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Motion Detection Alarm System

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Abstract: *Motion detection is the process of identifying and tracking changes in the position of objects in a video sequence with alarm triggering. It allows us to detect when something moves in a given frame and can be incredibly valuable in various fields. The proposed system is recommended for security in both residential and commercial building applications. Traditional motion detection systems rely on passive infrared (PIR) sensors, which can be fooled by environmental factors such as sunlight and shadows. Background subtraction algorithms offer a more reliable and accurate solution for motion detection. The background subtraction algorithm for motion detection involves comparing frames to identify differences between them, highlighting areas with movement and generate alarm. It utilizes a background model, thresholding, and object detection. The system can be used to detect moving objects in a variety of environments, including homes, businesses, and public spaces. The main takeaway message of this study is that the system is a valuable tool for motion detection and alarm systems. Itoffers a more reliable and accurate solution than traditional PIR sensors, and they arenot susceptible to environmental factors that can fool PIR sensors*

Keywords: motion detection, alarm system, background subtraction algorithm, security, safety

I. INTRODUCTION

Within the realm of computer vision, a prominent and rapidly evolving field of research focuses on the analyzing humanactivity through video analysis has gained significant attention in recent times. Thissurge in interest is primarily driven by the remarkable advancements in computer vision technology and the accessibility of affordable hardware, particularly video cameras. The field of human motion analysis, in particular, has emerged as a focal point of research due to its potential for a wide range of applications, such as personal identification and visual surveillance.The core aim of motiondetection lies in the recognition of object motion within two consecutive images. This recognition plays a pivotal role in object identification. The primary research objective is the identification of pixels associated with the same object, contributing to enhanced object recognition capabilities. However, it is essential to acknowledge the fundamentalassumptions upon which this research is founded:

- A Well-Fixed Camera: Camera stability is paramount for isolating and accurately detecting motion.Stable Lighting Conditions: Ensuring that the lighting remains stable without flickering is critical for precise motion detection.
- Contrasting Background: A clear contrast between objects and their background aids in reliable motion detection.
- High Camera Frame Rate and Resolution: High-resolution images captured at a rapid frame rate are essential for capturing fine-grained motion details.

Motion analysis of the human body has a broad range of applications, including physical performance assessment, medical diagnostics, and virtual reality. In the realm of moving object detection, several techniques are utilized, with the optical flow method, background subtraction method, and frame subtraction method being the most prevalent.

The optical flow method calculates the optical flow field within an image,allowing for a comprehensive detection and distinction of moving objects from the background. On the contrary, the background subtraction method relies on identifying the discrepancies between thecurrent image and a reference background image to detect moving objects.

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However, this method, despite its simplicity, is susceptible to environmental changes and lacks robustness in the presence ofinterference.

The frame subtraction method determines the presence of moving objects by calculating the disparity between two consecutive images. Nonetheless, any motion detection system relying on background subtraction must address critical challenges, such as image noise from low-quality sources, variations inlighting conditions, and the detection of small movements from non-static objectsline waveying tree branches.

In the realm of motion detection systems employing background subtraction, several pivotal challenges must be addressed. These include combating image noise that often arises from subpar image sources, navigating gradual variations in scene lighting conditions, discerning minor movements in non-static objects likeswaying tree branches, and the intricacies associated with shadow regions. Thesecomplexities underscore the importance of developing robust algorithms that can effectively differentiate genuine motion from these confounding factors in real- world scenarios.

The principal objective of this research isto develop an algorithm capable of detecting moving objects at specific distances, particularly for object tracking applications. This paper is organized as follows: Section 2 provides a comprehensive literature survey, Section 3 delves into the specifics of moving object detection, Section 4 presents experimental results, and Section 5 concludes the paper. The references are listed at the end of the document.

II. LITERATURE SURVEY

Motion detection is a critical component in various applications, including surveillance and computer vision. Several studies and surveys have explored different techniques to address the challenges and improve theefficiency of motion detection. In this literature review, we examine some of the significant contributions related to motion detection, which align with the objectives and methodology of our "Motion Detection Alarm System."

Wang and Zhao[1]: BackgroundSubtraction Technique

Wang and Zhao proposed a motion detection approach based on background subtraction. They focused on video sequences containing geometry information of the target, extracting relevant data to analyze motion and achieve detection results. This technique effectively improvedcompression ratios, which can be vital in motion detection for storage and transmission efficiency.

Rakibe and Patil[2]: BackgroundSubtraction Algorithm

Rakibe and Patil presented a motion detection method based on the background subtraction algorithm. They initially established a reliable statisticalbackground model and then conducted subtraction between the current image and the background image using a threshold. This approach enabled the detection of moving objects. To enhance accuracy, morphological filtering was applied to eliminate noise and address background interruption challenge.

Kavitha and Tejaswini[3]: RobustBackground Subtraction

Kavitha and Tejaswini aimed to overcome the limitations ofbackground subtractionalgorithms. Their work introduced a robust and efficiently computed background subtraction algorithmcapable of handling issues related to local and global illumination changes, including shadows and highlights. This approach contributes to more accurate motion detection in variouslighting conditions.

Shafie et al.[4]: Motion Detectionwith Optical Flow

Shafie and colleagues presented a motion detection method usingthe optical flow technique. Optical flow provides valuable insights into the spatial arrangement of objects and theirrelative motion. By detecting discontinuities in the optical flow, the method efficiently segments images into regions corresponding to different objects, enhancing the precision of motion detection

Shuigen et al.[5]: Temporal Differenceand Optical Flow Field

Shuigen and the team developedmotion detection by combiningtemporal difference and opticalflow field techniques. This approach demonstratesadaptability to dynamicenvironments. It involves calculating an absolute differential image from consecutive gray images, filteringit with a low-pass filter, and converting it into a binary image. Optical flow fields are also used to identify moving object areas.

Devi et al.[6]: Motion Detection Using Frame Matching

Devi and colleagues proposed a motion detection method based on background frame matching. This technique efficiently compares pixel values between subsequent frames captured at two-second intervals. By comparing a reference frame with an input frame containing the moving object, differences in pixel values are determined, allowing for accurate motion detection.

Lu et al.[7]: Real-time DetectionAlgorithm

Lu and the team presented a real- time motion detection algorithm that integrates temporaldifferencing, optical flow, double background filtering (DBF), and morphological processingmethods. This comprehensiveapproach enhances the performance of motion detection, offering real-time and reliable results.

These research contributions provide valuable insights into motion detection techniques, including background subtraction, optical flow, and frame matching. Our "Motion Detection Alarm System" leverages some of these methodologies, incorporating the Frame Differencealgorithm and libraries such as OpenCV and winsound to create an efficient, user-friendly motion detection solution with applications in security and surveillance.

III. MATERIAL AND METHODS

Motion Detection using Frame Difference Algorithm and Graphical User Interface (GUI)

In the implementation of our "MotionDetection Alarm System," we have combined the Frame Difference algorithm with a user-friendly graphical user interface (GUI) created using the tkinter library. Additionally, the project utilizes various libraries, such as OpenCV forimage processing, Pillow for image handling, and imutils for utility functions.

Frame Difference Algorithm:

The core of the motion detection system is the Frame Difference algorithm, a widely recognized method for identifying moving objects within a sequence of frames captured by a static camera. This algorithm compares the intensity of each pixel in consecutive frames to discern differences. The absolute differential image, denoted as Id(k, k+1), is computed as per the following formula:

$$Id(k, k+1) = |Ik+1 - Ik| \quad (1)$$

Transformation to Gray Image:

The absolute differential image often presents gaps within moving object areas, and their contours may not be entirely closed. To facilitate subsequent operations, we transform the absolute differential image into a grayscale image using the formula:

$$Y = 0.299*R + 0.587*G + 0.114*B \quad (2)$$

Filtering and Binarization

To address holes and irregularities within the grayscale image, Gaussian low-pass filtering is applied using the OpenCV library. The resulting filtered image, denoted as Id1, is then binarized using a binary thresholding method. This binary image, Id2, serves as basis for the detecting motion:

$$Id2(x, y) = \quad (3)$$

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Motion Detection andAlarm Trigger

When the system is in motion detection mode, it continually captures frames from the camera. If a significant change is detected in the binary image Id2, indicating motion, the system triggers analarm. The alarm is manifested through the win sound library, which produces a series of beeps. The system's alarm trigger sensitivity is governed by an alarm counter, which accumulates when motionis detected. The alarm is triggered when the counter surpasses a predefined threshold, indicating sustained motion.

IV. EXPERIMENTAL RESULT

The following figures display the outcomes of image sequences generatedusing this method

Below figures shows the difference ofimages when there is no movement in given frames

In cases where the image sequences exhibit no motion, the comparison between the two images results in a black binary output image, indicating that there is no variation in a singlepixel

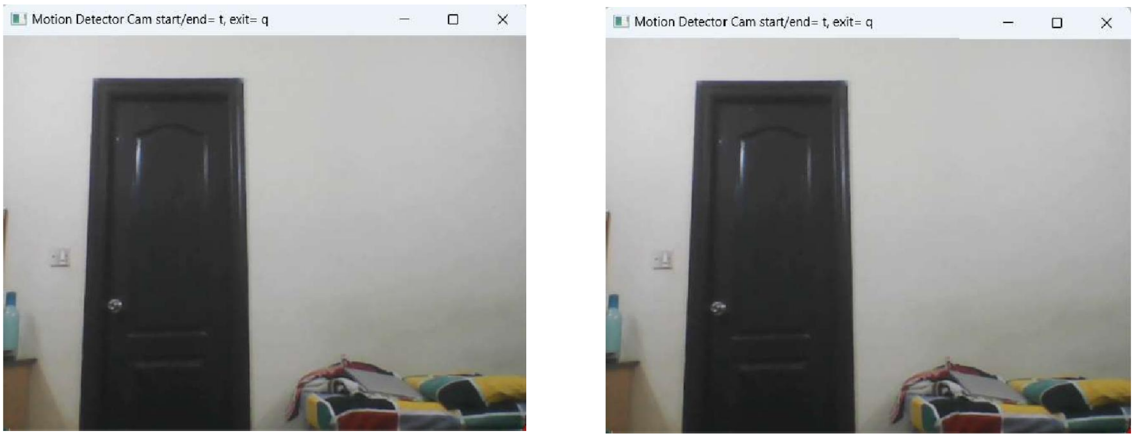

Fig 1: Input first frame(a)(b)

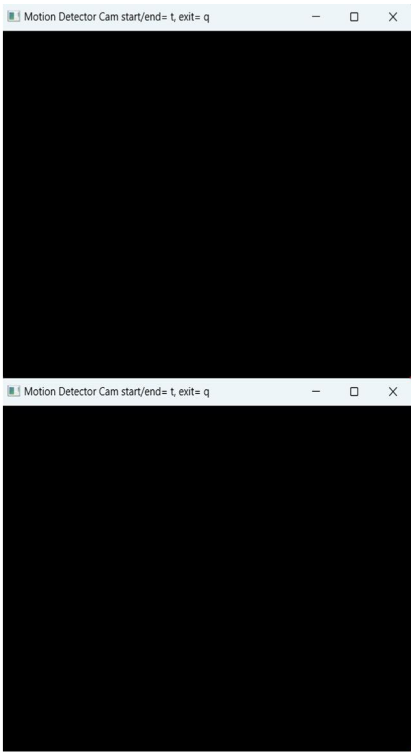

Fig 2: Difference between two frameshowing

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When there is movement in the frame :

In scenes with motion, the binary image that represents the difference between two frames displays the moving elements in white, while areas with noalterations appear in black.

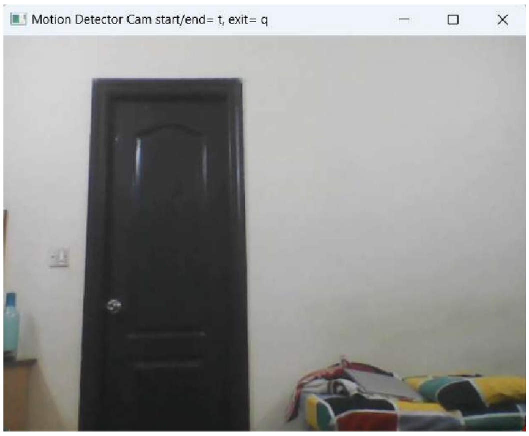

Fig 3: Input first frame(a)

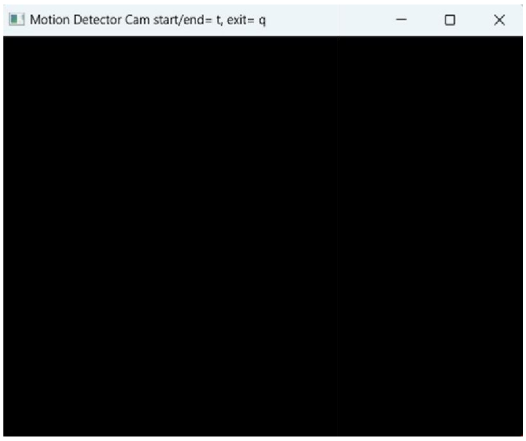

Fig 4:Output Of First frame(a)

Fig 5: Input Second frame(b)

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Fig 6:Difference between two frameshowing moving object

Flowchart:

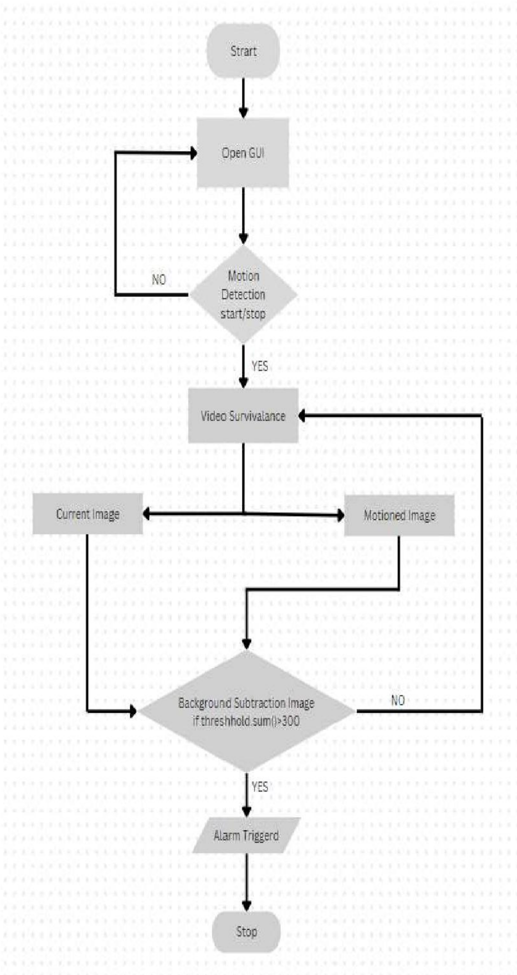

Fig 7: Flowchart

In this video processing workflow, the initial step involves initializing the first frame and subsequently reading the next frame. The option to resize the frame is presented, followed by the possibility to convert the frame to grayscale. If the first frame is None, it is initialized. The core operation is then performed by calculating the absolute difference between the current frame and the first frame, and this result is thresholded to create an image delta.

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Contours are then identified thresholded image.
If there are any detected contours, an alarm is triggered, and a rectangle is drawn around the largest contour found. The frame is then displayed for real-time observation. To conclude the process, the user has the option to press 'q' in order to quit. If 'q' is indeed pressed, the video capture is released, and all open windows are closed, marking the end of the procedure. This workflow is commonly used in tasks such as motion detection and surveillance systems.

Graphical User Interface (GUI) :
The provided code snippet creates a graphical user interface (GUI) using Tkinter in Python for a motion detection system dashboard. It consists of various elements organized in a visually appealing layout. At the top, there's a dark blue bar displaying the title "Dashboard" and the current date. Just below it, a canvas section is designated for the main toolbar, featuring a "Motion Detect" button with an associated image and a label describing the system. A separate canvas is reserved for the console, where system messages will be displayed. It is styled with a black

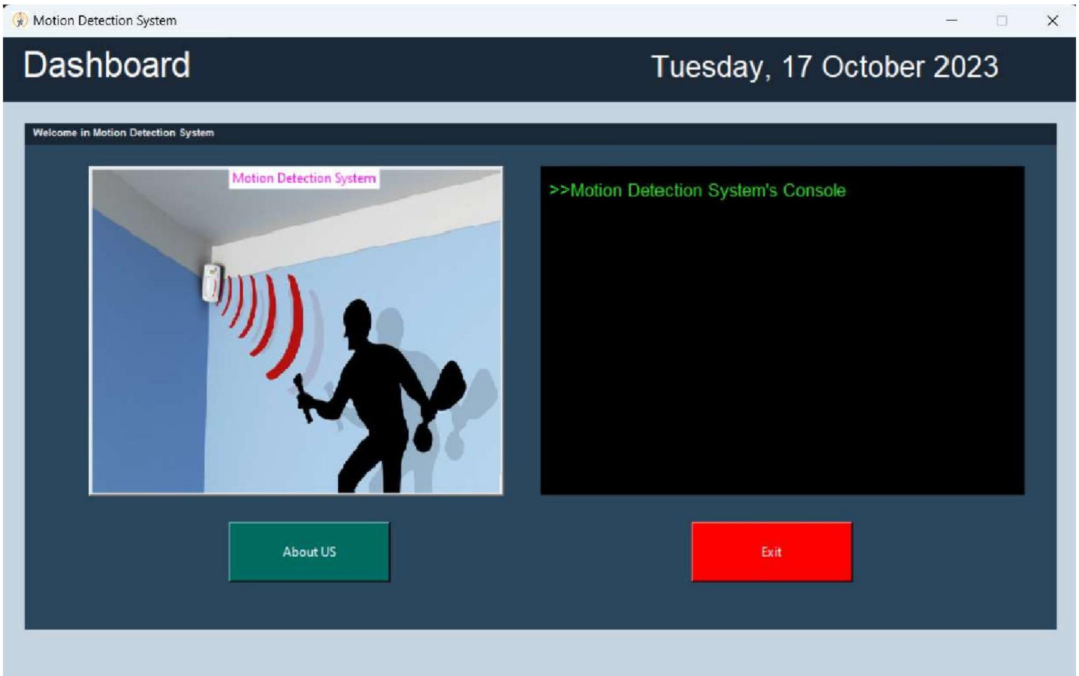

Fig 8 :Graphical User Interface Of motion Detection Alarm System

Limitations :
The proposed method is capable of detecting motion caused by air movement. When the air is in motion, the camera is no longer in a static position. Consequently, even when there is no movement of objects, this can lead to motion detection and result in gaps in the binary output image

Fig 9: *Input Frame (1)*

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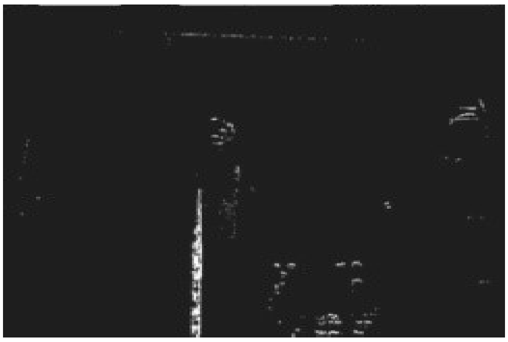

Fig 10: Binary difference between the two frames showing holes

V. CONCLUSION

In our current research, the detection of moving objects is accomplished through the integration of the frame difference method and morphological operations. The central focus of our work revolves around comprehending the principles underlying the frame difference method and addressing associated challenges. Our experimental findings underscore the effectiveness and efficiency of this method. Looking ahead, potential enhancements may involve implementing user alerts through multimedia SMS, email notifications, or the live streaming of captured video for added functionality and utility.

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