By: Yousef Ali and Ibrahim Aljalal

An integrated UGV-UAV system for Crowd Control

1-Abstract:

This project will attempt to solve the issue of high dense public areas. The solution will be by making multiple drones and robots communicate with each other to target those who are in need in a crowd. We will assume that the drones have two cameras one is a regular camera which will detect the blue color (we will assume that anyone who needs a service will wear blue cloth or will have a blue flag) and an infrared camera that will detect if there is a large number of crowd. Also, an additional motion detection algorithm was added to this project which was experimentally proved to be very effective.

2-Introduction:

Crowded areas such as Makkah and Madena will require a lot of manpower to manage. Also, in our modern world a great number of the population is concentrated at condensed areas such as New York, Tokyo London etc. As a result of this concentration sometime highly crowded places will unfortunately result in deaths (like what happen in Makkah few years ago) if there were some difficulty in the management of the crowed.

3- Literature Survey:

Here are some references related to crowed:

3.1- https://www.cambridge.org/core/journals/prehospital-and-disaster-medicine/article/abs/crowd-behavior-at-mass-gatherings-a-literature-review/06478D2F18259B8E2EC0D39FA11937C0

3.2- https://ieeexplore.ieee.org/abstract/document/8703458

3.3- https://link.springer.com/article/10.1007/s12652-016-0432-x

3.4- https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0240963

3.5- https://ieeexplore.ieee.org/abstract/document/5659493

3.6- https://www.tandfonline.com/doi/abs/10.1080/19361610.2014.913229

3.7- https://ieeexplore.ieee.org/abstract/document/8703471

3.8- https://www.workingwithcrowds.com/journal-of-crowd-safety-and-security-management/

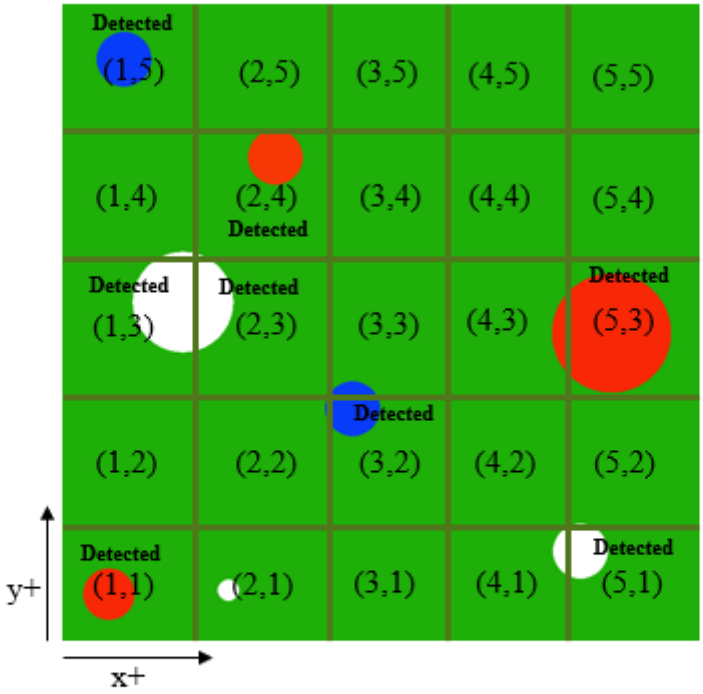
These literature surveys and journals will be considered as a support and reference for the project.

4-project problem:

In large public open areas such as Makkah it very crucial to have to provide the necessary services such as basic medicine, disease inspection (it is not safe for a human to inspect disease especially if it is very contagious also it consumes a lot of human power), information inquiry or free food (such as water and Dates) etc.

5-Simulation Setup and Approach:

One of the important parts of this project is the opnenCV which should be integrated with the drones and robots **(TurtleBot3)**. There will be **12 nodes** related OpenCV 3 publishers 3 subscribers first pair (Publisher and its subscriber) is for blue color detection in order for it to know if someone needs a service or help. Second pair for red color detection for identification of crowd gathering and the last pair is for motion detection. **Note these publishers will be used from actual camera streaming.** The rest of the six nodes have the **same idea** but will be used for images detection instead of camera so we will use servers and clients. Note that the coordinates of the colors or motion detection could be easily identified for x and y by segmentation. More details for the project will be provided in a zip file.




```
Results:
["Blue",[(3,2),(1,5)]]
["Red",[(1,1),(5,3),(2,4)]]
["Motion",[(5,1),(1,3),[2,3]]
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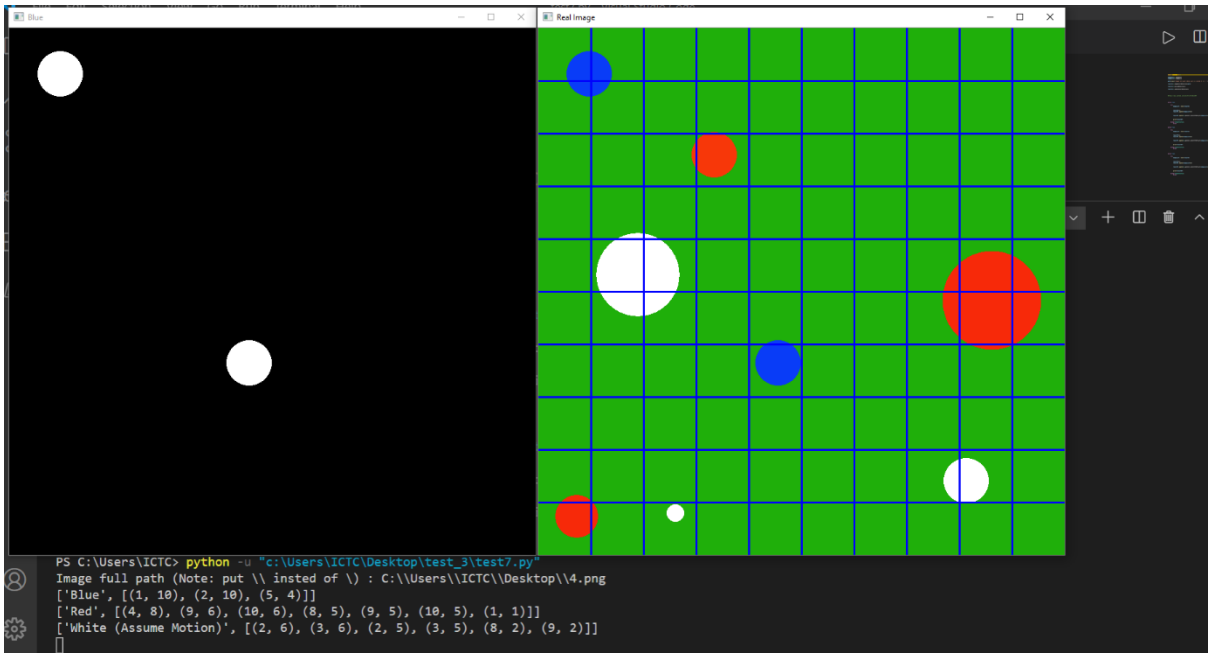
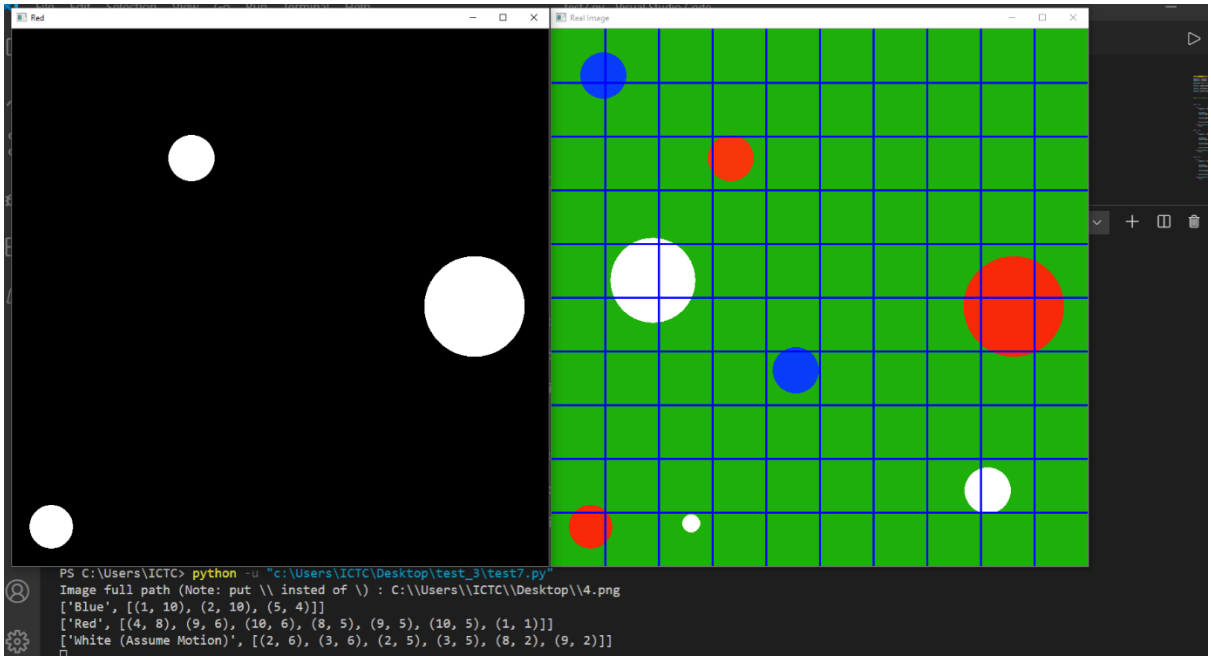
6-Results and discussion:

6.1- Motion detection blue color:



6.2- Motion detection red color:



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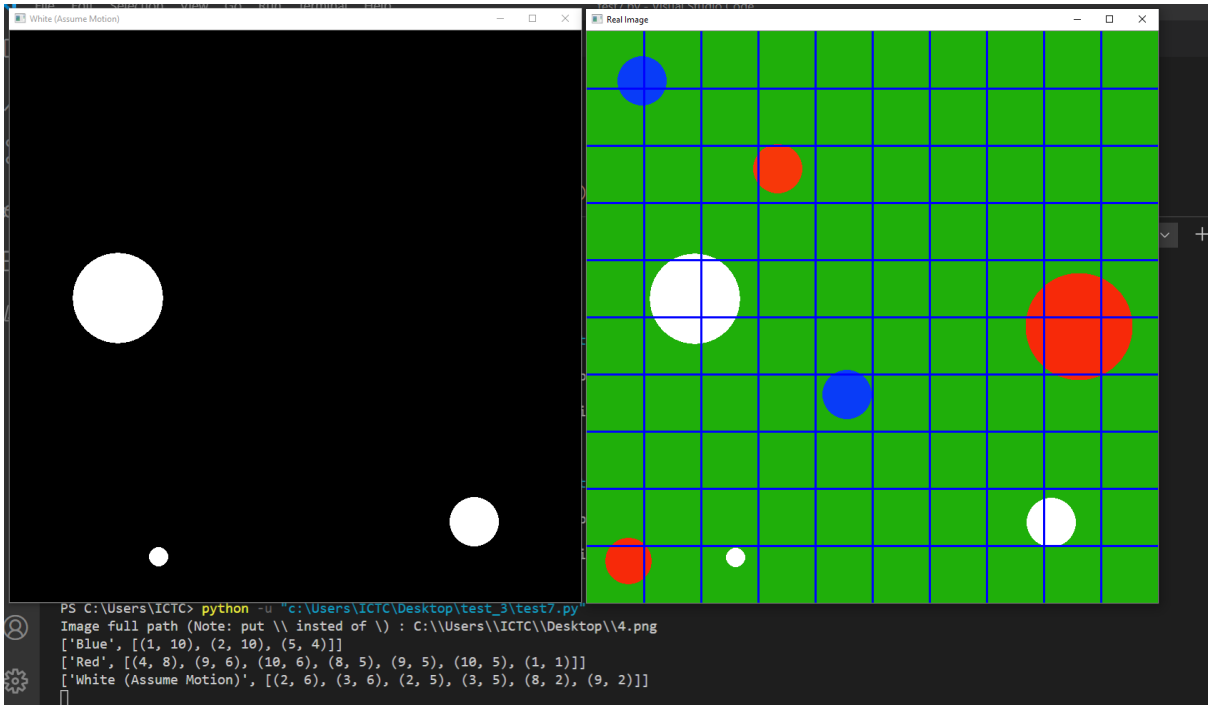
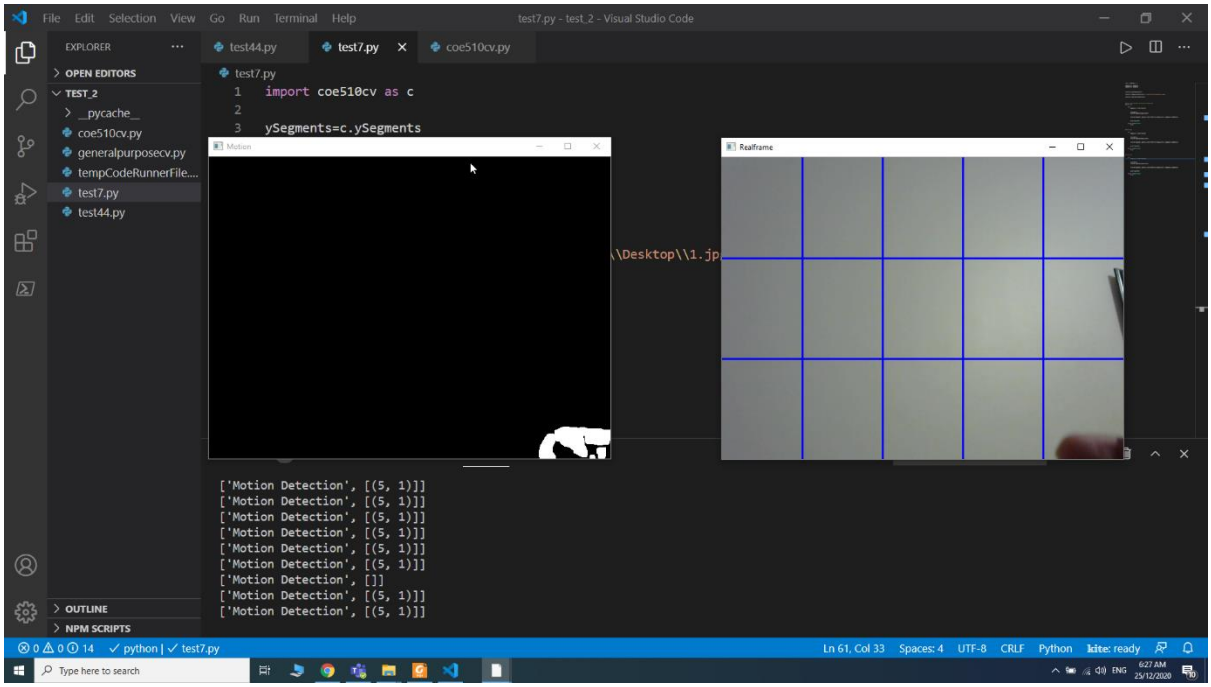
6.3-Motion detection white color:

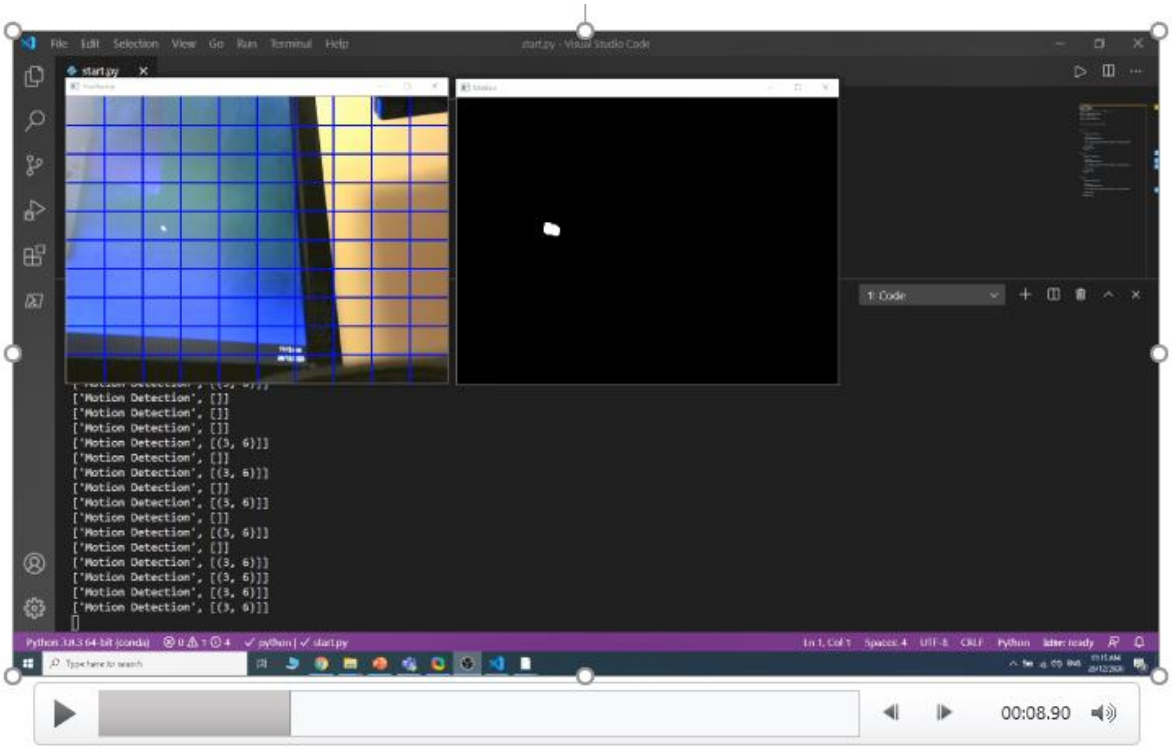
Note: the white color will be assumed as motion when we will use the server and client.



6.4-Motion detection Snapshot:



6.5-Motion detection (part of the video):



6.6-EXE File:

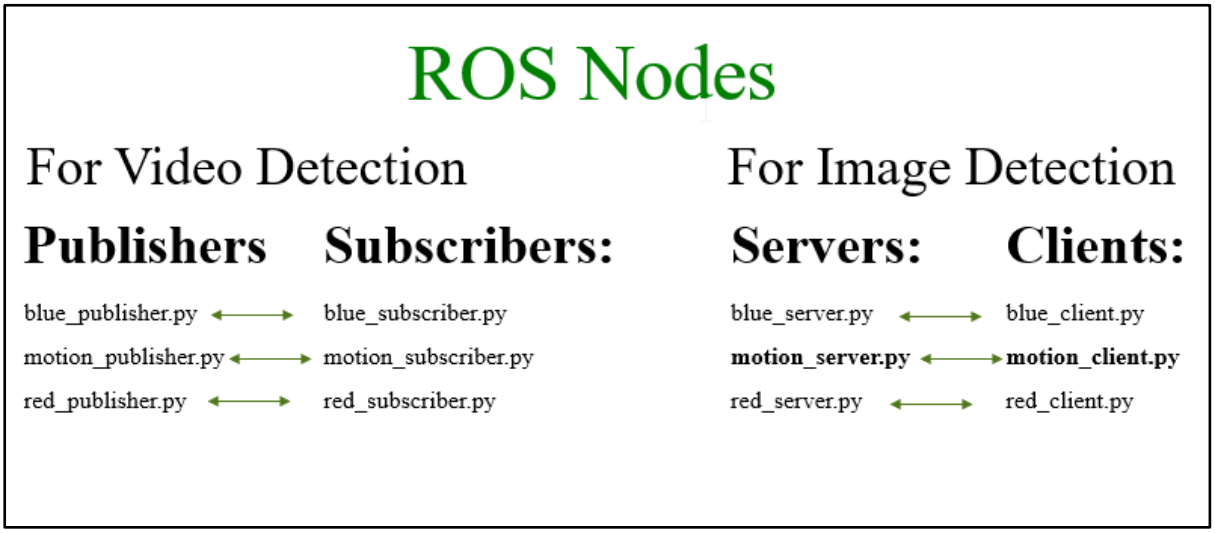
Note: You could use the exe file to see how the software works even if you don't have python on you computer.

URL:

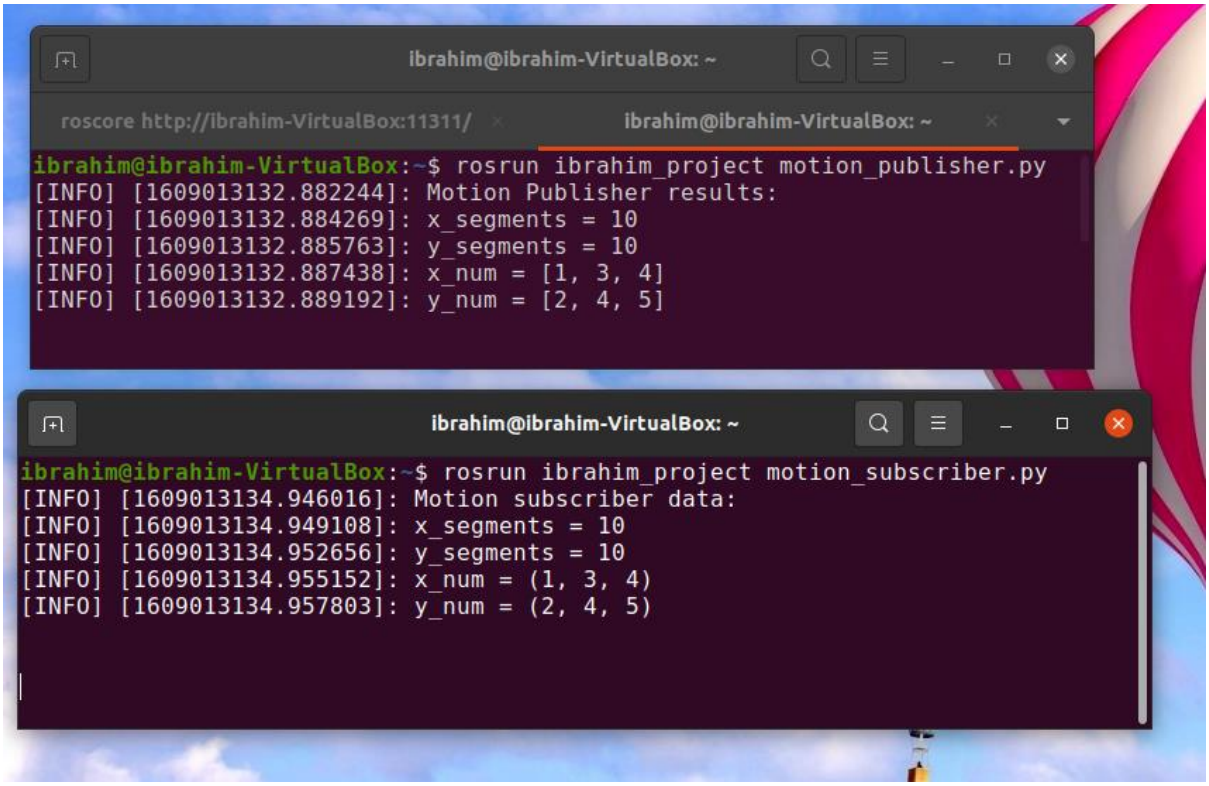
https://drive.google.com/drive/folders/1SHTNAtZzVMG6yjDRK-7k1pYQNmsuU9S7?usp=sharing

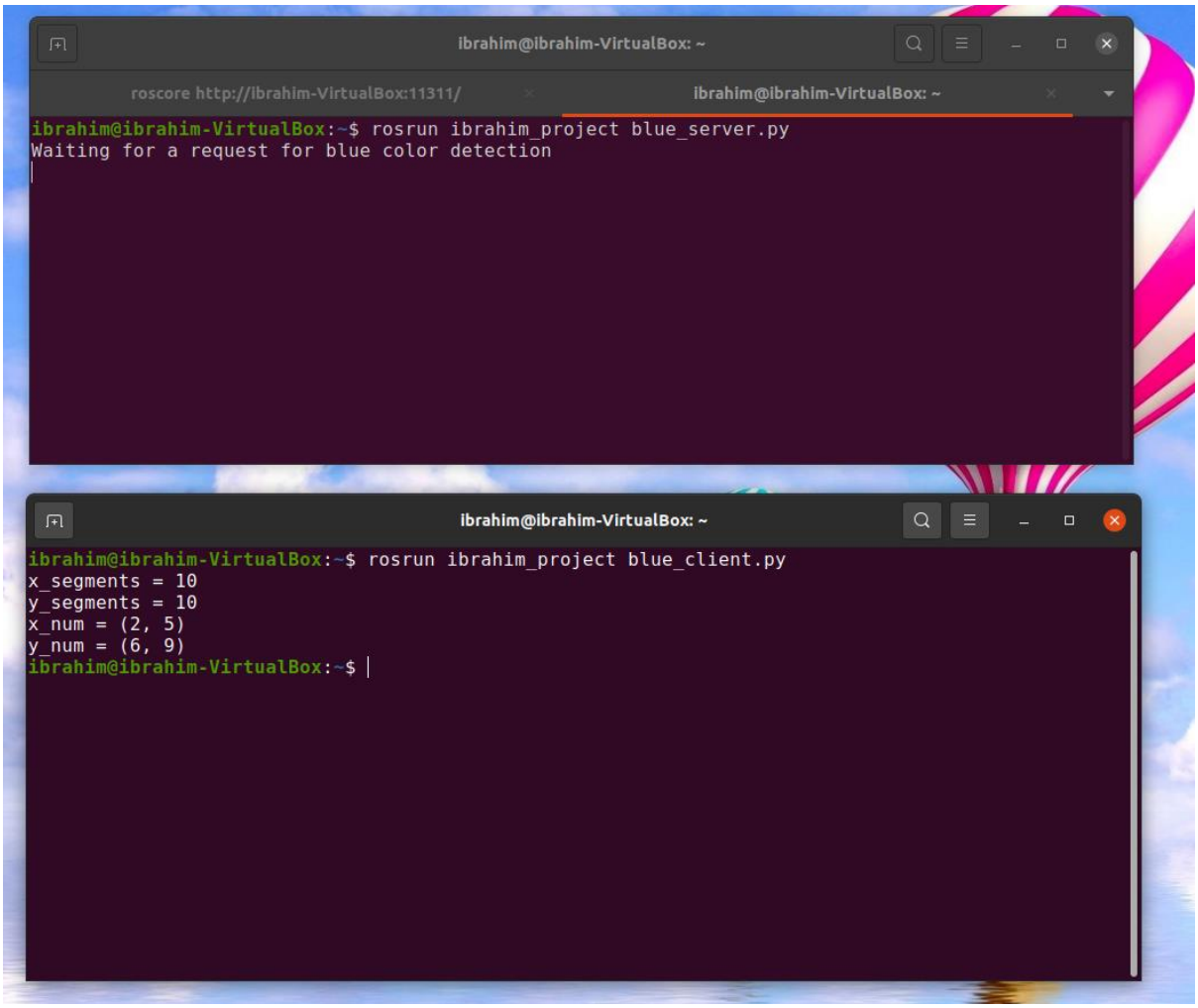
6.7-ROS nodes related to opnCV:

These nodes are all in a package called ibrahim_project



6.8- One publisher-subscriber and server-client will be shown in the ibrahim_project package. Note the rest are very close to the below snapshoots.





6.9- discussion:

Note that to know at what coordinate distance the object is exactly at you also need to know in addition to x_num and y_num (_num is the number of the square) the number of segments. If you know the number of segments you will immediately know the length of each segment (Since you already know the full width and height of your camera frame)

$$x = x\_num \times segment\_x\_length - 0.5 \times segment\_x\_length$$

$$y = y\_num \times segment\_y\_length - 0.5 \times segment\_y\_length$$

Where x and y are in unites (such as meters)

6.10-Limitation:

The main limitation is that OpenCV works only on my windows device so we will assume in our nodes that the data generated by OpenCV is received. Note: this limitation is not a conceptual one and could be easily fixed if someone has experience in Linux and since we did not dig deep in solving these issues this simple problem will only waste time for it to be solved.

7- Conclusion:

We could conclude from this project that it possible to control robots and have good understand of the environment by image processing (especially by using the segmentation technique).

8- Reference

1-https://www.youtube.com/user/ProgrammingKnowledge

2-https://www.cambridge.org/core/journals/prehospital-and-disaster-medicine/article/abs/crowd-behavior-at-mass-gatherings-a-literature-review/06478D2F18259B8E2EC0D39FA11937C0

3-https://www.youtube.com/channel/UC5hHNks012Ca2o_MPLRUuJw/featured

4- https://ieeexplore.ieee.org/abstract/document/8703458

5- https://link.springer.com/article/10.1007/s12652-016-0432-x

6- https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0240963

7- https://ieeexplore.ieee.org/abstract/document/5659493

8- https://www.tandfonline.com/doi/abs/10.1080/19361610.2014.913229

9- https://ieeexplore.ieee.org/abstract/document/8703471

10- https://www.workingwithcrowds.com/journal-of-crowd-safety-and-security-management/