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Object Movement Detection

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Abstract- A primary objective of computer vision systems is to identify and track moving objects. Though, these systems often face challenges due, to factors, such as changes in the environment, which make the process of detecting moving objects difficult. Motion detection is a established field in computer technology and image processing that focuses on identifying types of objects or instances within digital photos and videos such as humans, flowers or animals. Object motion detection has been extensively studied for applications like face recognition, character identification and vehicle tracking. Additionally, object counting plays a role in refining and strengthening object detection using Open CV's capabilities. Various techniques provided by Open CV are valuable for both object detection and counting tasks. Object counting finds its applications across domains including transportation, medicine, and environmental science. The continuous advancements, in computer vision and image processing research have significantly contributed to enhancing the quality of life. To overcome the limitations of existing and recently developed methods we conducted tests, on open-source images using a set of variables. The software system for motion detection presented in this paper enables us to detect movement in relation, to an object or a specific visual area. This project implements a motion detection and notification system using webcams, combining image processing and deep learning techniques. The system uses Open CV for real-time image capture and motion detection with image differentiation, and integrates a pre-trained You Only Look Once (YOLO) deep learning model with Py Torch. When motion is detected, the system takes a snapshot, sends an email notification with an image attachment for remote access, and sounds an alarm. This hybrid approach improves the system's ability to efficiently detect and respond to movement. This application is related to the field of home automation, security systems and surveillance and provides an instant multimodal notification system with visual evidence and audible alarms.

Keywords: Motion Detection, Open CV, Pixel Background Subtraction, Alert Sound, Email Notification, Py Torch, YOLO, Deep learning

I. INTRODUCTION

There is an increasing along with the advancement of technology. The number of surveillance cameras has recently grown in order to address this problem. Despite this, it is challenging to manually store and check data continuously. There are a number of approaches to perform this task without using humans. In systems for visual surveillance, Real-time object movement detection is a challenging task. It frequently serves as the foundation for more

complex processing, including classifying the detected moving object. The motion of objects in video processing in a surveillance system are essential and concerns about security and safety are prevalent nowadays. It enables many processor vision applications to extract data from frames and video sequences, including CCTV surveillance, understanding an activity in focus, examining traffic flow, classifying and detection any motion an object, and comprehending an activity out of focus. This shows that locating and tracking objects is a crucial field of computer vision research, with applications in several surveillance systems.

In the modern era, motion detection surveillance and security systems are increasingly widespread. This kind of technology is used in shops, financial institutions, supermarkets, airports, office buildings, and even private homes. There are two different kinds of video surveillance and security systems: analog and digital. In conventional security systems, cameras are used to transmit analog video pictures to monitors or time-lapse video cassette recorders (VCR). Although the system application can benefit from a variety of local image processing functionalities, doing so requires a lot of processing power and high-power hardware. Analog systems are still a cheaper option despite the growing use of digital video surveillance and security systems. Charge coupled device (CCD) cameras and digital cameras are the most frequently used cameras in the system. Motion detection is the capacity to recognize movement. Object Movement Detection is one of the main concept in Computer Vision which is mostly used in surveillance systems. It automatically identifies and track a moving object in a specified environment. It allocates frames for the objects from the camera and then identifies changes in object positions, sizes and orientations. It uses many approaches like Background Subtraction, Optical Flow Analysis, Deep learning, Neural Networks. Our proposed system uses Computer vision techniques to detect, track, and analyze moving objects in a video stream. Our proposed system consists of advanced Computer vision techniques and Deep Learning algorithms to detect, track objects in an effective way. It uses yolo weights, yolo config file, coco. names file. YOLO (You Only Look Once) is a deep learning approach used to detect the objects from images with their positions and confidence scores. Sound device and Sound file library is used to create alert sound whenever a object movement is detected. In this way we can reduce human error, continuous monitoring and implementing automatic testing.

The motion detection and notification system presented in this project leverages the power of web cameras, image processing techniques, and deep learning to create a versatile solution for real-time surveillance. The system leverages Open CV for webcam integration and image processing, and uses motion detection algorithms to identify significant changes in sequential images. To improve accuracy and adaptability, the project integrates a You Only Look Once (YOLO) deep learning model pre-trained using Py Torch. When motion is detected, the system captures a snapshot, sends an email notification with an image attachment, and sounds an alarm, enabling comprehensive and immediate response to security events. This combination of image processing and deep learning techniques makes the system a robust tool for applications in home automation, surveillance, and smart home environments.

II. LITERATURE SURVEY

In 2012, Usham Dias [1], Wong method by W.K. In this method, the image is divided into m x n regions and converted into RGB images. The proposed algorithm tries to find the center point that indicates the location of the object. Next, perform temporary data allocation. If an object is found at a shorter distance than in the previous frame, itis moved from its position and assigned a label when the buffer is modernized. Similarly, a label is assigned if the object's distance is greater than a threshold. The new label is created as a new entry in the buffer and is considered valid. The proposed method uses the center of the object to determine the object's location, which makes it more accurate in terms of timing and allows for easier and more accurate location of nearby objects.

In 2017, Tsung-Yi Lin [2], proposed a feature pyramid network for object detection. With his introduction

of Faster-RCNN, YOLO, and SSD in 2015, the entire structure of object identifiers appears to have been solved. Analysts are beginning to consider improvements to each part of these networks. Highlight Pyramid Network is a project that improves identification headers by constructing feature pyramids using his highlights from different layers. This feature pyramid idea is not new in computer vision research. In the days when highlights were physically planned, feature pyramids are now a powerful way to detect patterns at various levels. Using feature pyramids in deep learning is also not a revolutionary idea. SSPNet, FCN, and SSD all demonstrated the benefit of aggregating highlights from multiple layers before classification. However, we still need to clarify how the feature pyramid should be divided between RPN and region-based detectors.

In 2017, Kaiming He [3], proposed Masked R-CNN. In this article, Mask RCNN is certainly not an everyday object detection network. This was aimed at solving the difficult task of sample section: creating a mask for each object in the scene. However, Mask R-CNN represents a significant extension of the Faster R-CNN framework and further facilitated the study of object location. The basic idea of is to add a binary mask prediction branch in addition to the current bounding box and characterization branch after ROI pooling. Obviously, both perform multiple preparation tasks, and the new ROI Align layer contributes to improvements over the bounding box benchmark.

In 2017, Navaneeth Bodla[4], proposed Soft-NMS to improve object detection in one line of code. In this paper, non-maximal suppression (NMS) is widely used in anchor-based object detection networks to reduce nearby copies of positive propositions. It is further evident that NMS repeatedly removes applicant boxes when the probability of having a high IOU with a more secure applicant box is low. This can cause sudden behavior when two objects with similar classes are near each other. Soft-NMS introduced a small improvement that only limitedly reduced security values for duplicate applicant fields. This scaling limit gives you more control over the optimization of localization runs and can result in higher accuracy if advanced validation is also required.

In 2017, ZhaoweiCai[5] proposed an approach to UC San Diego, Nuno Vasconcelos UC San, Cascade R-CNN: high-quality object detection. Cascade R-CNN looks at updating R-CNN grouping and regression heads while FPN looks at how he can design better R-CNN necks that leverage backbone highlights. The basic assumption is simple but sensible: the higher the IOU rule you apply when planning positive goals, the fewer false positive predictions the network will make. In any case, you cannot simply increase this IOU threshold from the commonly used 's 0.5 to the more powerful 0.7. This is because a more powerful negative model may be generated during training. Cascade R-CNN's answer is to chain different detection heads, each depending on the bounding box recommendation of the last his detection head.

In 2017, Tsung-Yi Lin PriyaGoyal Ross GirshickKaiming He Piotr Dollar[6] proposed focus loss for dense object detection. To understand why single-stage locators are typically not comparable to two-stage detectors, RetinaNet investigated the frontal basis class bump problem using the dense predictions of single-stage detectors. Take YOLO for example. YOLO tried to predict his classes and bounding boxes for every potential his region. Therefore, most of the revenue during training is adjusted to the negative class of SSD solved this problem through online hard model mining. YOLO used the objectivity score in his first phase of training to create a more accurate visual classifier. Retina Net believes that the duo has not gotten to the bottom of the problem yet, so to help the network know what is important, they are researching another loss function called Focal Loss. Developed. The focal loss added her the power to the cross-entropy loss. The alpha limit is used to adjust such focusing effects.

In 2018, Shu Liu, Lu Qi [7], proposed a path aggregation network for segmentation of instances. In this article, we demonstrate that because of the close relationship between event detection and object detection, other case segmentation networks may also benefit from object detection research in a

roundabout way. PANet targets and increases the data flow of Mask R-CNN's FPN neck by adding an additional base-up pass after the initial top-down pass. To account for this change, the first FPN neck has a ↑↓ structure, and PANet pools highlights from different layers, similar to the ↑↓ ↑ structure before. In PANet, instead of doing separate pooling for each element layer, we added a layer of "adaptive feature pooling" after ROIAlign in Mask RCNN to merge multi-scale features.

In 2018, ChengjiLiu[8], proposed object detection based on YOLO network. In this article, YOLO v3 is the latest format of his YOLO version. Following the rules of YOLOv2, YOLOv3 has acquired an additional-thoughts from previous explorations, resulting in a beastly powerful incredible single-stage finder. YOLO v3 has made significant adjustments to the speed, accuracy, and unpredictability of execution. Moreover, it turns out (channel) and depth (layer) of BiFPN neck and detection head.

In 2019, Zhong-Qui Zhao [9], In the proposed system, the authors use the concept of deep learning using CNN networks. Find 3D object detection and video detection using Yolo weights, scaling, and cascading networks.

In 2020, D. Venkata Siva Prasad [10], Detect objects using frame difference and Kalman filter. This filter estimates the process state at a particular point in time and collects feedback in the form of measurements to create boundaries.

In 2020, Juncai Zhu [11], First, the method detects moving regions using a background correction method, and then combines this method with a lightweight YOLOv3 SOD network with high capacity for small target detection to determine the location of moving objects. Can be detected accurately. In conclusion, we use frame-to-frame object matching to retrieve the missing detections. Next, we developed the MDR105 dataset to verify the performance of the proposed algorithm. The MDR105 dataset contains a large number of videos and rich scenes, making it very valuable for motion detection research. The MDR105 dataset contains many videos and rich scenes.

In 2022, authors [12-13], Convolutional neural networks, regional convolutional neural networks, You Only Look Once, UNet and deep sort techniques are implemented for single-object and multiple-object detection. CNN is used for image processing, classification, and segmentation, and R-CNN is used to locate elements in images. YOLO is a neural network-based real-time object detection technology that can detect any object. The deep sort method is a tracking method used online that assigns bounding boxes to monitored objects.

III. RELATED WORK

Many different moving object identification methods have been reported in recent years. A strategy based on statistical backdrop modelling was recommended by Mahbub et al. To find moving objects, this technique compares each edge segment of the current frame with each edge segment of the background. However, this method is unable to identify a moving edge segment that crosses a backdrop edge segment. The authors attempt to develop a good motion detection system for critical sectors such as banks and businesses. They begin by taking sample images from a web cam that is recording images, then storing those images in a buffer to calculate the difference between the sampled images. When they detect movement, a counter is raised, and when it reaches a specific level, they transmit a message to a mobile phone indicating that movement has occurred and sound a buzzer. This paper discusses certain image processing techniques that we selected to use in our solution.

1. Computer Vision

Computer Vision (CV) is a subfield of computer science that focuses on giving computers the ability to understand visual data. Gerald Jay Sussman was given the task by Martin Minsky in the early 1970s or late 1960s to connect a computer to a camera and have the device report what it saw. The field of study known as "Computer Vision" (CV) strives to develop methods that will enable computers to "see" and

decipher the content of digital images such as pictures and movies. It appears to be simple since everyone, even very young toddlers, can figure out the computer vision problem. Despite this, the issue is still largely unresolved due to both a lack of knowledge on biological vision and the intricacy of visual perception in a dynamic physical universe that is practically infinitely changing.

2. Computer Vision VS AI

Studying computer vision focuses on making it easier for machines to see, as demonstrated in figure. It is a field of study that falls under the broad categories of machine learning and artificial intelligence, and it may make use of both specialized methods and general learning algorithms.

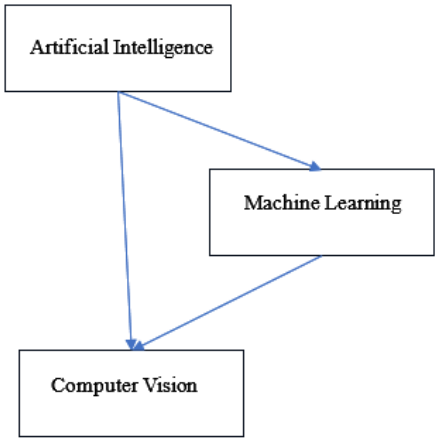

Figure-1: Computer vision and AI Correlation

3. Computer Vision and Image Processing

Computer Vision and image processing are not the same thing. The act of transforming an old image into a new one, usually by improving or streamlining the information is referred to as image processing in some contexts. It is a type of digital signal processing that does not care how images are interpreted. For a given computer vision system, image processing such as pre-processing images may be necessary.

Adjusting the photometric properties of the image, like color and brightness. Cropping the edges of an image, similar cantering an object in a picture. Eliminating digital noise from a picture, such as digital artifacts caused by poor light.

4. Motion Recognition

Motion detection can be used to trigger an automated task when it detects motion. Motion detection, for instance, can be used to activate lights in a room when someone walks in or to identify illegal activity in security systems. Many tools are available to detect motion, including software and hardware like infrared sensors (IR sensors) and picture processing methods. When a human body produces heat, it emits infrared radiation, which can be detected by an infrared sensor. Image processing allows motion to be recognized by comparing two photographs with one another. This is achieved by comparing pixels in the two images that are in the same spot. If the images are the same, then two pixels are the same. The pixel difference between some pixels will be larger than zero if the photographs are not identical. Differences in the pixels where humans are in a picture will show up when comparing an image of the same room with people in it with an empty image.

5. Open CV

A free software library for computer vision and machine learning is called Open CV (Open source Computer Vision Library). A major component of artificial intelligence is computer vision. Applications like photo editing, robotics, and self-driving cars all mostly rely on computer vision. An Android application subsystem called Open CV was designed for taking, analyzing, and processing images. The problems that had to be fixed to take a picture and ascertain whether movement had occurred were specified by the Open CV branch. A significant component of real-time operations, which are essential in today's systems, is currently played by Open CV, a sizable open-source library for computer vision, machine learning, and image processing. It can identify objects, people, and even handwriting in images and videos. When paired with additional libraries like Numpy, Python can process the Open CV array structure for analysis. on identify visual patterns and their different features, we use vector space and apply mathematical operations on these features. The collection has over 2500 optimized algorithms that encompass a wide range of traditional and advanced computer vision and machine learning methods. Image processing was

the main focus when Open CV was designed. When creating every function and data structure, the Image Processing coder was taken into account. However, Matlab is a general-purpose programming language. We can obtain almost anything in the world as toolboxes.

IV. EXISTING SYSTEM

This paper's major objective is to enable a basic camera that is attached to a general-purpose computer to identify objects moving through it and measure the duration of the object's stay in the camera's field of view. This software can therefore be used for monitoring. To start, you'll take the initial frame with a camera. We are going to start with this frame. To determine motion, the phase difference between the object's new frame and the baseline frame will be computed. The new frames will be called delta frames. Pixel intensity will then be used to adjust your delta frame. The revised frame will be called Threshold. After that, you will utilize sophisticated image processing methods to capture significant objects on the threshold frame, such as contouring, dilation, and shadow removal. This is an illustration of what you will achieve. It will be possible to note the timestamps of items coming into and going out of the frame. You will be able to choose the screen-on time as a consequence.

VI. PROPOSED SYSTEM

Our goal was to build a surveillance system that could capture photo as soon as motion was detected, send EMAIL messages to the user's phone, and detect motion in addition to informing the user of the incursion. To detect motion, we must first take real-time pictures of the region that will be watched and monitored. This is achieved using a camera that broadcasts a series of images at a predetermined frame rate. We compare the live photos from the camera to one another to determine whether motion is present in them. This allows us to identify changes in these frames and predict when motion will arise. For the user to see the frames as soon as possible, we must save them in memory if motion is detected. The ability to use video coverage as evidence in court helps the user prove inappropriate behavior in specific situations. The software contains an alert system since it recognizes motion and the user might want to get an EMAIL immediately informing them that the software has detected an intrusion.
This alarm system instantly generates an auditory alert signal in the wav file format if it detects motion of any kind. This helps to stop any security breech that might occur at that moment. When motion is detected, the user receives an EMAIL on their cell phone along with a location featuring the intruder's photos. We also give an alert sound to user when any motion is detected in environment using warning systems like buzzers etc. Often, pictures are only interested in specific areas of the study and application of images. These aspects are referred to as goals or foreground. Isolating the target from the rest of the image is the first step towards identifying and analyzing it. "Image segmentation" is the process of extracting the target of interest by splitting an image into sections, each with unique attributes.

The picture segmentation technique used in this work is called threshold segmentation. Specified otherwise, an image's range that is compared to the threshold and thereafter divided into two groups is defined by the grey scale image segmentation threshold. The backdrop subtraction approach makes use of the difference between the background image and the current image to detect moving targets. The essential idea is that the first frame image is preserved as a backdrop image. Subtracting the current image fk from the previously saved background image B yields the pixel to pixel on the moving target, or as the background pixel, if the pixel difference above the bound threshold.

A precise selection of the background subtraction threshold is necessary for successful motion detection. It is crucial that motion detection be accurate. Too low of a threshold value leads to many false change points; too high of a threshold limits the range of movement changes. The dynamic threshold should be selected because the appropriate threshold request considers the effects that cameras and scenes have on color wavelengths and variations in lighting. Background subtractions are utilized for motion detection in fixed cameras. Its benefits

include easy deployment, successful and speedy detection, and full feature data delivery of the target. The proposed motion detection and notification system has several advantages that contribute to its effectiveness and versatility. First and foremost, leveraging the power of Py Torch to integrate a pre-trained YOLO model increases the accuracy and adaptability of the system in recognizing different movement patterns. This deep learning approach enables the system to recognize complex scenarios and distinguishes it from traditional motion detection systems. Additionally, the system's real-time capabilities ensure instant response to detected movements and timely alerts and notifications.

Customization options such as motion detection thresholds and email settings allow the system to adapt to specific user needs and deployment scenarios.

Additionally, the combination of image processing technology and deep learning enables robust and accurate motion detection, providing a comprehensive solution for security and surveillance applications. In addition to audio alerts, the system's ability to send email alerts with image attachments for remote access increases flexibility and improves user awareness. Overall, the proposed system features the integration of state-of-the-art technologies and provides a reliable and intelligent solution for real-time behavior monitoring in various applications.

1. System Architecture

The system architecture of the provided Python code is designed to capture live video, detect objects using YOLO (You Only Look Once), monitor for object movement, and send email alerts when motion is detected.

It starts by continuously capturing video frames from a camera using Open CV. YOLO is utilized to identify objects within these frames, requiring pretrained YOLO weights and configurations. To alert the user, the code generates an audible alert using Sound Device and Sound File library. Then, an email alert is triggered, with the captured image attached, using the SMTP library.

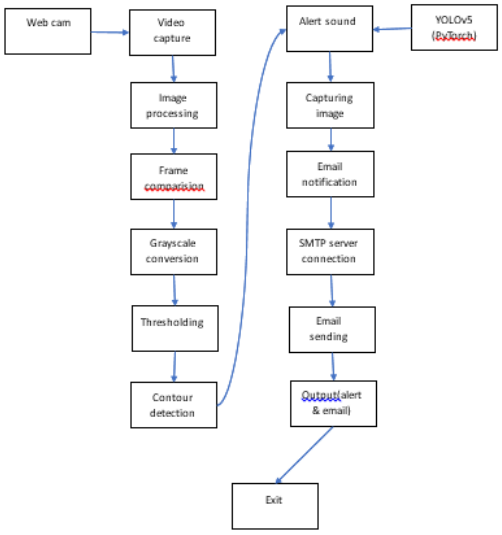

Figure 2: System architecture of Object Movement detection

2. Methodology

This methodology orchestrates advanced motion detection and notification systems by seamlessly integrating various methods. First, use Open CV's "cv2. Video Capture (0)" to initialize the webcam and establish a real-time connection for continuous image capture. "Py Torch's Torch. jit. load" uses his pre-trained YOLO model to add deep learning capabilities to the system, improving its ability to recognize complex movement patterns. It is possible to meet specific requirements by fine-tuning parameters such as motion detection threshold, notification email address, and alarm sound file path. The "send _email_ with_ image" method turns out to be the central component, making it easy to send email notifications with image attachments for remote access. At the same time, the "play_ alert_ sound" function incorporates an acoustic alarm to increase user alertness.

The core of motion detection lies in the complexity of the "Detect_ Movement" function. This function uses image processing techniques to detect motion through grayscale conversion, absolute difference calculations, and binary thresholding. The main loop constantly captures frames, converts them to Py Torch tensors, and uses the "Detect_ Movement "function for real-time motion detection. When motion is detected, the system cleverly captures a

snapshot, initiates an email notification, and plays an alert sound to alert the user instantly. The loop terminates gracefully by freeing system resources with cap. release() and cv2.destroyAllWindows().This carefully developed methodology combines image processing and deep learning, giving the system the advanced capabilities needed for efficient real-time behavioural monitoring and notifications in a variety of applications.

VI. RESULTS

When security is a worry, the "Smart webcam motion detection surveillance system" is a home or business security system that can be very helpful. Modern technology breakthroughs have led to a remarkable improvement in the methods employed by thieves and criminals to steal. Because of this, surveillance systems need to adapt to the way the world is changing. The most recent technologies used in the battle against theft and destruction are video surveillance and monitoring. With the use of technology, it is feasible to track and record every square inch of the area of interest. The most important feature of digital video surveillance systems is motion detection. It causes a large reduction in storage capacity by enabling the camera to only take pictures when necessary.

If motion is detected that is not predicted, an alarm can go off. As a result, employees are no longer needed to continuously monitor. The motion detector satisfies the need for an inexpensive, portable security system in daily life. In the future, computerized home security could advance significantly. With new technologies, the future seems bright and easier.

Figure-3: Web cam frame with plain background and no movement

The "detect_ movement" function compares the current frame to the previous grayscale frame to determine if there is a significant difference. If there is no significant difference (no movement detected), the function returns "Movement_ detected = False." If not movement is detected. The detect_ movement function checks if "movement_ detected" is "False", indicating no movement. If there is no movement, the code in this block is executed. The frame is then displayed with "cv2. im show('Frame', Frame)." The loop continues until the 'q' key is, then the camera is released and all The Open CV window is destroyed.

Figure 4: Web cam frame when objects movement is seen (produces alert sound and sends the captured picture)

The "Detect_ movement" function is called to determine if there is movement in the current frame. This function returns a boolean value 'movement_ detected' indicating whether motion was detected, if motion was detected it returns 'Detected_ Frame' for the frame itself, otherwise it returns 'None'. If movement_ detected is True (indicating that movement was detected), the code in the block after if Movement_ detected: is executed. It clicks on that movement detected frame image and uses cv2.imwrite to save it as "image.jpg". Use send_ email_ with_ image to send an email with the recognized image as an attachment. Play alert tone with play_ alert_ sound. After processing to detect motion (regardless of whether motion is detected), the code continues to display the current frame using cv2.imshow('Frame', Frame).This loop will continue to capture frames from the webcam until the 'q' key is pressed. When the loop ends (when 'q' is pressed), the camera is released and all Open CV windows are destroyed (cv2. Destroy Al l Windows ()).

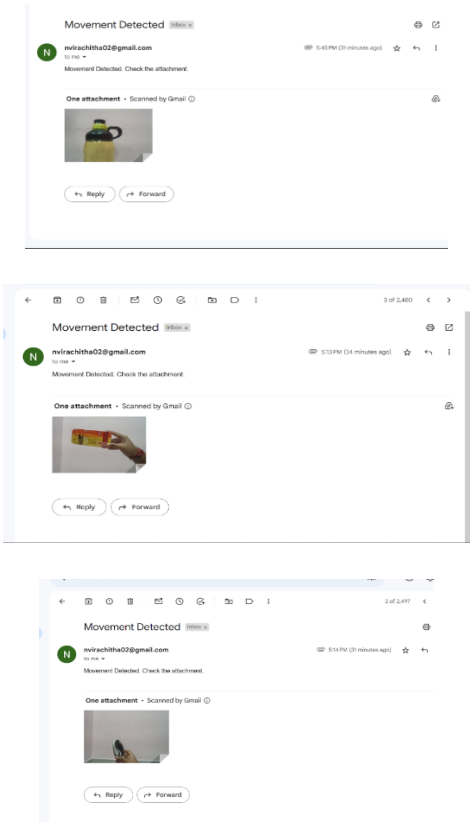

Figure 5: Images of the object movement is captured and sent via Email

When motion is detected, the code takes a snapshot of the webcam frame, sends an email with the snapshot, and plays an alert sound. These actions serve as a notification mechanism for detected movement. The loop then continues to capture and process subsequent images from her webcam.

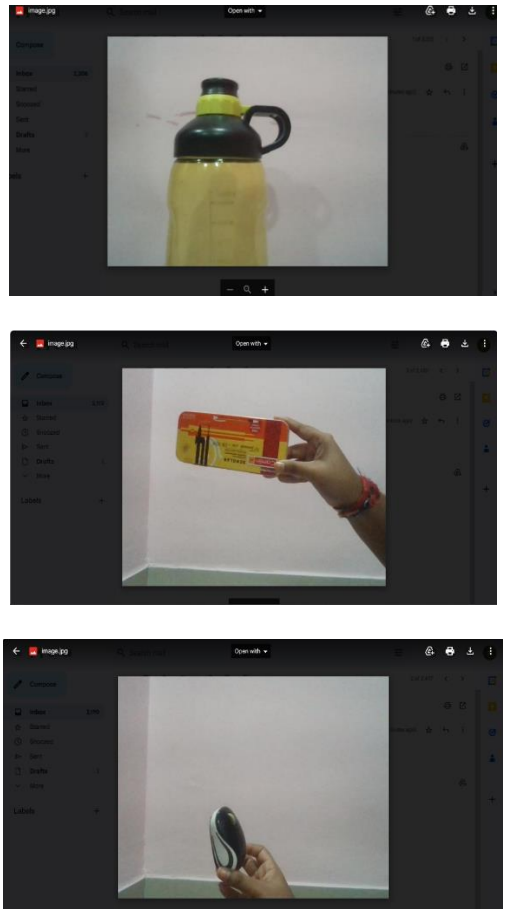

Figure 6: Picture attachment in Email can be easily downloaded or printed or saved in the users drive

In this case, the image sent via email serves as a visual record or notification of the detected movement. You can use the attached image to see the nature and context of the detected movement. Users can visually inspect the image to determine if it is a false positive or if further action is required. Images sent via email serve as documentation of detected events. This may be useful for historical reference, analysis, or reporting purposes. It is a practical approach to security and monitoring applications that allows users to receive instant notifications and take appropriate actions based on the visual evidence provided.

VII. CONCLUSION

In summary, our application shows what can be done with computer vision. For example, it can be used to create basic surveillance applications and more sophisticated AI integrated applications that can use machine learning to carry out tasks like object detection, emotion detection, facial recognition, and so forth. The newest technologies used in the battle against theft and destruction are video monitoring and surveillance. With the use of technology, it is feasible to track and record every square inch of the area of interest. The most important feature of digital video surveillance systems is motion detection. It allows the camera to capture only, when necessary, rather than all the time, resulting in a significant decrease in storage capacity. When unexpected motion is detected, an alarm can be activated. This relieves personnel from constant monitoring.

The motion detector fills the requirement for a low-cost, modest security system in everyday life. A Computerized home-based security has a lot of potential in the future. With breakthrough technologies, the future seems bright and easier. It allows the camera to capture only, when necessary, rather than all the time, resulting in a significant decrease in storage capacity. When unexpected motion is detected, an alarm can be activated. This relieves personnel from constant monitoring. The motion detector fills the requirement for a low-cost, modest security system in everyday life. A Computerized home-based security has a lot of potential in the future. With breakthrough technologies, the future seems bright and easier.

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