UNIVERSITY OF HERTFORDSHIRE

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Assignment Title:

Final Project Report

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Motion Detection System

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Table Of Context

Abstract

This report will talk about the problem of this project and the solution that will be considered for the topic which will aim to provide benefits of smart home security and how they help us during extreme situations as well help protect homes. It will go through the challenges that impact smart home security when an intruder is in your garden. Automated functions that a CCTV system that records 24 hours and can be viewed through a monitor. Actions to take while an intruder is detected by a CCTV feed will sound an alert when it detects a motion.

It will also discuss how the technology has evolved since the inception of a traditional form of home security systems to more reliable and robust Motion sensing Technology that will benefit every household and prevent intrusion for the foreseeable future.

Moreover, also discusses motion detection system technology and how it will be implemented in everyday homes. Nowadays security system has evolved to the point where intruders find wonder abilities in every device, and motion sensors are no exception when it comes to intruders breaking into houses in this project, I will demonstrate a simple motion detection system that implements algorithms and methodologies to create a motion detection system.

Acknowledgment

I would like to thank my Module leader **Paul Morris** for the help he has given me in aiding me to get on with this project, I would also like to express my gratitude towards my supervisors who have helped shaped my project and given me advice on how to approach problems faced while performing research

1.0 Introduction to the Topic

This is a literature review that will summarize all the data search and evaluation of the available literature in your given subject or chosen topic area about how a Smart Home Security can implement a Motion Detection System that Detects Intrusions into Homes. Based on the topic I have selected I will be comparing recent research and draw conclusions based on the strength and weaknesses of the topic regarding **“*Motion Detection System that Detects Intrusions for Homes”.*** In addition, I will elaborate more on the impact of how it affected the health and safety of users and the future of society.

1.1 Purpose

The purpose of this assignment is to allow me, with the support of my supervisor, to identify in detail all aspects of the project. Specifically, the problem to be addressed, the proposed solution or solutions to be considered, the resourcing and skills to be used, an analysis of risk and an understanding of the work-load and schedule to be followed.

1.2 Supervisor meeting Discussion

After discussing with my supervisor and going through different ideas and methods that could be used in my project, I have a broad idea of what possible options are available in proceeding with this assignment. we have gone through possible problems that could be addressed in my assignment with the help of suggested software and tools which could aid in the process of completing the project. I have discussed certain problems that could be identified which I will be going through and try to address the problems with a solution.

1.3 <u>Motivation</u>

Before getting into computer science, I've been fascinated by the movie Mission Impossible where Tom Cruise the main character drops down from the ceiling and barely Triggers the motion sensor which has inspired me to recreate the kind of motion detection system, I’ve discovered many types of technologies that got me intrigued and interested in Security systems. It has also given me the Knowledge and drive to pursue further advances in technology and innovate on current developing systems. The motivation behind my project is to develop A motion sensor that tracks any movement in the area using camera footage and triggering an alarm Which alerts using a voice text to speech program that notifies that there is an intruder in the area.

1.4 Keywords –

Motion Sensor

Security

Sensor

Infra

2.0 Problems that my project will attempt to address

The problems that my project will attempt to tackle are listed down below -

- To get rid of blurry lines around the edges of the images by implementing a high-quality output of the image.
- To detect a movement in the dark or low lighting conditions.
- To minimize interference while capturing an object.
- Avoid any static that may cause the sensor to lose quality due to interference with electrical signals.
- Detecting an object after which the speed of the object is moving.

3.0 Brief about Motion Sensing Technology

In the current day and age motion sensing technology has developed significantly over the years, it has involved a basic laser projectors motion detector which has been used since ancient cultures started agriculture. Many of the same techniques that are used today in modern motion detection of persons and things may be traced back to the early decades of the twentieth century.

Motion detectors may be used for a lot more than the James Bond-style security systems that we see in movies. By recognizing when a person's arm moves too close to machinery, today's motion detectors can avoid major industrial equipment mishaps. When entering a business with automated doors, the ordinary individual employs a motion detector in everyday life.

3.1 The inception of Motion Detection

3.1.1 Pre-1800s

The detection of motion has its origins in astronomy, which has a long history. Early farmers utilized the movement of stars to decide when to plant crops and when to harvest them by looking to the skies. Heinrich Hertz invented the first motion-detecting technology, radar. Hertz investigated the nature of waves and discovered that they may bounce off things and travel at varying speeds.

Smith, G., 2021. *History of Astronomy*. [online] Cass.ucsd.edu. Available at: <https://cass.ucsd.edu/archive/public/tutorial/History.html> [Accessed 22 November 2021].

3.1.2 World War II

The optimal atmosphere for the development of motion detection technology was created during World War II, with decades of research into the physics of waves and the requirement to track air and naval vessels. By the 1940s, radar technology had improved to the point that the military could predict assaults and direct aircraft. After the war, the widespread use of radar would rise to new applications for motion detectors.

3.1.3 The World's First "Genuine" Motion Detector

Samuel Bagno designed the first motion detector that also served as a burglar alarm in the early 1950s. Bagno used the foundations of radar to detect a thief or a fire using ultrasonic waves, a wavelength that humans cannot hear. The Doppler effect, which is the difference in the frequency of waves of a moving object, such as a train sounding louder as it approaches closer, was also used by Bagno's motion detector.

3.1.4 Motion Detectors of the 21st Century

Motion sensors nowadays are based on some of the same fundamental ideas as Samuel Bagno's motion detector. Motion is still detected by microwave and infrared sensors because of frequency aberrations. New motion detectors, such as microwave sensors, can now be hidden behind bookcases and other obstructions while still providing a large detection area.

Todayinsci.com. 2021. *October 13 - Today in Science History - Scientists born on October 13th, died, and events*. [online] Available at: <https://www.todayinsci.com/10/10_13.htm> [Accessed 22 November 2021].

According to Porter, most motion detectors, even newer ones, use infrared to detect substantial changes in the temperature of the surrounding room. Walking about in a room normally triggers these sensors, but he claims that utilizing something as simple as a piece of styrofoam to hide your body may fool them.

Because carrying a huge piece of styrofoam might arouse suspicion, Bishop Fox security experts, who regularly examine physical security systems for customers, sought additional ways to get around these sensors.

Constantin, L., 2021. *Researchers show ways to bypass home and office security systems*. [online] CSO Online. Available at: <https://www.csoonline.com/article/2133815/researchers-show-ways-to-bypass-home-and-office-security-systems.html> [Accessed 19 November 2021].

3.2 <u>Types of Motion Sensor Technologies</u>

3.2.1 Common Types of Motion Sensor Technologies

There are different types of motion sensors ranging from sensors that turn on the lights, turn on the heating in the room, turn on the faucet to run water, motion-sensing curtains which open or close depending on the lighting condition outside the house, and windows which saves energy efficiently and is more reliable in the long-term use and sustainability of the environment. Different types of motion-sensing technology are energy efficient and secure and are commonly used in security cameras with motion capturing technology that is used to detect any intruders that break into secure facilities Usually officers and institutional buildings that have confidential information are any valuable items that require more secure and tight security to ensure that the is no vulnerability and the system is maintaining itself more efficiently.

According to Miguel Gudino an electrical engineer who specializes in computer science and electronic passive components. He thinks that engineers should never stop learning, and he is dedicated to extending his engineering expertise while also assisting others in staying current with electrical technology.

3.2.2 Passive infrared sensors [PIR]

According to Miguel Gudino, a PIR motion sensor is usually found in restrooms and office buildings where it is covered in white plastic and emits a low power frequency which is cheap and easy to use, and the way it senses movement is the change in the temperature when an object moves in the area and find temperature irregularities.

The PIR has a Pyroelectric sensor that emits infrared radiation which is low-level radiation that can be detected if a human passes in front of it, It is made of two special materials which are detected infra radiation. The sensor is triggered when there is a change in the two slots which causes a change in the infrared field, and it takes a motion which is considered a movement by the sensor. (In figure 2.1, 2.2).

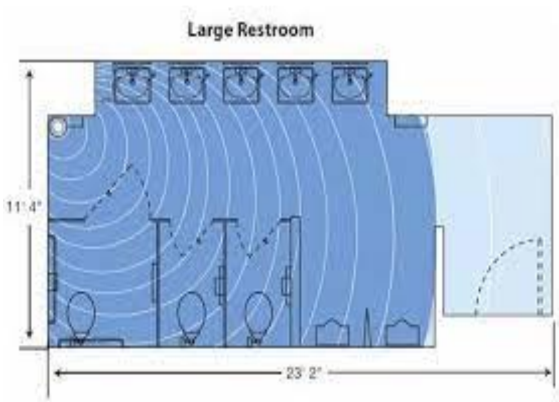


Fig 2.1: Passive infrared sensor(PIR) Design Layout

(Light Guide: Occupancy and Vacancy Sensors, 2022)

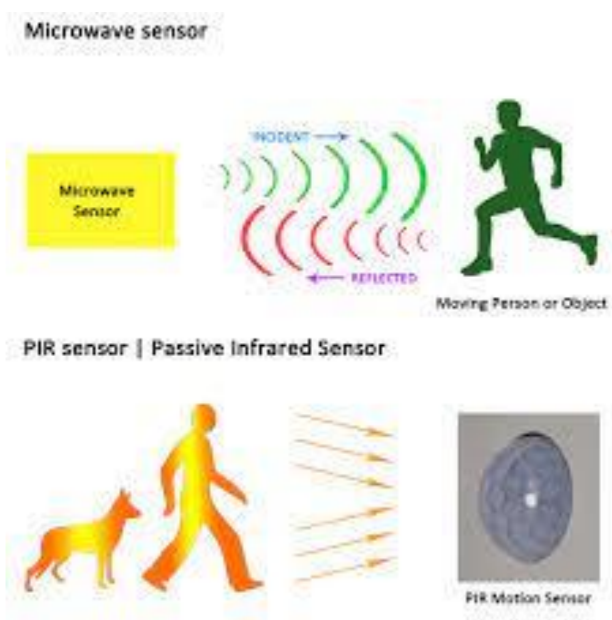
Fig 2.2: Object sensor

(The Beginner's Guide to Motion Sensors | SafeWise, 2022)

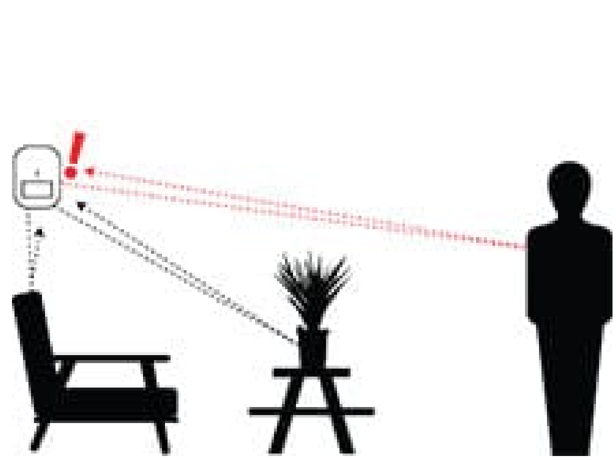
3.2.3 Microwave Motion Sensors

The Microwave motion sensor image microwaves radiation that detects any movement in the area this is the same as how a speed gun detects how fast a car is going using microwave radiation that detects any movement in the area it can also detect a change in frequency that activates the motion detector.

(In figure 2.3)



(Radar Sensor VS PIR Motion Sensor on Solar Light, 2022)



(The Beginner's Guide to Motion Sensors | SafeWise, 2022)

Fig 2.3: Microware Motion Sensors

According to Miguel Gudino, the microwave sensor shows how it is compared to PIR where it covers more area than the passive infrared sensor but is more expensive and is vulnerable to electricity in its interference.

3.2.4 Dual-Tech Motion Sensors

The Dual Tech Motion Sensor is a combination of both passive infrared sensors and microwave motion sensors which causes fewer false alarms and is more reliable when these two sensors work together Where the rising temperature room temperature can cause the PIR sensor to get triggered and an object which is moving can trigger the microwave sensor if there is a wind, it will require both motion sensors to trigger the alarm but only if both sensors go off. (In Figure 2.4, 2.5).

According to Miguel Gudino, these types of hybrid tech motion sensors have less chance of raising false alarms and the dual tech hybrid sensors that requires separate activations to get triggered with one requiring a rise in temperature and the other having an object blown by the wind can only trigger these sensors and raise the alarm.

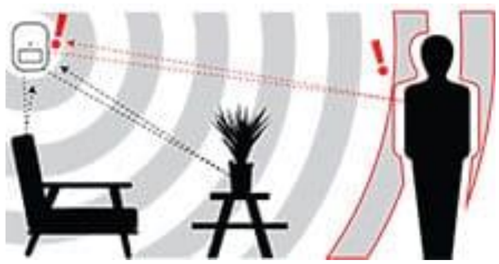
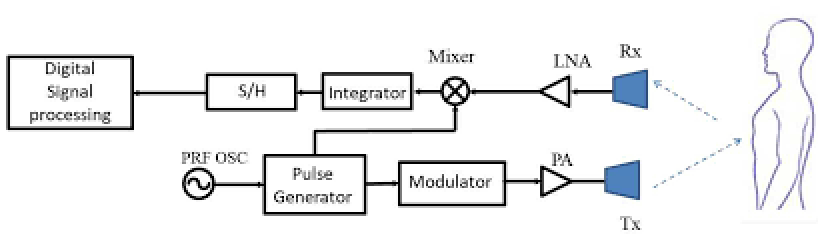


Fig 2.4: Dual-Tech Motion Sensor

(The Beginner’s Guide to Motion Sensors | SafeWise, 2022)



(MDPI Sensors, 2022)

Fig 2.5: Dual-Tech Motion Sensor Flowchart

Gudino, M., 2021. *Types of Motion Sensors*. [online] www.Arrow.com. Available at: <https://www.arrow.com/en/research-and-events/articles/how-motion-sensors-work#:~:text=There%20are%20three%20types%20of,%2C%20and%20Dual%20Tech%2FHybrid.> [Accessed 19 November 2021].

3.3 Less Common Types of Motion Sensor

These are fewer lesser common types of motion detectors that are not popular in the market and are usually bought by big companies and offices that have tight security and require these highly advanced motion detectors that help to prevent intruders from breaking into the facility. This can range from laser sensors, vibration, ultrasonic, reflection, etc.

3.3.1 Area Reflective Sensors

Area reflective sensors send out signals in the form of infrared rays that bounce off and reflect upon any object that may be in its way and detects objects while it is capturing its movements to create and measure the distance how far an object may be.

According to Kasey Tross, these are sensors that project infrared lights from an LED light that is used to reflect from there is which is measured by the distance an object or person is moving in a specific area.

3.3.2 Ultrasonic Motion Sensors

Ultra-motion sensors are sensors that send out ultrasonic waves that reflect and bounce the rays of any object that may be in its way, it uses ultrasonic waves to detect any movement made by an object or a person and create pulses that it uses as information.

According to Kasey Tross, these sensors use ultrasonic waves which reflect any moving objects that come in their way and use pulses of electrical signals go to demand how far an object is and the distance from which it is located.

Vibration Motion Sensors

Vibration motion sensors can detect vibrations that may be caused by any small movements that may be made by an object or a person while within the radius of the sensor, this allows for any vibration to be collected as information data that can be used to detect how far an object is and sets off the alarm by activating it's handled which sets off the alarm switch as it vibrates.

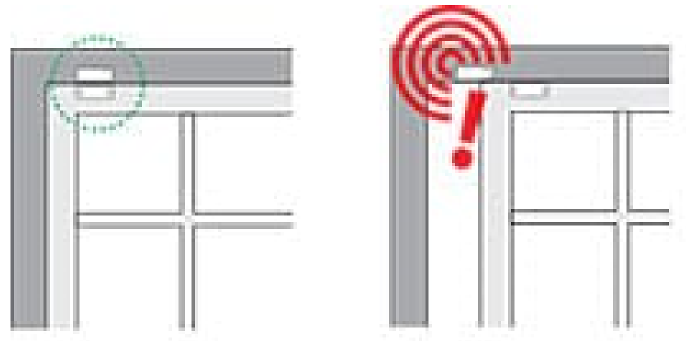
According to Kasey Tross Vibration motion sensors are that detect any kind of vibration that may be caused by an object or a person that may be moving across the area where the sensor is active these are vibration motors that are attached to a handle that goes off an activates an alarm when it takes a movement these are usually unreliable and cheap sensors that I used in less common areas and is less efficient.

3.4 Specialized motion sensors

3.4.1 Contact sensors [Doors / Windows]

They are used when a door has a magnetic attachment to switch the sensor to text as it closes and opens and sets off the alarm if the security system is active.

According to Kasey Tross, It is a magnet that when sports of movement on the door or window the sensor and the magnet which is attached opposite to the window or door is moved are opened which sets off the trigger to the alarm when the security system is in motion as shown in (Figure 4.1).

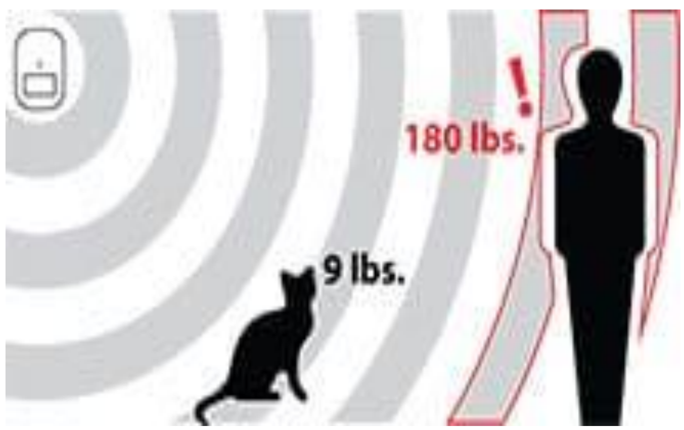


(The Beginner's Guide to Motion Sensors | SafeWise, 2022)

Fig 4.1: Contact Sensor in a Door / Window

3.4.2 Pet-immune motion sensors

Some pets' sensors are not detected if they are under a weight that may not be detected by most sensors including passive infrared sensors and microwave senses. In this case, a dual technology motion sensor cannot be detected and triggers a false alarm which makes them resistant to any fault that may be triggered by them. (In Figure 4.2).



(The Beginner's Guide to Motion Sensors | SafeWise, 2022)

Fig 4.2: Pet - immune motion sensor

3.4.3 Video motion sensors

These are motion sensors that are captured by security cameras that process advanced signals that are triggered when a motion is detected and start recording this footage is stored on memory storage which is controlled wholly by when the camera detects emotion which saves on a lot of storage and not wasting its resources on unlimited amounts of recording hours which may not be of any use since it captures motion which may be a more useful form of information.

Tross, K., 2021. *The Beginner's Guide to Motion Sensors | SafeWise*. [online] SafeWise. Available at: <https://www.safewise.com/resources/motion-sensor-guide/> [Accessed 19 November 2021].

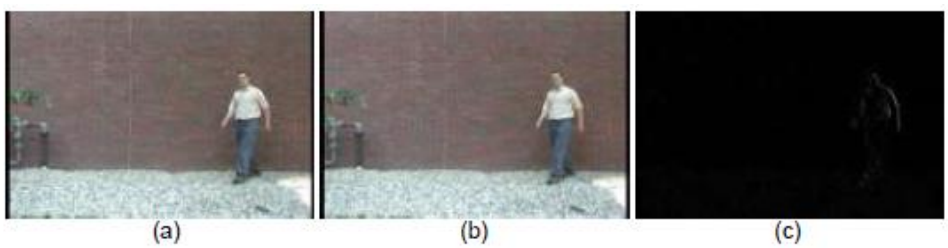
3.5 Algorithms and Methodologies

3.5.1 Image Subtraction

It is one of the most popular forms of image processing that can be done using the vision off the computer the image subtraction can be represented in the formula whereas:

$$\Delta I(i,j) = I_{Curr}(i,j) - I_{Prev}(i,j)$$

$\Delta I(i,j)$ shows to image intensity difference between two frames in a sequence. $I_{Curr}(i,j)$ *and* $I_{Prev}(i,j)$ show how the image intensities for the frames of current and the previous. (In figure 1).



(ResearchGate, Shamir Alavi, 2022)

Figure 1

3.5.2 Edge Detection

Edge detection is a method of detecting and pinpointing sharp discontinuities in a picture known as edge detection.

Discontinuities are sharp variations in pixel intensity that define the edges of objects in a picture [6]. In general, the goal of edge detection is to minimize the quantity of data in a picture while retaining the structural qualities that may be utilized for future image processing [7]. Edge detection using traditional approaches entails convolving the picture with an operator (a 2-D filter) that is designed to be sensitive to big gradients in the image while returning zero values in uniform regions [6]. Edge detection may be done in a variety of ways, depending on the technology used.

3.5.3 Sobel Operator

As seen in Figure 1, the operator is made up of a pair of 3x3 convolution kernels. One kernel is just 90° rotated from the other.

-1	0	+1
-2	0	+2
-1	0	+1

G_x

+1	+2	+1
0	0	0
-1	-2	-1

G_y

FIGURE 1: Masks used by Sobel Operator

These kernels, one for each of the two perpendicular orientations, are designed to respond maximally to edges traveling vertically and horizontally relative to the pixel grid. The kernels can be applied to the input picture individually to provide distinct gradient component measurements in each direction (let us call these Gx and Gy). These may then be used to determine the absolute magnitude and orientation of the gradient at each site [3]. The magnitude of the gradient is calculated as follows:

$$|G| = \sqrt{(G_x^2 + G_y^2)}$$

Typically, an estimated magnitude is calculated using the following formula:

$$|G| = |G_x| + |G_y|$$

The spatial gradient is caused by the angle of orientation of the edge (relative to the pixel grid):

$$\theta = arctan(G_y / G_x)$$

3.5.4 Canny Edge Detection

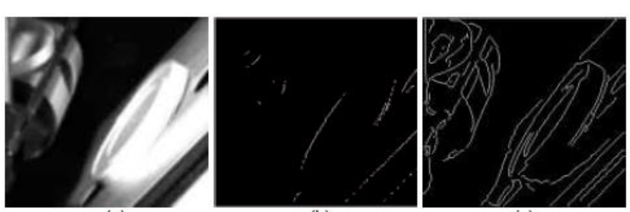
Smoothing: Blurring the image to remove noise.

Finding Gradients: The edges are marked where the gradients of the image have large magnitudes.

Non-maximum suppression: Only local maxima are marked as edges.

Double thresholding: Potential edges are determined by thresholding strong and weak edges

Edge tracking by hysteresis: Final edges are determined by suppressing all the edges that are not connected to a very certain (strong) edge.



(a) (b) (c)

FIGURE 2: (a) Original image (b) Sobel edge (c) Canny edge

(ResearchGate, Shamir Alavi, 2022)

3.5.5 Algorithms Used for Motion Detection

The following three methods were employed using image subtraction and edge detection as the major tools.

1. Take frames out of a video stream.

2. Save the frames you've extracted as picture files.

3. As mentioned, subtract the prior picture from the present image (1).

4. Make a binary image of the image.

5. Assign a label to each linked component.

6. Conduct a blob analysis (i.e. measure properties of each labeled image region).

7. Calculate and identify each identified region's center of mass (to detect as many moving elements as feasible).

8. To detect motion, play the tagged pictures as a continuous video stream.

3.5.6 Edge Detection after Image Subtraction

Afterimage removal, this technique does edge detection. The following is the algorithm:

1. Extract frames from the video stream.

2. Write the extracted frames as image files.

3. Subtract the previous image from the current image.

4. Convert the image to grayscale.

5. Detect edges.

6. Label connected components.

7. Perform blob analysis.

8. Calculate the center of mass of each labeled region and label it.

9. Play the labeled images as a continuous video stream to detect motion.

3.5.7 Image Subtraction after Edge Detection

Edge detection is performed before picture subtraction in this scenario. The following is the algorithm:

1. Take frames out of a video stream.

2. Save the frames you've extracted as picture files.

3. Inspect all of the photos for edges.

4. Take the prior image and subtract it from the current image.

5. Create a binary image from a subtracted image.

6. Make a list of all the components that are linked.

7. Conduct a blob analysis.

8. Calculate and identify the center of mass of each designated section.

9. To detect motion, play the annotated pictures as a continuous video stream.

3.5.8 Comparison of the Motion Detection Algorithms

Considered Scenarios

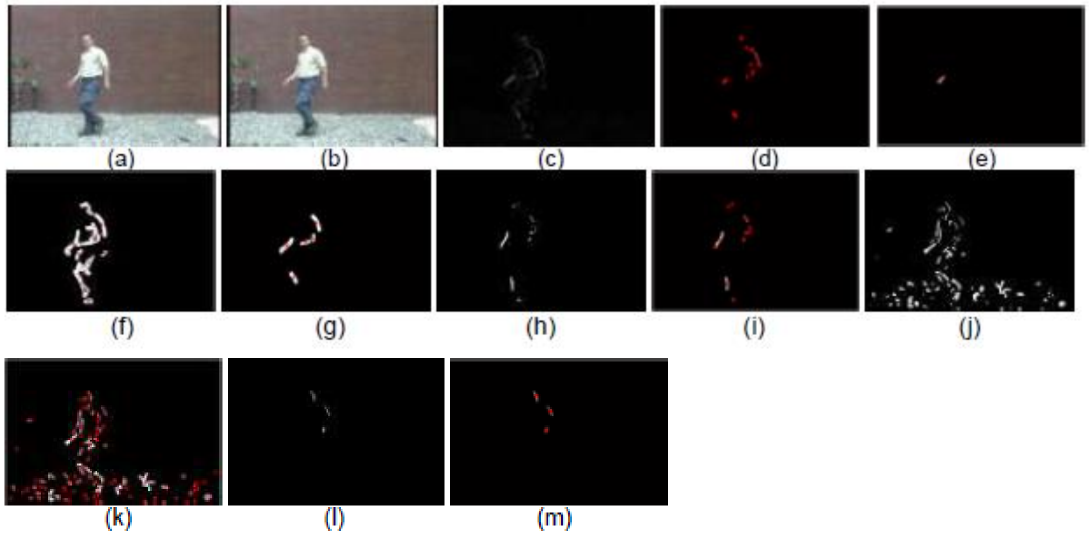
For comparison, two distinct situations were considered:

Scenario 1: A guy is strolling as the rest of the world remains still. As a result, we only have one moving item in this case (as in Figure 1)

Scenario 2: Plastic caps are gathered and transferred from one conveyor belt to the next. The belts and hats are both moving in this scene. As a result, in this circumstance (as seen in Figure 2), we have many moving objects.

3.5.9 Visual Comparison

Two successive frames have been picked from the retrieved frames for comparison and analysis:



(ResearchGate, Shamir Alavi, 2022)

FIGURE 3: Comparison of motion detection algorithms on scenario 1, (a) and (b) two consecutive frames (c) subtracted image (d) algo 4.1 (e) algo 4.2 – Sobel (thresh = 0.17) (f) algo 4.2 – Canny (thresh = 0.17) (g) algo 4.2 – Canny (thresh = 0.55) (h) subtracted image of Sobel edges (i) algo 4.3 – Sobel (thresh = 0.17) (j) subtracted image of Canny edges (thresh = 0.17) (k) algo 4.3 – Canny (thresh = 0.17) (l) subtracted image of Canny edges (thresh = 0.55) (m) algo 4.3 – Canny (thresh = 0.55)
algo = algorithm

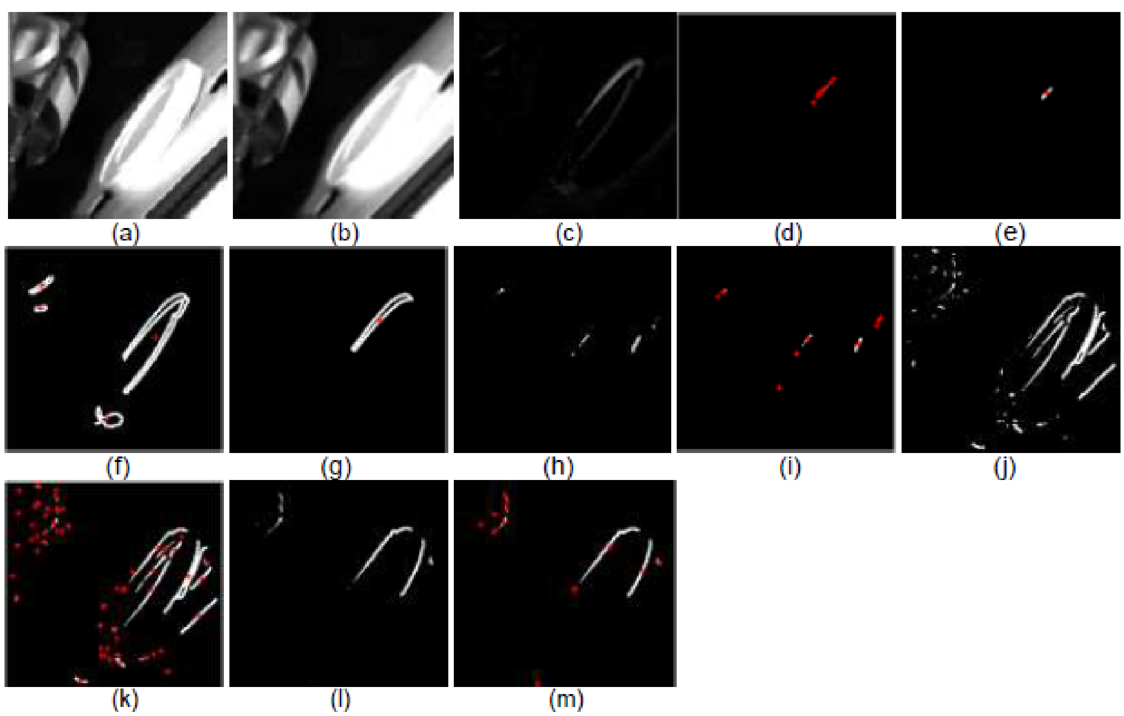


FIGURE 4: Comparison of motion detection algorithms on scenario 2, (a) and (b) two consecutive frames (c) subtracted image (d) algo 4.1 (e) algo 4.2 – Sobel (thresh = 0.17) (f) algo 4.2 – Canny (thresh = 0.17) (g) algo 4.2 – Canny (thresh = 0.55) (h) subtracted image of Sobel edges (i) algo 4.3 – Sobel (thresh = 0.17) (j) subtracted image of Canny edges (thresh = 0.17) (k) algo 4.3 – Canny (thresh = 0.17) (l) subtracted image of Canny edges (thresh = 0.55) (m) algo 4.3 – Canny (thresh = 0.55)

N.B.: For Canny edges, higher threshold = thresh, lower threshold = 0.4 * thresh, standard deviation of the Gaussian filter = 1. For instance, in figure 4(j), higher threshold = 0.17, lower threshold = 0.4 * 0.17 = 0.068, standard deviation of the Gaussian filter = 1.

Algorithm	Edge	Scenario 1	Scenario 2
4.1		Detects motion quite well despite data loss due to binary conversion of the subtracted image - fig 3(d)	Partially detects motion of only one cap - fig 4(d).
4.2	Sobel	Minor visual detection – fig 3(e).	Minor visual detection – fig 4(e).
	Canny (thresh=0.17)	Great visual detection (detects movement of the whole body) – fig 3(f).	Unable to detect the motion of the belts (but better than Sobel as in fig 4(e)) – fig 4(f).
	Canny (thresh=0.55)	Detection of strong edges only (better than Sobel as in fig 3(e)) – fig 3(g).	Unable to detect the upper cap and the belts (still better than Sobel as in fig 4(e)) – fig 4(g).
4.3	Sobel	Detection quality almost similar to that of algo 4.1 -fig 3(i).	Partially detects both the caps but cannot detect movements of the belts – fig 4(i).
	Canny (thresh=0.17)	Detects movement of the man but erroneously detects several portions of the still pavement as moving objects – fig 3(k).	Great visual detection – detects movement of both the caps and the lower belt; slightly detects movement of the upper belt as well – fig 4(k).
	Canny (thresh=0.55)	Detection of strong edges only (no false detection) – fig 3(m). However, detection quality is lower than that of Sobel detection as in fig 3(i).	Unable to detect the motion of the belts – fig 4(m). However, detection quality is better than that of Sobel detection as in fig 4(i).

TABLE 1: Comparison of the motion detection algorithms under different scenarios

Average** time taken to obtain the above shown figures (only the ones in which motions are detected):

Algorithm	Edge	Scenario1***		Scenario 2****	
		Figure	Average time(sec)	Figure	Average time(sec)
4.1		3 (d)	3.0717644	4 (d)	4.1041660
4.2	Sobel	3 (e)	3.7338478	4 (e)	6.4473798
	Canny (thresh = 0.17)	3 (f)	4.0066358	4 (f)	6.4270532
	Canny (thresh = 0.55)	3 (g)	3.8619630	4 (g)	6.3946814
4.3	Sobel	3 (i)	7.5335376	4 (i)	13.8421282
	Canny (thresh = 0.17)	3 (k)	13.3262350	4 (k)	26.4577750
	Canny (thresh = 0.55)	3 (m)	12.6463506	4 (m)	25.0108116

TABLE 2: Comparison of average time taken by the algorithms to detect motion

** Each program has been run 5 times on the same system (Intel® Core(TM) i5 CPU M430 @ 2.27 GHz, 4GB DDR3 RAM, ATI Radeon HD 5400, Win 7 64-bit) and their average was considered.
*** Total number of frames in the video stream for this scenario = 80
**** Total number of frames in the video stream for this scenario = 249

Alavi, S., 2021. *Comparison of Some Motion Detection Methods in cases of Single and Multiple Moving Objects*. [online] India: ResearchGate. Available at: <https://www.researchgate.net/publication/306357420_Comparison_of_Some_Motion_Detection_Methods_in_cases_of_Single_and_Multiple_Moving_Objects> [Accessed 19 November 2021].

3.6 Results and Discussion

It is evident from the table 1 comparisons that image subtraction is only good enough to identify motion in the situation of a single moving object against a stationary background. When there are several moving objects, however, it fails to complete this duty successfully.

The best result for a single moving object was obtained by doing Canny edge detection following picture subtraction with a low threshold setting. Sobel edge detection was unable to match Canny edge detection. In the case of several moving objects, however, using Canny edge detection before picture removal yielded the best results.

A low threshold value was utilized here as well.

Table 2 shows that among the three motion detection methods evaluated here, the "Image Subtraction Method" is the fastest. Edge detection after picture removal is significantly faster than the other two approaches. A detailed examination of the average times required by this approach reveals that it is not as slow as the simpler image subtraction method (the extra time consumed by algo 4.2 over 4.1 is less than 1 second for scenario 1 and a little over 2 seconds for scenario 2). Canny provided the best result for several moving objects, but at the cost of a long computation time (26.4577750 seconds).

3.7 Conclusion

To summarise, motion detection requires edge detection in addition to image removal. Canny edge detection, although being computationally slower and more expensive as a result, consistently produces the best results. Furthermore, if we can overlook the longer calculation time, "Image Subtraction after Edge Detection" is the best approach among the three stated above.

With research in the future, only Canny edge detection will be utilized in future studies since it has been considered to operate best among all other edge detection methods now available and is regarded as a "contemporary standard". With Canny, it's also vital to enhance the longer computation times. Edge detection is particularly useful in circumstances involving many moving objects. This study's findings testing under varied lighting conditions and varying the distance of the object can be expanded further by moving items, and then going live with a more efficient algorithm and system.

4.0 Motion Detection Program

4.1 Type of Motion sensor that will be used in the program for motion detection testing

4.1.1 Video motion sensors

These are motion sensors that are captured by security cameras that process advanced signals that are triggered when a motion is detected and start recording this footage is stored on memory storage which is controlled wholly by when the camera detects emotion which saves on a lot of storage and not wasting its resources on unlimited amounts of recording hours which may not be of any use since it captures motion which may be a more useful form of information.

Tross, K., 2021. *The Beginner's Guide to Motion Sensors | SafeWise*. [online] SafeWise. Available at: <https://www.safewise.com/resources/motion-sensor-guide/> [Accessed 19 November 2021].

4.1.2 Video Motion Sensor used in the project

It will capture an image and process using algorithms to identify if there is any motion or movement detected and set off the alarm if it is triggered. I will be using an object to test for any motion that can be captured by a camera. (In Figure 4.1)

```
#Gray conversion and noise reduction (smoothening)
gray_frame=cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)
gray_frame=cv2.GaussianBlur(gray_frame,(25,25),0)
```

Fig 4.1: Video Motion Sensor algorithm

4.2 Programs that will be used in the project

The program that I will be using is called Python Fig and PyCharm, which will be used in developing a motion sensor that will be used to detect any movement and will access a camera to capture any objects in motion. It will also use different algorithms and methodology which will be discussed later in the report and any additional add ONS and plugins which help in making the program run successfully.

(Python (programming language) - Wikipedia, 2022)

Fig 4.2: Python **Fig 4.3: PyCharm**

4.2.1 Purpose of using the program

The purpose of using these programs is to gain access to addons and plugins that make them easier to use. It allows for lesser complications with coding and programming and is more organized in my personal opinion. Python is also the most reliable programming language that I've used to write efficient and effective code for any program.

4.2.2 Addons and plugins in python

```
pip install pyttsx3
pip install pywin32
pip install numpy
pip install opencv-python
```

Fig 4.4 Addons and Plugins

4.2.3 Python Interpreter Libraries for Object Detection

I've used libraries that will be used in detection objects with the help of libraries that have been imported for the program which is shown in (figure 4.5)

```python
#imports
import imutils
import time
import datetime
import cv2
import pyttsx3
import threading
```

Fig 4.5: Imported Libraries

4.2.4 Additional Python Interpreter Libraries for Program

Here are some additional programs libraries that will be used for the program to run successfully. They were imported from the Python interpreter tool for additional back-end support for the PyCharm. (Figure 4.6)

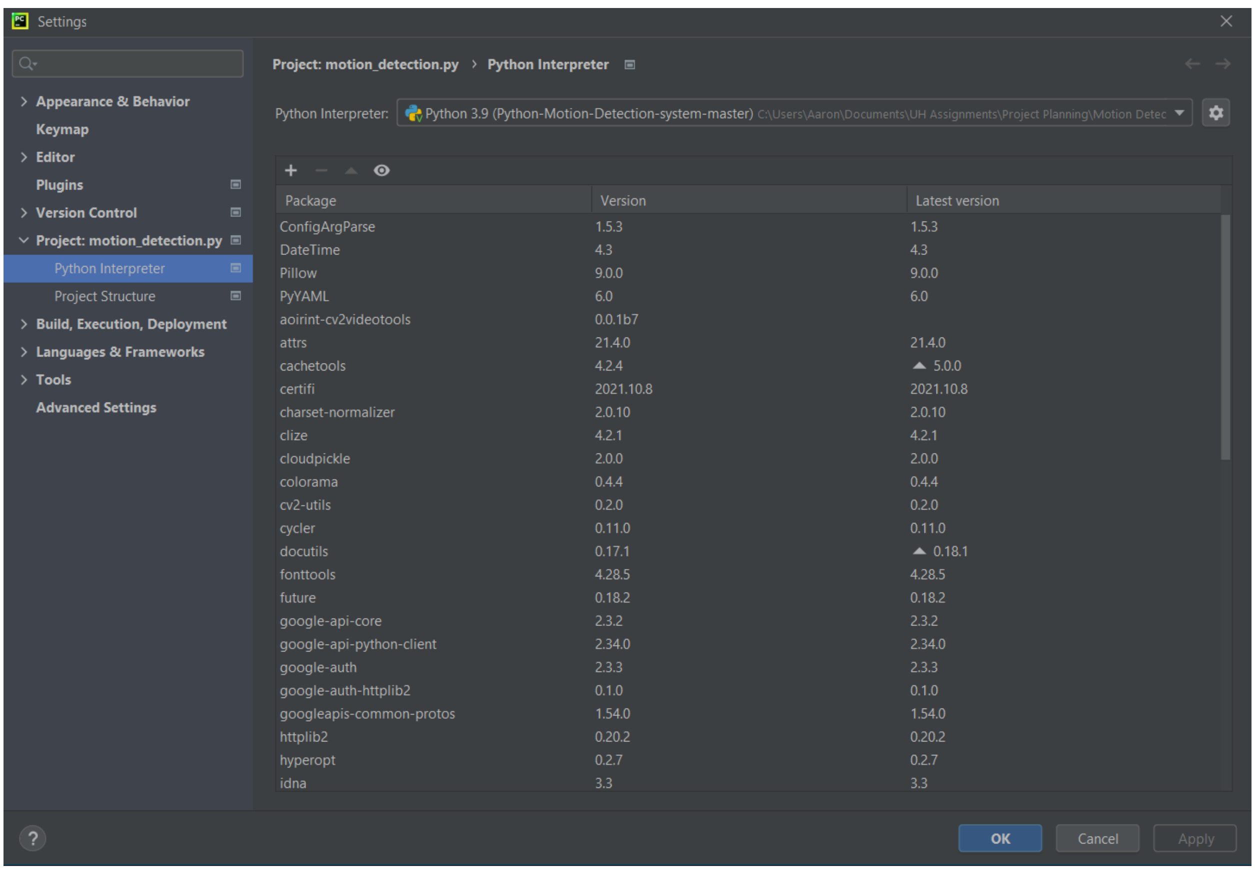


Fig 4.6: additional libraries imported for the PyCharm program

4.2.5 Limitations of the program

- I've implemented boxes that detect objects in motion and capture the motion detected within the grid of the motion. Its limitations of it are that it doesn't capture the object in the center of the grid.
- It has no data capturing method which may be required to track and predict the movement of the object. I've implemented a basic capturing method that collected image data to store and then uses it to detect motion in the video capture feed.
- The difficulty of capturing an object is if the movement is too quick and doesn't detect the object. It doesn't capture a rapid movement of the object in motion, this is due to the hardware limitations of my device.
- Can't detect movement in the dark or low lighting environment. The limitation here is that the program can't detect motion due to low light conditions in the room environment.

5.0 Stakeholders involved in this Project

In this section, the data provide a complete set of stakeholder groups to which the project is relevant. This includes those involved in the specification, development, design, use, and maintenance of any artifact or outcome from the project in (figure 5.0).

Stakeholders	Role
University Assignment Submission	As part of an assignment, this project was created in an attempt to solve a problem with the topic of my choice.
Potential Household	Motion sensors can be used outside homes when an object is detected, or any movement usually has a good view of the entrance.
Restricted areas	It can be used in areas where no one is allowed to enter and only accessed by authorized members.
Supermarkets	It can be used to track customers and keep an eye on home many of them are there in a massive store.
Banks	It can be used to set off alarms if there is a break-in with the help of motion detection.

Fig 5.0: Stakeholders in the Project

5.1 Risk – During the project implementation table of identified risks

This section requires details of the perceived risks associated with all stages in the implementation of the project solutions identified. Reference the lecture on Risk for guidance on what to consider in this section. Each risk will include a list of measures that will mention the likelihood of occurrence, consequences of occurrence, and consideration of how to mitigate in (Figure 5.1).

Risk Identification	Mitigation
Skill Shortfall in using the program	Spending time and researching how to use the program.
Real-time performance shortfalls	Implementing the latest hardware or software that performs efficiently.
Errors and missing extensions	After going through the code for the program I was able to solve the issue and got the program running properly.
Output Technical fault after the program was working properly, I ran into a technical issue with the out where the camera was not switching on when the program running.	Changed settings and assigned the camera device to run when the program is executed.
Missing Program Drivers	Installed and updated the drivers that are required for the camera device to run along with the program.

Fig 5.1: Risk Identification & Mitigation

5.2 Risk – Due to the implementation of a table of identified risks

This section requires details of the perceived risks associated with the post-implementation of the project to be stated. This will reference the list of stakeholders in section 5 and consider to whom these risks apply. Reference the lecture on Risk for guidance on what to consider in this section. Each risk listed must include a measure of the likelihood of occurrence, consequences of occurrence, and consideration of how to mitigate in (Figure 5.2).

Risk Due to Implementation	Mitigation
Unauthorized access/use of a system (inc hacking)	By increasing the security of the passwords by making the limit word limit larger with special symbols and characters. To decrease the possibility of brute force attacks for guessing the password we can also 128-bit encryption.
Damage to or destruction of physical system assets and environment	The infiltrator must be well equipped with gadgets to get around the tight security in place which is designed to protect the facility from these types of attacks.
Damage to or destruction of data or code inside or outside the system	Using such techniques to keep their system secure they have full disc encryption, firewall, advanced antivirus, VPN, and two-factor authentications.

Naturally disasters/occurring risks	Having more than one motion detection camera will allow for a more reliable and accurate solution in the case of any disasters.

Fig 5.2: Risk due to implementation

6.0 Statement of Success

This section allows you to define the purpose of the project in terms of your desired learning outcomes. By success, we are NOT measuring the success of the artifacts as complete systems or experiments, but what you consider to be successful in terms of the knowledge you will acquire through undertaking the project.

6.1 The assistance that supported me in completing my project -

- All the resources were available online which helped me make progress in my project. Research made by others helped me compare my data with others and gave an overview of the topic that I have chosen.
- The material was made available by the teacher and guidelines were given to follow and keep track of the progress made with the help of a project plan and deadlines to be met every week until the final deadline.
- Feedback was given by the Supervisors after handing in the work which helped make changes and add more content to the work.
- Class meetings were held every week to discuss how to make progress on the project. Everyone was able to share ideas and thoughts in going about certain tasks and what was required to be achieved.
- Deadlines helped me get my work done on time and gave me a clear map of what tasks needed more attention to complete within the time limit. Spreading out the workload so that it was easier to focus on what task needed more priority than others.

6.2 Obstacles that affected my progress in completing my project -

- Due to recent events, I faced challenging times and had a few weeks tough on me. The recent outbreak has affected most the businesses and institutions which has led to the closure of many small and large shops, companies, and even airports. Though this did not affect my progress massively I’ve managed to get work done on time and handed into the classroom.
- My work schedule has also made it challenging to manage work and assignments to be handed in on time. With quick feedback and motivation with the help of the teacher, it has been easier to get as much work done as possible before the deadline.
- Resources took a little longer to gather as it was difficult to go about conducting primary research due to the recent pandemic lockdown making it difficult to collect data physically and having to only rely on online forms and questionnaires that I had prepared for my research.

6.3 Reasons for choosing this research project -

- Reasons for choosing the project which was linked to other subjects that I was studying; I also had a personal interest in this field of research which helped me get motivated in proceeding with the research as plans that include gaining knowledge and skills to improve my understanding of the topic as it is important to make a reasonable conclusion based on the research that I have collected.
- As I'm part of learning how tech works and how technology companies produce new software, I'm interested in how technology companies are responsible for the health, safety, and wellbeing of their users.
- Performing research and finding out more about how others view the topic I have selected give me an idea of how I can make the future better for others with the data that I have gathered to make those changes.
- The data that I collect may someday become useful to me in my career. With this research material, I will be able to decide on what the demographic wants and requires and how it affects them in their daily life.
- The research data that I have collected will turn out to help someone that may need it for their research. This will prove useful to them in giving them an insight into this topic of research.

6.4 Skills that I have gained after my research is completed -

- A Deeper understanding of research methodologies
- Presentation skills
- Report writing skills
- Planning
- Time management
- Collection of data
- Analysis and evaluation of data
- Gathering data from secondary resources

7.0 Final thoughts and views on the success of my Research -

This research helped build my knowledge and changed my perspective on how others perceive ideas and thoughts. It has personally developed my understanding of how technology has changed the way how people interact with each other and how it affects the way we go on with our daily lives.

The resources I have used and collected using primary research and secondary research methods in gathering as much data as possible have given me the ability and skills to continue further and help me in my career moving forward.

I would like to thank my teacher, Mr. Paul Morris, for providing me with all the resources that have been provided to me for helping me work on my research project and for people who have participated in providing data to further the progress on the success of my research.

8.0 Ethics

Based on the topic I've chosen which is a Motion detection system, ethical approval will not be required as there is no human interaction.

9.0 Reasons for choosing this research project -

- Reasons for choosing the project which was linked to other subjects that I was studying; I also have a personal interest in this field of research which helped me get motivated in proceeding with the research as a future that includes gaining knowledge and skills to improve my understanding of the topic as it is important to make a reasonable conclusion based on the research that I have collected.

- As I'm part of learning how tech works and how technology companies produce new software, I'm interested in how technology companies are responsible for the health, safety, and wellbeing of their users.

10.0 Conclusion

In conclusion, this talked about the problem of this project and the solution that was considered for the topic which will aim to provide benefits of smart home security and how they help us during extreme situations as well help protect homes. It goes through the challenges that impact smart home security when an intruder is in your garden. Automated functions that a CCTV system that records 24 hours and can be viewed through a monitor. Actions to take while an intruder is detected by a CCTV feed will sound an alert when it detects a motion.

It also talks about the problem this project will aim to provide benefits of smart home security and how they help us during extreme situations as well help protect homes. Moreover, it also discusses the challenges that impact smart home security when an intruder is in your garden. Automated functions that automatically adjust lighting, turn off all the lights during the day and on during the night, and a CCTV system that records 24 hours and can be viewed through your mobile phone at any time. Actions to take while an intruder is detected by a CCTV feed and to move to a safe room in the house and alert the police.

It also discusses how the technology has evolved since the inception of a traditional form of home security systems to more reliable and robust Motion sensing Technology that will benefit every household and prevent intrusion for the foreseeable future.

It also Discusses motion detection system technology and how it will be implemented in everyday homes. Nowadays security system has evolved to the point where intruders find wonder abilities in every device, and motion sensors are no exception when it comes to intruders breaking into houses in this project, I will demonstrate a simple motion detection system that implements algorithms and methodologies to create a motion detection system.

11.0 References

Tross, K., 2021. *The Beginner's Guide to Motion Sensors | SafeWise*. [online] SafeWise. Available at: <https://www.safewise.com/resources/motion-sensor-guide/> [Accessed 19 November 2021].

Alavi, S., 2021. *Comparison of Some Motion Detection Methods in cases of Single and Multiple Moving Objects*. [online] India: ResearchGate. Available at: <https://www.researchgate.net/publication/306357420_Comparison_of_Some_Motion_Detection_Methods_in_cases_of_Single_and_Multiple_Moving_Objects> [Accessed 19 November 2021].

Constantin, L., 2021. *Researchers show ways to bypass home and office security systems*. [online] CSO Online. Available at: <https://www.csoonline.com/article/2133815/researchers-show-ways-to-bypass-home-and-office-security-systems.html> [Accessed 20 November 2021].

Gudino, M., 2021. *Types of Motion Sensors*. [online] www.Arrow.com. Available at: <https://www.arrow.com/en/research-and-events/articles/how-motion-sensors-work#:~:text=There%20are%20three%20types%20of,%2C%20and%20Dual%20Tech%2FHybrid.> [Accessed 19 November 2021].

Tross, K., 2021. The Beginner's Guide to Motion Sensors | SafeWise. [online] SafeWise. Available at: <https://www.safewise.com/resources/motion-sensor-guide/> [Accessed 19 November 2021].

Wikipedia. "Motion Detection." Internet: http://en.wikipedia.org/wiki/Motion_detection, May 20, 2012 [Jun. 16, 2012].

R. B. Wahyu, Tati R. Mengko, Bambang Pharmasetiawan and Andryan B. Suksmono. "Motion Detection Using Image Subtraction Edges Detection." Risalah Lokakarya Komputasi dalam Sains dan Teknologi Nuklir XVII, pp. 157-171, Aug. 2006.

J. Matthews. "An Introduction to Edge Detection: The Sobel Edge Detector." Internet: http://www.generation5.org/content/2002/im01.asp, 2002.

J. Canny. "A Computational Approach to Edge Detection." IEEE Transaction on Pattern Analysis and Machine Intelligence, vol. PAMI-8, no. 6, pp. 679-697, Nov. 1986
Wikipedia. "Image subtraction." Internet: http://en.wikipedia.org/wiki/Image_subtraction, Sep. 27, 2011 [Jun. 16, 2012].

R. Maini and Dr. H. Aggarwal. "Study and Comparison of Various Image Edge Detection Techniques." International Journal of Image Processing (IJIP), vol. 3, iss. 1, pp. 1-11, Feb. 28, 2009.

"Canny Edge Detection." Internet: http://www.cvmt.dk/education/teaching/f09/VGIS8/AIP/canny_09gr820.pdf, Mar. 23, 2009.

E. Nadernejad, S. Sharifzadeh and H. Hassanpour. "Edge Detection Techniques:

Evaluations and Comparisons." Applied Mathematical Sciences, vol. 2, no. 31, pp. 1507 – 1520, 2008.

M. Juneja and P. S. Sandhu. "Performance Evaluation of Edge Detection Techniques for Images in Spatial Domain." International Journal of Computer Theory and Engineering, vol. 1, no. 5, pp. 614-621, Dec. 2009.

M. Heath, S. Sarkar, T. Sanocki and K. Bowyer. "Comparison of Edge Detectors: A Methodology and Initial Study." Computer Vision And Image Understanding, vol. 69, no. 1, pp. 38–54, Jan. 1998.

Smith, G., 2021. *History of Astronomy*. [online] Cass.ucsd.edu. Available at: <https://cass.ucsd.edu/archive/public/tutorial/History.html> [Accessed 19 November 2021].

Todayinsci.com. 2021. *October 13 - Today in Science History - Scientists born on October 13th, died, and events*. [online] Available at: <https://www.todayinsci.com/10/10_13.htm> [Accessed 19 November 2021].

12.0 Appendices -

12.1 Appendix A

12.1.1 Gantt Chart for the Project

To go proceed with the project, I've created a **Gantt Chart** to demonstrate the flow of tasks that will be required to project be discussed further in the success of the project shown in

(Figure 12.1)

Tasks	Start Week	Finish Week	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Research Stage	**1**	**2**												
In this first Stage, Data will be collected for the use in my project, with the help of tools that will be required for the project.														
Planning Stage	**2**	**2**												
In the second stage, I will use the data that I've gathered on the tools that will be used to in the program to demonstrate the project plan.														
Design Stage	**3**	**3**												
In the third stage, will require creating a design structure of the prject which will be a blue print to tasks and the desired output.														
Implentation Stage	**4**	**9**												
In the fourth stage, will be a exploring the planning and design stage and go through the program that is required for the project and will document the success and failure of the task.														
Follow up Stage	**9**	**12**												
In the Final Stage, will be about testing the program that was create for the project and making the necessary changes to the code to make it work successfully.														

Fig 12.1: Gantt Chart

12.2 Appendix B

12.2.1 Motion Detection System Output Screen

12.2.2 Object Detection Test –

Example 1

Empty Room – Unoccupied

After the libraries were installed and implementing the code for the object detection program and running the program which is shown in figure 3. In the image, the output shows a white background with the room status on the top left of the **Security feed** window, which captures the object in the frame. It also displays the date and time at the bottom left of the Security feed display output screen. There are two other windows called the **Threshold (Foreground mask)** and **Frame Delta**, the threshold foreground mask shows the negative overlay of the Security feed, and the **Frame Data** captures the first frame of the output screen to detect motion from the **Security Feed** shown in (Figure 12.2).

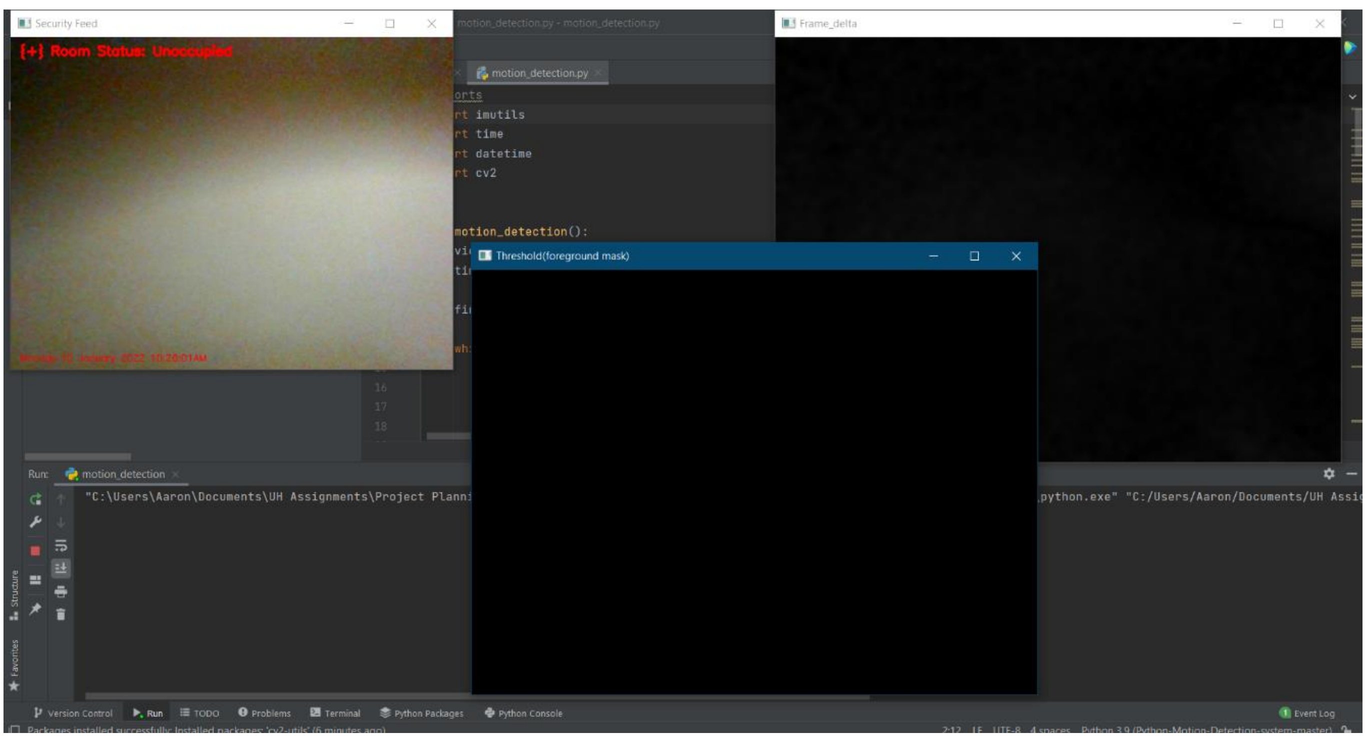


Fig 12.2: Unoccupied Room Status

Example 2

Object in the Room – Occupied

When an object is brought in front of the camera, the **Security Feed** displays a room status as occupied and highlights the object it has detected with a green box. It also displays the **Threshold (foreground mask)** of the object in black and white to detect the object in view. And the final window shows the **Frame Delta** of the object which is a negative image of the first frame in which it can compare the motion detected by the output in the **Security** Feed shown in Figure 12.3).

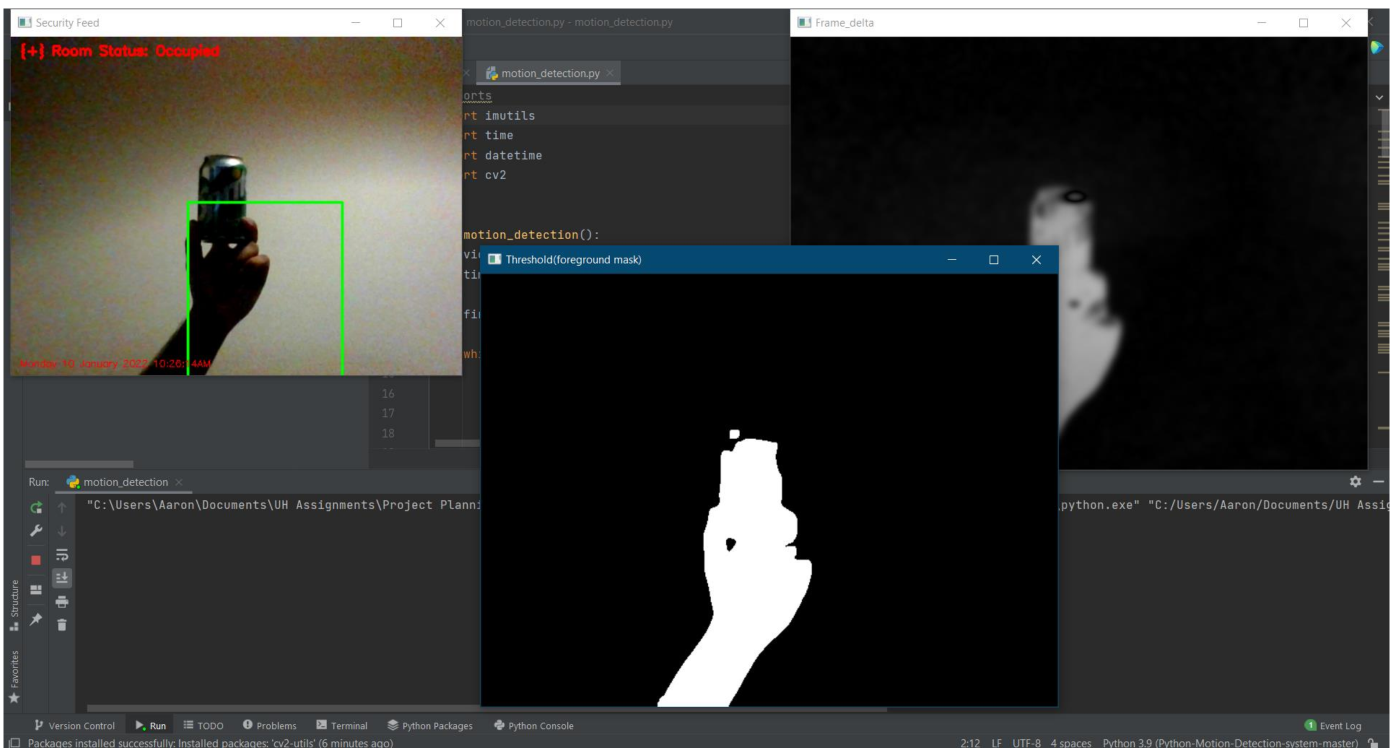


Fig 12.3: Room Occupied Output Display

Example 3

Using another object in the Room – Occupied

Here is another object which I've used to test and detect an object in the capture view. I've noticed that it detects more than one object separately which highlights both objects with green boxes of their own. This is demonstrated in Figure 12.4 as shown below.

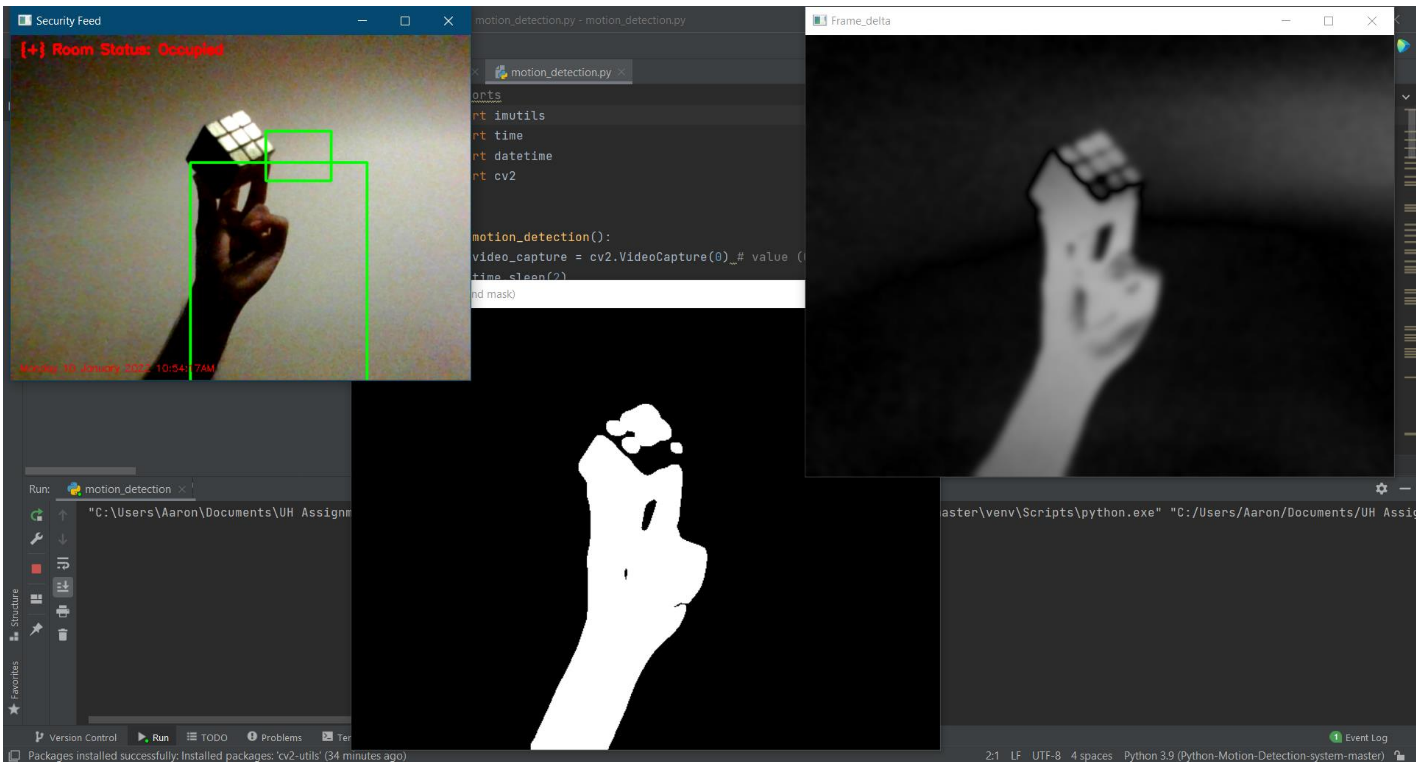


Fig 12.4: Room Occupied Output Display

12.2.3 Motion Detection Test

Sudden Detection of an object in Motion – Room Occupied

When an object suddenly gets in the frame of the camera, the **Security Feed** displays a room status as occupied and highlights the object it has detected with a green box. It also displays the **Threshold (foreground mask)** of the object in black and white to detect the object in view. And the final window shows the **Frame Delta** of the object which is a negative image of the first frame in which it can compare the motion detected by the output in the **Security Feed.** As shown in (Figure 12.5).

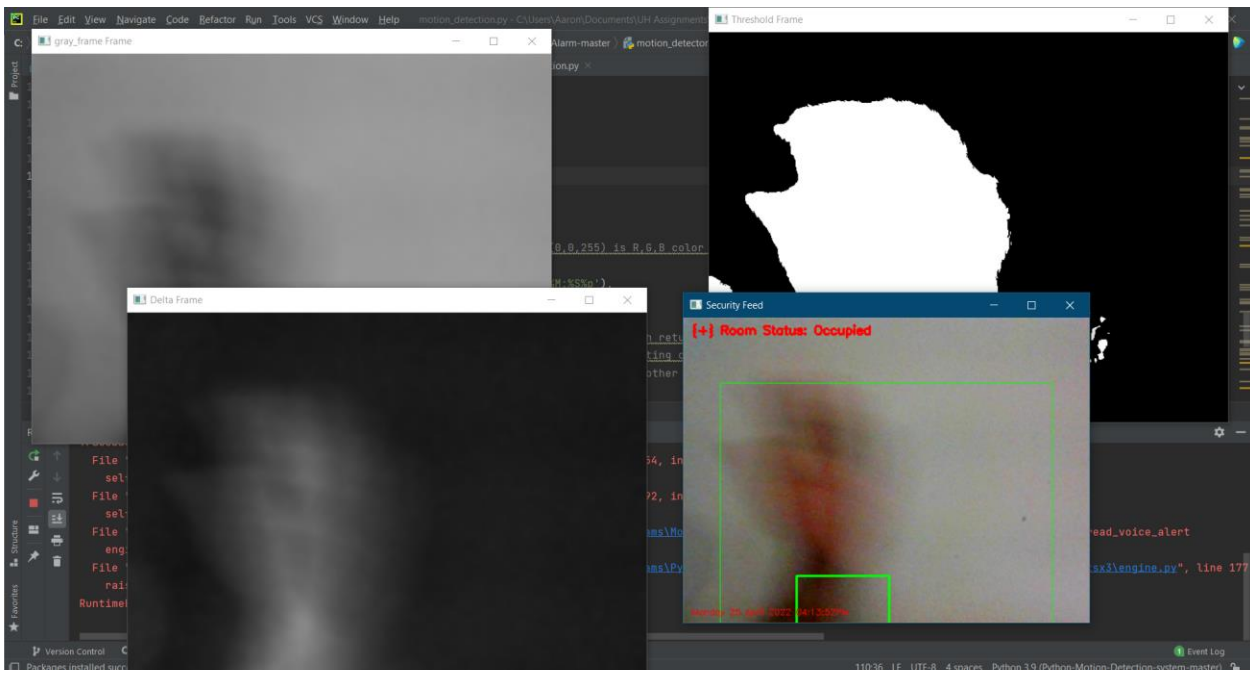


Fig 12.5: Motion Detection Output Display

Detection During a Semi Bad / Low lighting conditions

When an object is brough in front of the camera, in low light condition it does seem to capture light source within the room. The **Security feed** displays the room as **Occupied** even when there is no actual motion detected in the **Security feed**.

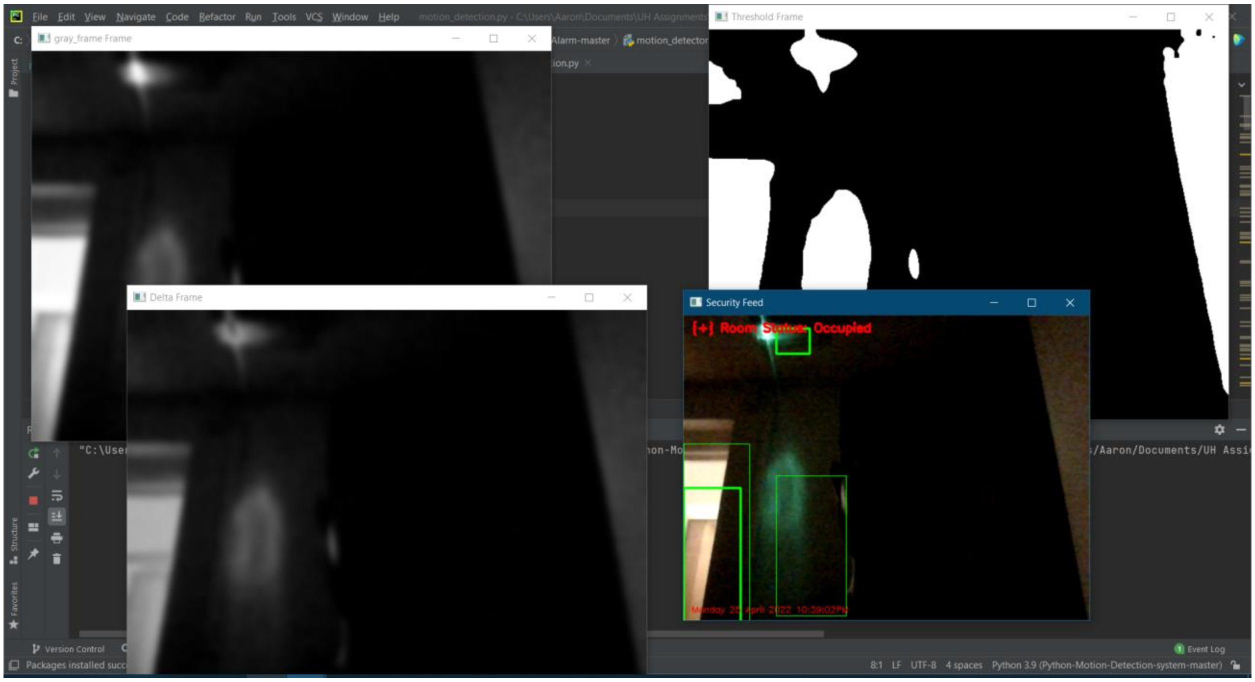


Fig 12.6: Detection During bad lighting conditions

Detection with no light source at all

When there is no light source in the room the security feed is shown as **Unoccupied** in my case there is just a black void in all the frames. Hence my program cannot detect any motion or object in extreme darkness.

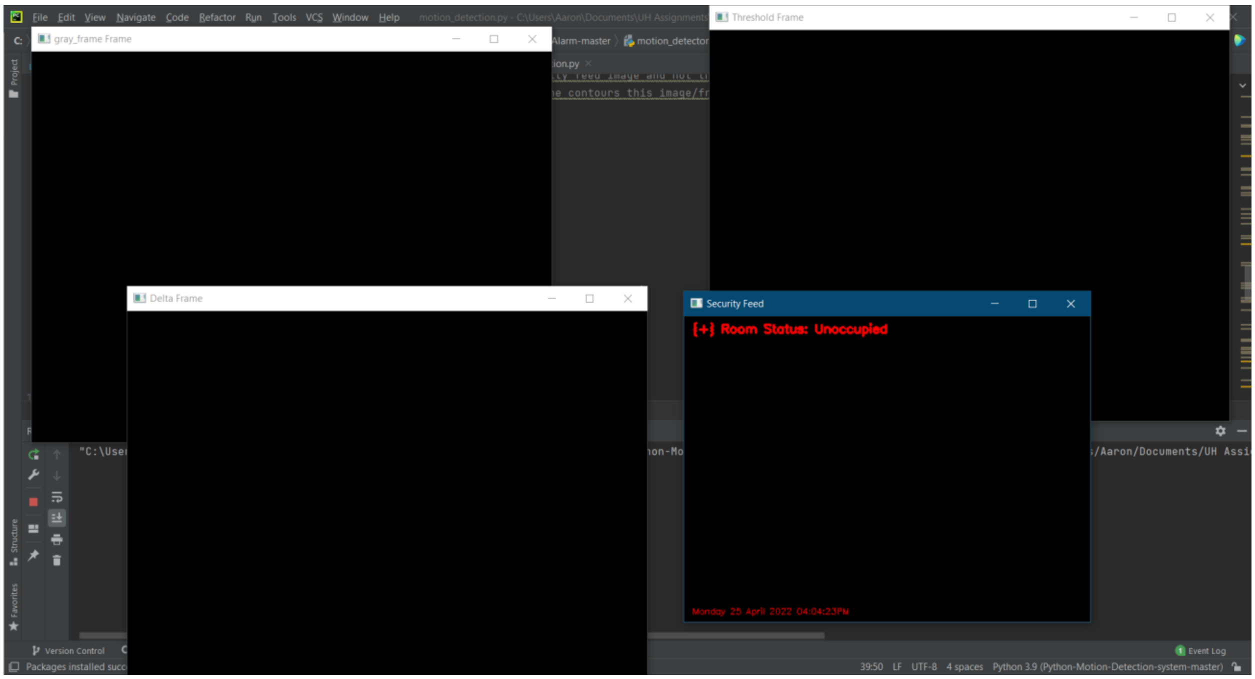


Fig 12.7: Detection with no light source

12.3 Appendix C

12.3.1. Implementation of Voice Alert when motion is detected

```
#Setting parameters for voice
engine = pyttsx3.init()
voices = engine.getProperty('voices')
engine.setProperty('voice', voices[1].id)
engine.setProperty('rate', 150)
```

Fig 3.1: Implementation of Voice

12.3.2 Implementation of Date and time in the Security Feed

```
''' now draw text and timestamp on security feed '''
font = cv2.FONT_HERSHEY_SIMPLEX

cv2.putText(frame, '{+} Room Status: %s' % (text),
            (10, 20), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255), 2)
# frame is the image on wich the text will go. 0.5 is size of font, (0,0,255) is R,G,B color of font, 2 on end is LINE THICKNESS! OK :)

cv2.putText(frame, datetime.datetime.now().strftime('%A %d %B %Y %I:%M:%S%p'),
            (10, frame.shape[0] - 10), cv2.FONT_HERSHEY_SIMPLEX, 0.35, (0, 0, 255),
            1)  # frame.shape[0] = hieght, frame.shape[1] = width,ssssssssssssss
# using datetime to get date/time stamp, for font positions using frame.shape() wich returns a tuple of (rows,columns,channels)
# going 10 accross in rows/width so need columns with frame.shape()[0] we are selecting columns so how ever many pixel height
# the image is - 10 so oppisite end at bottom instead of being at the top like the other text
```

Fig 3.2 Implementation of Date and Time in the Security Feed

12.3.3 Full Working Code

```
#imports
import imutils
import time
import datetime
import cv2
import pyttsx3
import threading


# This function plays the audio message
def thread_voice_alert(engine):
    engine.say("Object Detected")
    engine.runAndWait()

def motion_detection():
    video_capture = cv2.VideoCapture(0) # value (0) selects the devices default camera
    time.sleep(2)


baseline_image=None
status_list=[None,None]
video=cv2.VideoCapture(0)

#Setting parameters for voice
engine = pyttsx3.init()
voices = engine.getProperty('voices')
engine.setProperty('voice', voices[1].id)
engine.setProperty('rate', 150)

baseline_image = None  # instinate the first fame

while True:
    check, frame = video.read()
    text = 'Unoccupied'

    status=0
    gray_frame=cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY) # make each frame greyscale wich is needed for
threshold

    gray_frame=cv2.GaussianBlur(gray_frame,(25,25),0)
    # uses a kernel of size(21,21) // has to be an odd number to ensure there is a valid integer in the center
    # and we need to specify the standard deviation in the x and y direction which is the (0) if only x(sigma x) is spec-
ified
    # then y(sigma y) is taken as same as x. sigma = standard deviation(mathematics term)


    if baseline_image is None:
        baseline_image=gray_frame

        # the first frame is set for background subtraction(BS) using absdiff and then using a threshold to get the fore-
ground mask
        # foreground mask (black background anything that wasn't in the image in the first frame but is in the new
frame over the threshold will
```

```
    # be a white pixel(white) foreground image is black with the new object being white...there is your motion de-
tection
  else:
    pass

  frame = imutils.resize(frame, width=500)
  frame_delta = cv2.absdiff(baseline_image, gray_frame)
  # calculates the absolute difference between each element/pixel between the two images, first_frame - greyscale
(on each element)

  # edit the ** thresh ** depending on the light/dark in the room, change the 100(anything pixel value over 100 will
become 255(white))
  thresh = cv2.threshold(frame_delta, 100, 255, cv2.THRESH_BINARY)[1]
  # threshold gives two outputs retval, threshold image. using [1] on the end I am selecting the threshold image that
is produced

  threshold = cv2.dilate(thresh, None, iterations=2)
  # dilate = dilate,grow,expand - the effect on a binary image(black background and white foregorund) is to en-
large/expand the white
  # pixels in the foreground wich are white(255), element=Mat() = default 3x3 kernal matrix and iterartions=2
means it
  # will do it twice

  cnt = cv2.findContours(threshold.copy(), cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)[1]
  # contours gives 3 different output images, contours, and hierarchy, so using [1] on the end means contours =
[1](cnt)
  # cv2.CHAIN_APPROX_SIMPLE saves memory by removing all redundant points and compressing the contour,
if you have a rectangle
  # with 4 straight lines you don't need to plot each point along the line, you only need to plot the corners of the rec-
tangle
  # and then join the lines, eg instead of having to say 750 points, you have 4 points.... look at the memory you
save!

  cnt = cv2.findContours(threshold.copy(), cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)

  for c in cnt[-2]:

    if cv2.contourArea(c) > 800:  # if contour area is less then 800 non-zero(not-black) pixels(white)
      (x, y, w, h) = cv2.boundingRect(c)  # x,y are the top left of the contour and w,h are the width and hieght

      cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0),
              2)  # (0, 255, 0) = color R,G,B = lime / 2 = thickness(i think?)(YES IM RITE!)
      # image used for the rectangle is frame so that it's on the security feed image and not the binary/thresh-
old/foreground image
      # as it already used the threshold/(binary image) to find the contours this image/frame is what image it will
be drawing on

      text = 'Occupied'
      # text that appears when there is motion in the video feed
    else:
      pass

    continue

  delta=cv2.absdiff(baseline_image,gray_frame)
  threshold=cv2.threshold(delta, 30, 255, cv2.THRESH_BINARY)[1]
```

```
    (contours,_)=cv2.findContours(threshold,cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)

    for contour in contours:
        if cv2.contourArea(contour) < 10000:
            continue
        status=1
        (x, y, w, h)=cv2.boundingRect(contour)
        cv2.rectangle(frame, (x, y), (x+w, y+h), (0,255,0), 1)
    status_list.append(status)


    if status_list[-1]==1 and status_list[-2]==0:
        t = threading.Thread(target=thread_voice_alert, args=(engine,))
        t.start()

    ''' now draw text and timestamp on the security feed '''
    font = cv2.FONT_HERSHEY_SIMPLEX

    cv2.putText(frame, '{+} Room Status: %s' % (text),
                (10, 20), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255), 2)
    # frame is the image on which the text will go. 0.5 is size of font, (0,0,255) is R,G,B color of font, 2 on end is
LINE THICKNESS! OK :)

    cv2.putText(frame, datetime.datetime.now().strftime('%A %d %B %Y %I:%M:%S%p'),
                (10, frame.shape[0] - 10), cv2.FONT_HERSHEY_SIMPLEX, 0.35, (0, 0, 255),
                1)  # frame.shape[0] = hieght, frame.shape[1] = width,ssssssssssssss
    # using datetime to get date/time stamp, for font positions using frame.shape() wich returns a tuple of (rows,col-
umns,channels)
    # going 10 across in rows/width so need columns with frame.shape()[0] we are selecting columns so however
many pixel heights
    # the image is - 10 so opposite end at the bottom instead of being at the top like the other text

    cv2.imshow("gray_frame Frame",gray_frame)
    cv2.imshow("Delta Frame",delta)
    cv2.imshow("Threshold Frame",threshold)
    cv2.imshow("Security Feed",frame)

    key=cv2.waitKey(1)

    key = cv2.waitKey(1) & 0xFF  # (1) = time delay in seconds before execution, and 0xFF takes the last 8 bit to
check value or sumin

    if key == ord('q'):
        if status==1:
            cv2.destroyAllWindows()
            times.append(datetime.now())
        break


#Clean up, Free memory
engine.stop()
video.release()
cv2.destroyAllWindows
```