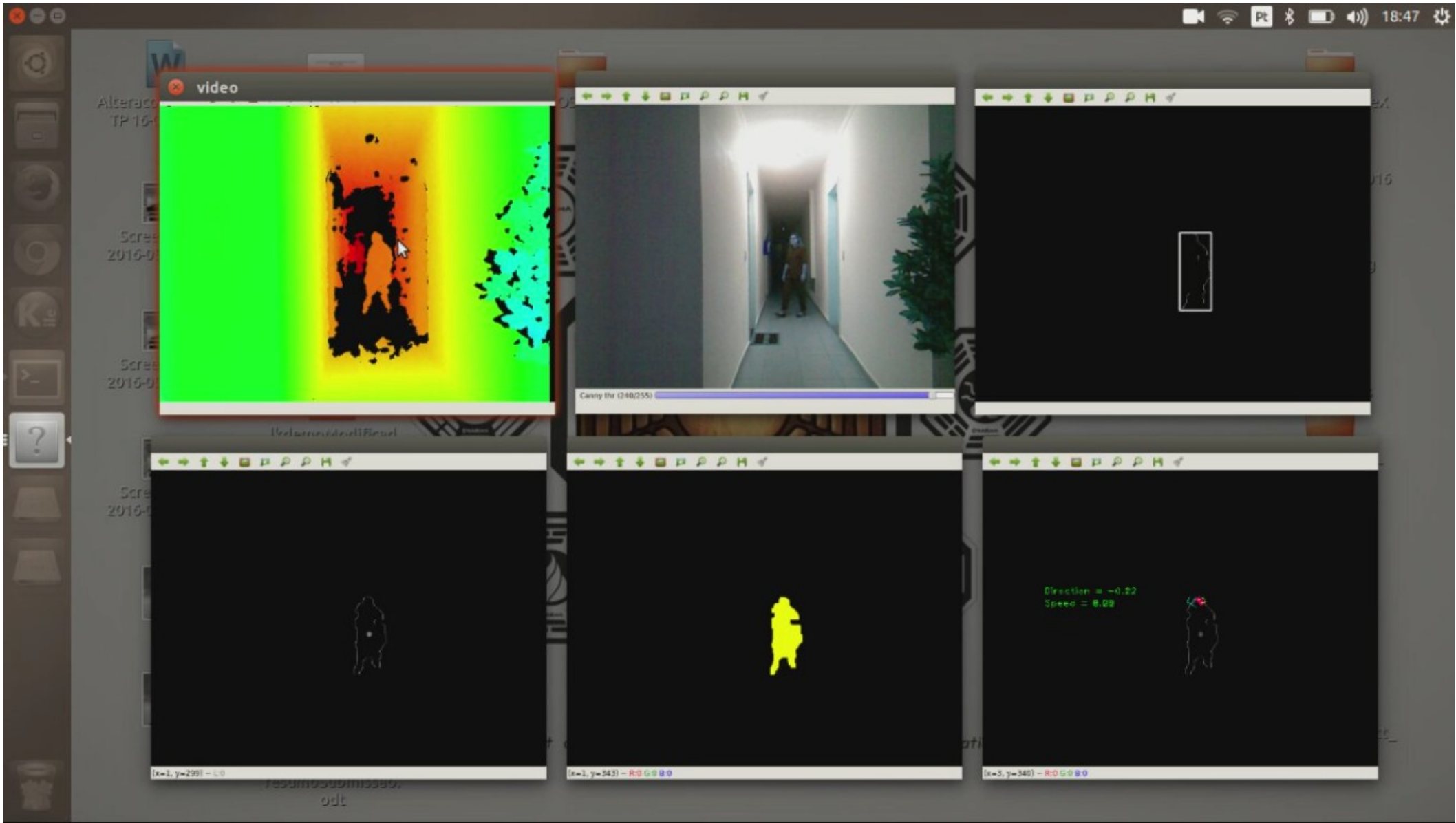


Figure 06: Dynamic Objects System

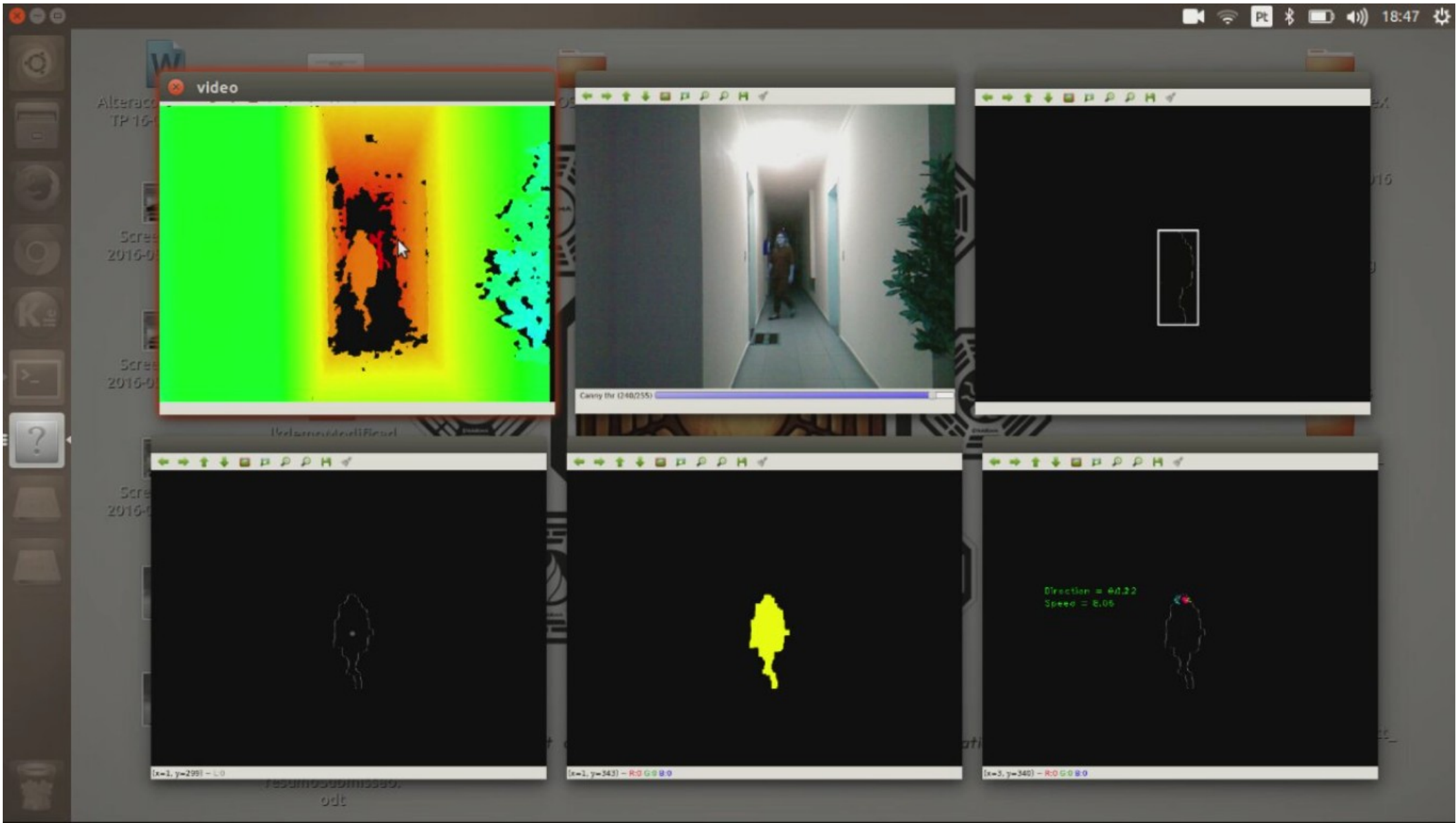
(5) Results 1

Dynamic Objects System (1)



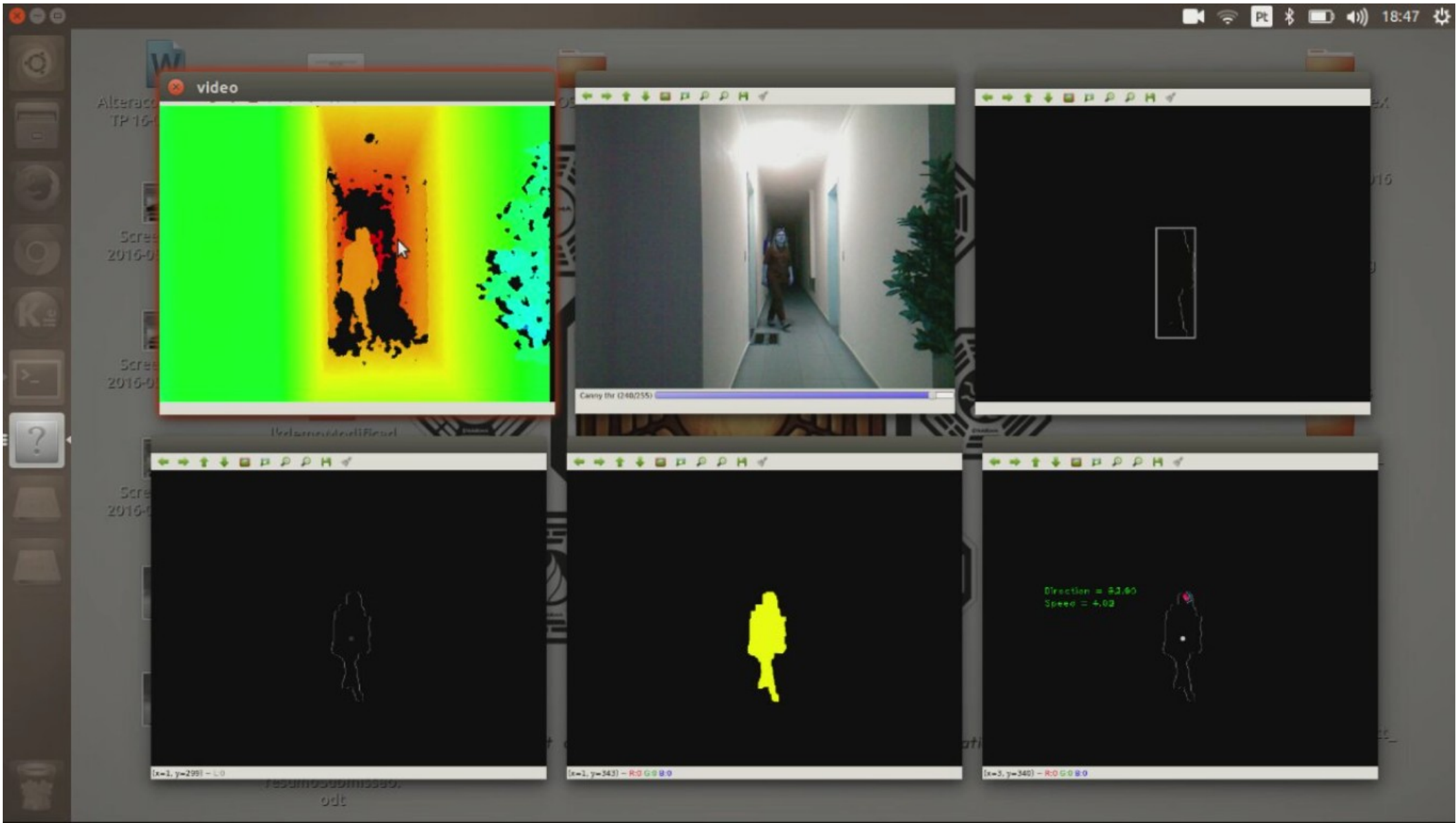
(5) Results 1

Dynamic Objects System (2)



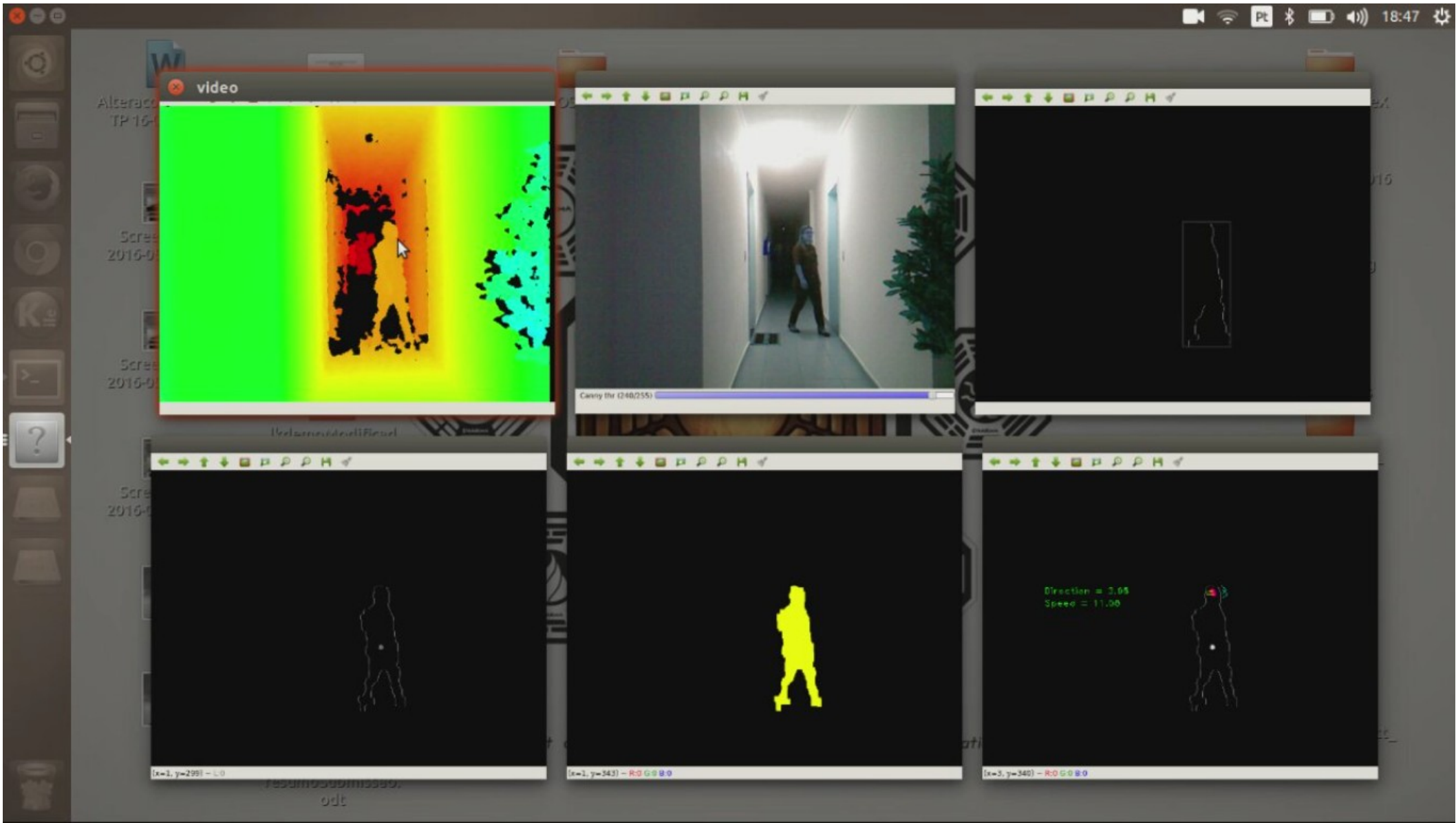
(5) Results 1

Dynamic Objects System (3)



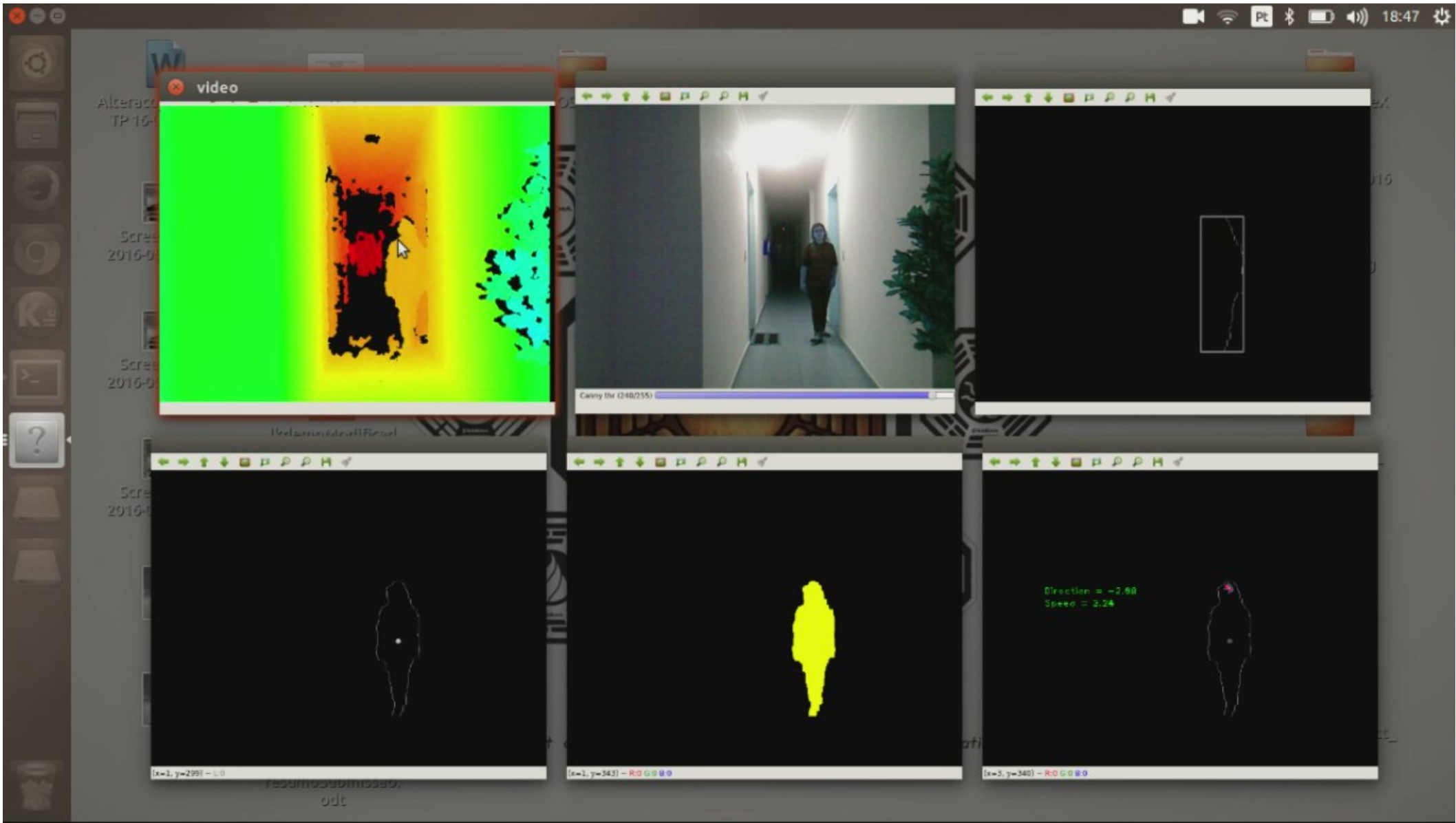
(5) Results 1

Dynamic Objects System (4)



(5) Results 1

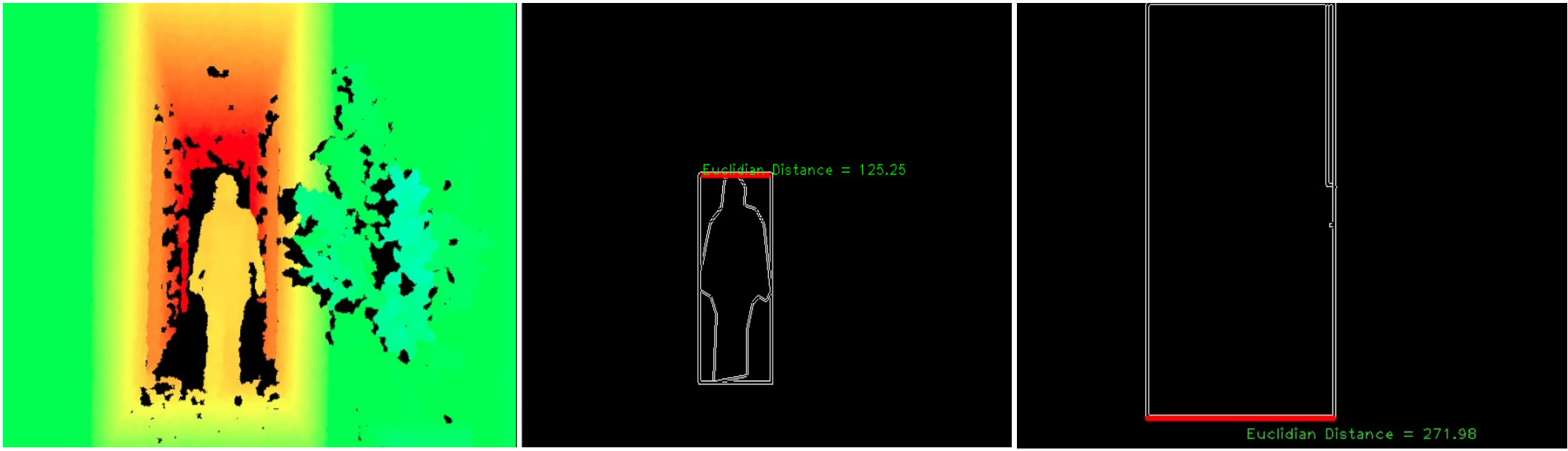
Dynamic Objects System (5)



(5) Results

Object Recognition and PEP Process

Images (a, b, c) shows the result of the algorithm that calculates the clearance width of the passage and the detected obstacles



(a) Depth Map

(b) Estimated width (Person)

(c) Estimated width (Passage)

Figure 07:Object Recognition and PEP Process

(5) Results

Context - Chance of passage

- For the projection (Chance of passage), the specific features were extracted and trained, thus providing the VIP with inferences made in real time.
- The possibility of crossing exists only when its width is greater than 80 cm;
- The passage must be in the center of the VIP’s path;
- The presence of people in the crossing increases the chances of collision-free mobility past the obstacles;

(5) Results

Context - Chance of passage

These inferences were performed in order to validate the obtained features and context classification;

Pass. Width	Pass. Pos.	Person Pos.	Obstacle Pos.	Chance
Passage >80	No Center	No Center	Center	29.9%
Passage >80	Center	Center	Center	60.0%
Passage >80	No Center	Center	Center	44.9%
Passage >80	Center	Center	No Center	95.0%
Passage <80	Center	No Center	Center	0.00%

The chosen method for this classification was Bayesian networks;

(5) Results

Context - collision with dynamic objects

To create a training dataset, different positions, distances, speeds and directions of moving people were collected, including data on possible collisions with the VIP in a hallway (indoor environment).

Depth	Speed	Direction	Position	Collision
$200cm$	$0.7m/s$	$93°$	$88°$	Yes
$81cm$	$2.8m/s$	$150°$	$29°$	No
$120cm$	$0.9m/s$	$88°$	$125°$	Yes
$152cm$	$2.4m/s$	$25°$	$152°$	No
$119cm$	$1m/s$	$86°$	$122°$	Yes

These inferences were performed in order to validate the obtained features and context classification;

The chosen method for classification was SVM;

(6) Conclusion

- Few projects have applied the prediction of collisions based on a better understanding of the context;

- Thus, this project makes an important contribution to the development of systems aimed at predicting collisions in different contexts;

- Among these contributions are the architecture, the method, the definition of classifiers for certain given contexts and especially the way inferences are made that predict collisions in the near future;

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