Develop the Framework Conception for Hybrid Indoor Navigation for Monitoring inside Building using Quadcopter

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Abstract

- Building security is crucial, but guards and CCTV may be inadequate for monitoring all areas. A quadcopter (drone) with manual and autonomous control was used in a trial mission in this project. Generally, all drones can stream live video and take photos. They can also be adapted to assist better decision-making in emergencies that occur inside a building. In this paper, we show how to improve a quadcopter's ability to fly indoors, detect obstacles and react appropriately. This paper represents a new conceptual framework of hybrid indoor navigation ontology that analyzes a regular indoor route, including detection and avoidance of obstacles for the auto-pilot. An experiment with the system demonstrates improvements that occur in building surveillance and maintaining real-time situational awareness. The immediate objective is to show that the drone can serve as a reliable tool in security operations in a building environment.

- ***Keywords—****semi-autonomous quadcopter; indoor navigation; object detection; image processing; ontology*

INTRODUCTION

- Buildings are concerned about preventing all dangerous situations both inside and outside the buildings, such as schools, universities building, office buildings, or shopping malls, etc.
- Some buildings need to be high security **inside the building** and may require much investment in guards and technologies
  - *Closed-Circuit Television (CCTV)*
  - *Operations room for monitoring and controlling the situation.*
- However, the CCTV may not cover all area of the buildings, or there may be blind spots in the CCTV coverage.

A quadcopter or drone [1] can solve with this problem in the building for taking photos and video then send back to security room.

- Flying in the building need to apply with some techniques
- **GPS** for navigation not support enough inside the building
- Drone should fly to destination anywhere in a building while avoiding obstacles (people, furniture) in its path

Reduce number of guards/ cheap cost in long term

OUR TWO CONTRIBUTIONS

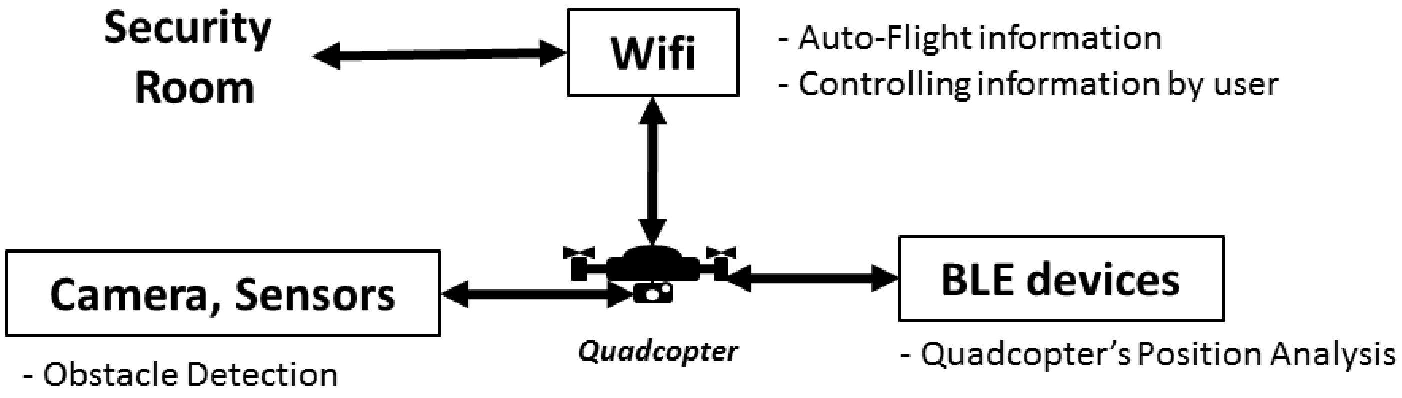
- **First,** we have developed an analysis of the best route for the quadcopter in the building with indoor navigation ontology providing the flight path.
- **Second,** we have used the obstacle detection by using image processing for identifying the objects and avoiding them.

Relate Work

- **SmartCopter** is a technique for controlling a quadcopter without GPS; it can automatically fly both outdoors and indoors by using vision-based tracking [10], but vision-based tracking may not be sufficient for autonomous flight.

- **A Camera Measurement Algorithm** was used for estimating distances in a building [11]. However, this approach may be too slow for processing for indoor navigation.

Hybrid Indoor Navigation For Indoor Quadcopter

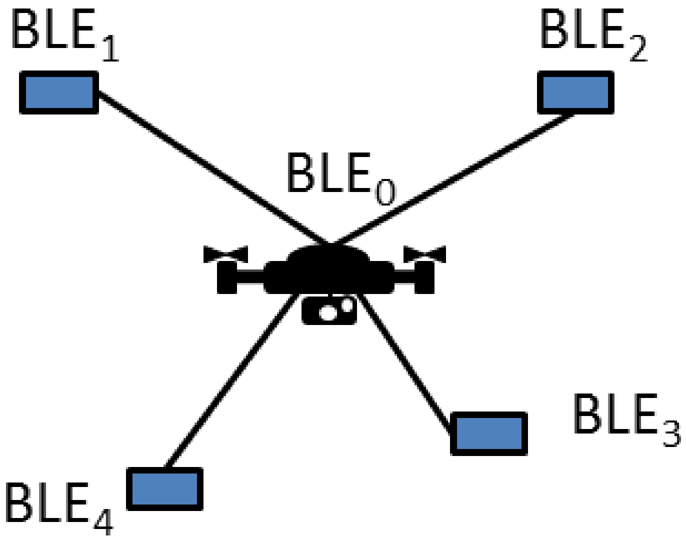


- The quadcopter can communicate and receive real-time flight information from the control room via Wi-Fi in the building.
- Calculate current position with BLE devices and use camera for obstacle detection.

Hybrid Indoor Navigation For Indoor Quadcopter

- ***Indoor Quadcopter's Position***

iBeacon

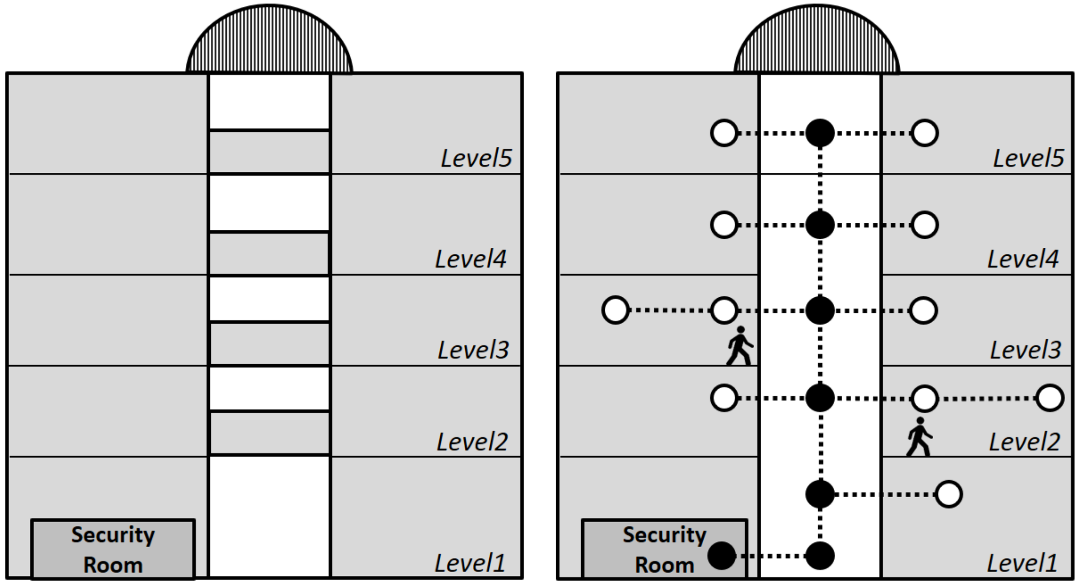


BLE for analysis the quadcopter's position

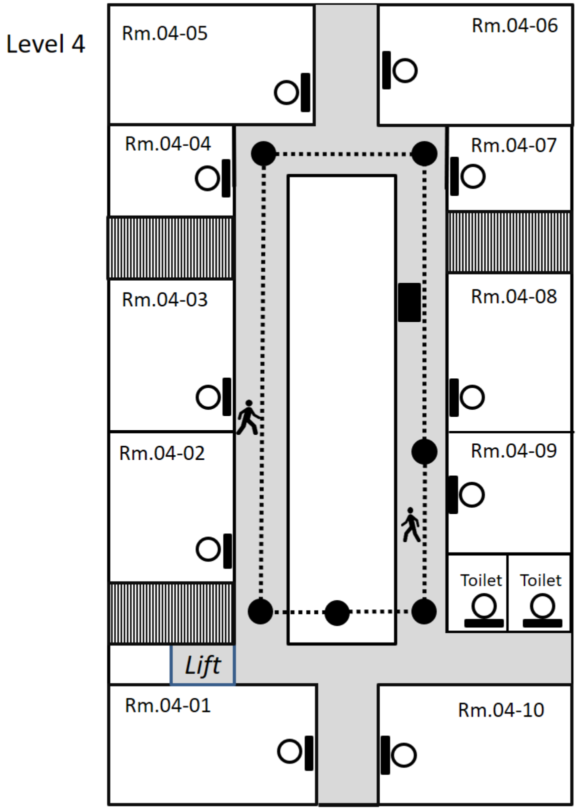
The quadcopter's position will be analyzed by Bluetooth Low Energy devices (BLE).

Hybrid Indoor Navigation For Indoor Quadcopter

- *Indoor Navigation Ontology*



nodes on building maps



- Show the instruction of indoor building where has any airspace
- Show indoor route of autonomous quadcopter inside the building

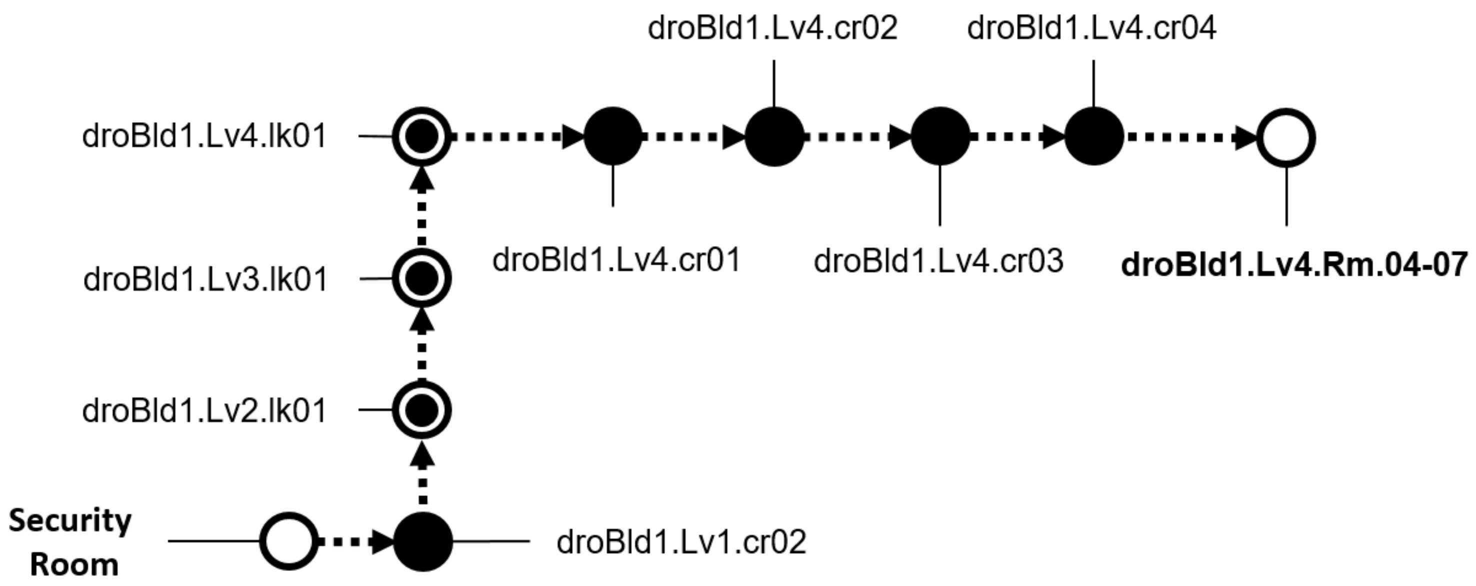
Some Attributes of Indoor Ontology for Indoor quadcopter

Name	Description
ID_dro	ID is a unique label for a coordinate for quadcopter (droBLD1.lev1.cr01)
x, y, z	(x, y, z) in Euclidean air space inside building (x=1500,y=560,z=195)
Defualt_direction	The default position of quadcopter when arriving this coordinate, the quadcopter will be set the direction about inspecting point as same as compass degree (352)
Building	Building Name (Bld1)
Level	Level of building (level3, level5)
Status	Status of a coordinate on the map (On, Off)

Hybrid Indoor Navigation For Indoor Quadcopter

- **Obstacle Detection**
- The obstacle detection recognizes the objects for getting the size and dimension of them by using image processing.
- This research focuses on the detection of object color.

The conception of an Algorithm for Indoor Quadcopter



All coordinates on the map are used to be the information for navigation. They can lead to developing to autonomous flight.

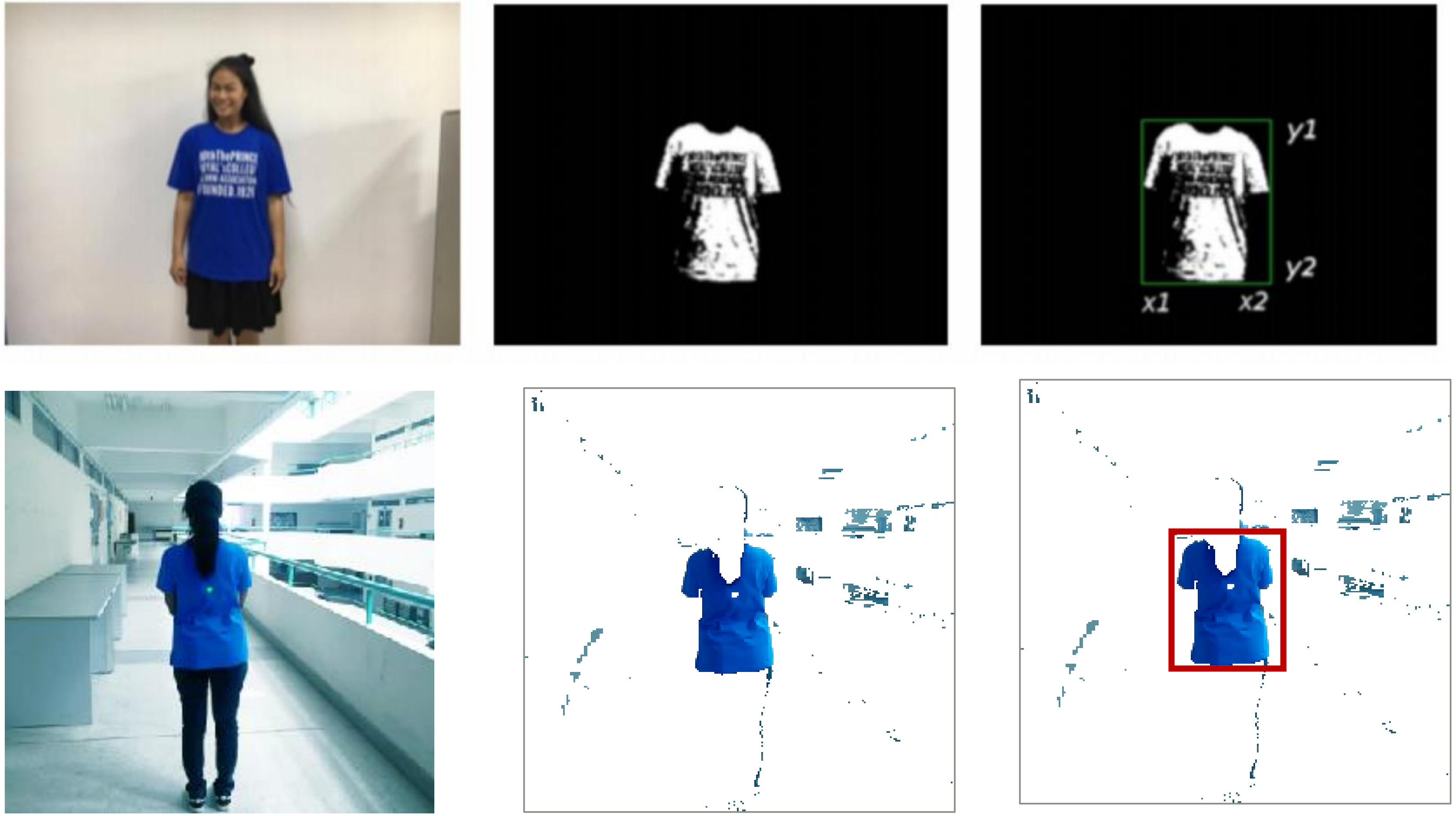
Experiment and Discussion

We design five routes for experiment, drone fly to the target on three coordinates. The result show flight of quadcopter missing from coordinate around 0.8-2 meters.

Routes No.	The distance of Quadcopter with Coordinate(meters)		
	Coordinate No.1	Coordinate No.2	Coordinate No.3
1	1.5 meters	1.3 meters	1.5 meters
2	0.8 meters	1.5 meters	1.2 meters
3	1.5 meters	1 meters	1.5 meters
4	2 meters	1.5 meters	2 meters
5	1.5 meters	2 meters	1.5 meters

Experiment and Discussion

<u>Color Detection</u>



Experiment and Discussion

- **Result HSV Color Space**

Color	Percentage of Color Detection in Different Distances				
	0.5 meters	1 meters	1.5 meters	2 meters	2.5 meters
Green	100%	100%	96.66%	96.66%	86.66%
Red	80%	40%	10%	0%	0%
Blue	96.66%	93.33%	50%	33.33%	13.33%

Green got to high accuracy detection, more than 80%.

CONCLUSION

- Developed the framework conception for hybrid indoor navigation of the quadcopter for supporting the building security
- Used Multi-level Indoor Navigation Ontology for the quadcopter indoor route
- Validated the color detection with the camera on the quadcopter

Future Work

- The auto-flight of quadcopter need to improve the efficient model
- The object detection should add the other techniques for helping to auto-pilot of the quadcopter as well.

Thank you

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