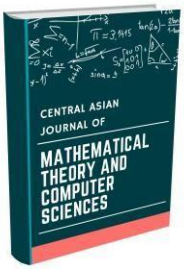

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Article

Pioneering Advanced Face Security System Using AI- Deep Learning Techniques

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Abstract: Computer vision is an important part of computer science that helps make machines smart and intelligent by detecting and analysing digital images and movies. One major use of this is activity recognition, which automatically sorts the actions an agent is doing. The goal of suspicious activity recognition is to determine what someone is doing by analysing a sequence of observations, taking into account various challenging situations. When the motion detection and tracking features of the surveillance system are activated, the user or owner receives an email. One of the most challenging tasks in computer vision and artificial intelligence research is identifying YOLO3 and CNN objects in both structured and unstructured settings. Video surveillance is very important in today's environment. When artificial intelligence, machine learning, and deep learning were added to the system, the technologies became too advanced. Distinct systems are set up using the combinations above, which help distinguish between distinct suspicious behaviours via live tracking of footage. Human behaviour is the most unpredictable, and it's hard to tell if it's normal or suspicious. In an academic setting, deep learning is used to find normal or suspicious activities. If it detects something suspicious, it sends an alarm message to the relevant person. Monitoring is generally done by taking consecutive frames from the video and using them. There are two key components to the overall structure. The first section calculates the features from the video frames, and the second part uses those features to classify the class as suspicious or normal.

Keywords: Technological Advances, Human-Computer Interaction, AI and Deep Learning, Real-Time Data Analysis, Closed-Circuit Television (CCTV), Public Safety and Security

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1. Introduction

Automated human activity recognition has become a prominent research topic in recent years, driven by rapid technological advancements. Video surveillance has several applications [23]. Some of these uses are normal, while others are worrisome, such as gaming, interacting with computers, watching exams, finding turmoil, analysing sports, and forecasting how people will act in crowds, among others. It is a crucial safety feature for both indoor and outdoor spaces [32]. Innovations are happening quickly, and there is too much video data to process manually, which is impractical and can lead to errors [42].

Additionally, it is quite challenging to constantly monitor public places [34]. Therefore, smart video surveillance that can track people's movements in real-time, categorise them as normal or unusual, and provide alerts is necessary [48]. Sensors like radar, cameras, and cell phones are used to find strange behaviour in people. They are being utilised for security purposes, such as monitoring suspicious activity, interacting with computers, and surveillance of individuals. Most of the systems we use today depend on video from CCTV cameras [27]. Use this for any task that requires immediate action. We utilise YOLO and RCNN here to detect objects. Yolo can see 49 pictures at once [38]. Convolutional neural networks (CNNs) and YOLO (You Only Look Once) are two common methods used for object detection. The CNNs belong to the CNN family, whereas YOLO belongs to the single-shot detector family. Object detection is one of the most effective methods for identifying any object. Twilio software integration enables authorities to be notified promptly when criminal activity is detected, enhancing responsiveness and efficacy in maintaining safety and security across various settings [43]. These devices use sensors, such as cameras and radar, to detect unusual behaviour in people.

The Existing system is a significant step forward in facial security, as it utilises advanced AI and deep learning algorithms specifically designed for face recognition [29]. This system excels at recognising faces in still images and old video recordings because it utilises advanced deep learning algorithms. The system also goes beyond just recognising faces by using machine learning techniques to predict which crimes are likely to occur [36]. It utilises historical crime data to make predictions about potential criminal events, aiding in the development of proactive crime prevention plans. Even with these clear strengths, the current system has two major problems: it can't detect faces in real-time, and it cannot determine the crime rate as it occurs [41]. These constraints make it more difficult for the system to respond quickly to security risks and prevent crimes before they occur.

As a result, it is crucial to incorporate real-time detection and crime rate identification features into the system [44]. To address these issues, our proposed improvements centre on incorporating real-time face identification systems and refining crime prediction algorithms to enable the system to quickly analyse and respond to events as they occur [39]. For the system to respond quickly to security risks in changing surroundings, it must be able to detect faces in real-time. The system will be able to detect faces in live video broadcasts using cutting-edge computer vision methods, such as Haar cascades, YOLO, or SSD [47]. This will make it easier to quickly find possible security threats.

Additionally, it is essential to enhance crime prediction capabilities by incorporating real-time data processing, enabling proactive intervention in criminal activities [21]. The system can learn about current events and update its predictive models using real-time data streams from various sources, including social media, CCTV cameras, and police records. This real-time study will help police departments better prepare for and address emerging threats [25]. The problem statement highlights two significant challenges afflicting the existing surveillance system: Late detection of strange behaviour. Even though many people utilise Closed-Circuit Television (CCTV) systems for security, the way they are currently set up typically doesn't work well enough to catch suspicious behaviour quickly [33]. CCTV footage is very useful for identifying criminals after a crime has been committed. Still, it usually doesn't function as an early warning system that can prevent crimes before they happen [28]. This delay in detection renders the system less effective in preventing crimes before they occur and mitigating their impact on public safety and security [45].

Data management that requires a lot of work: The existing system heavily relies on storing surveillance data in a standardised format, which means that security risks must be manually checked all the time [31]. To identify suspicious individuals or activities, this labour-intensive approach requires someone to review a large amount of footage [46].

This method is time-consuming and costly, and it also increases the likelihood of mistakes, which can result in delayed responses to security incidents and gaps in surveillance coverage. To make the surveillance system work more effectively, it is crucial to address these two primary issues [22]. We can significantly enhance public safety and ensure that security risks are addressed promptly by implementing tools that facilitate the early detection of suspicious behaviour and the more efficient management of surveillance data. To address the issue of late identification of suspicious activity, new methods such as real-time video analytics and enhanced motion detection algorithms can be employed [40]. These technologies enable surveillance systems to autonomously identify and notify authorities of anomalous behaviours or occurrences in real time, facilitating immediate intervention before the escalation of a security breach.

Additionally, utilising artificial intelligence (AI) and machine learning algorithms can enhance the system's predictive capabilities [35]. This enables it to identify trends and abnormalities in the surveillance data and address new security concerns before they occur. Additionally, since managing data requires considerable effort, we must utilise automated surveillance systems and intelligent video management systems [26]. These systems use complex analytics and metadata tagging to sort and rank surveillance material. This makes it easier for people to monitor security feeds more effectively [37]. These technologies free up staff to focus on critical security activities and respond quickly to incidents by automating routine tasks, such as reviewing footage and identifying anomalies [30]. We can enhance the effectiveness and responsiveness of the surveillance system in protecting public safety and security by addressing the issues of slow identification of suspicious activity and labour-intensive data administration. By utilising new technology and streamlining processes, we can transform the way surveillance operates [24]. This will allow us to take action before security concerns happen and make the world a better place for everyone.

Literature Survey

The study likely begins with an introduction that highlights the importance of surveillance systems in today's world, particularly in densely populated cities [4]. It discusses the challenges associated with monitoring busy areas and emphasises the importance of identifying suspicious activities promptly to prevent potential security issues. The authors then discuss their research methodology, which likely involved developing and applying algorithms or methods to analyse surveillance data [17]. This might involve using computer vision and machine learning to identify unusual behaviours, such as sudden movements, lingering, or leaving items behind in crowded areas [15]. In general, the study provides useful information on how to identify and analyse suspicious human behaviour in crowdsourced surveillance videos [11]. The results section typically presents the study's findings, including the accuracy of detecting suspicious activity and any issues that arose during the analysis.

A thorough examination of the identification and monitoring of dubious motions, human actions, and objects, in conjunction with fire detection, employing CCTV cameras [6]. This multidisciplinary study combines computer vision, machine learning, and fire detection methods to improve the effectiveness of surveillance systems in maintaining public safety and security. The article likely begins with an introduction that discusses the importance of surveillance systems in today's world and the challenges associated with monitoring and protecting public spaces. It emphasises the need for innovative technologies that can detect and respond to suspicious activity in real-time, with CCTV cameras being the primary tool for video surveillance [1]. The authors then provide detailed descriptions of the methods they employed in their research, which likely involved creating and utilising algorithms or strategies to identify and track suspicious movements, individuals, objects, and fire incidents in surveillance footage [14]. This might involve using computer vision algorithms to examine images, find objects, analyse motion, and find fires. The document provides valuable information on how to utilise CCTV cameras to detect and track suspicious movements, individuals, objects, and fires.

In this study, the authors examine diverse strategies and procedures used in creating an effective system for identifying suspicious behaviour in surveillance footage. Video surveillance is becoming an increasingly essential tool for maintaining safety and security in various locations, including airports, retail malls, banks, and city streets [18]. However, the sheer volume of video data generated by surveillance cameras makes it extremely challenging to watch and analyse in real-time. Traditional manual monitoring is not only time-consuming, but it is also makes mistakes and becomes tired [2]. Consequently, there is an increasing demand for automated systems that can identify unusual behaviour and notify security personnel without delay. The report also discusses how to categorise activities based on the attributes extracted from them. Deep learning models and other machine learning techniques have become quite useful for classifying activities in surveillance films [12]. The authors explore the utilisation of convolutional neural networks (CNNs) and recurrent neural networks (RNNs) for SAR, emphasising their capacity to autonomously learn distinguishing characteristics from raw video data and generate precise predictions [10]. In conclusion, the study provides a comprehensive overview of the most effective methods and strategies for recognising suspicious activity in video surveillance systems [20]. The authors establish a foundation for future studies in this vital domain of computer vision and security by addressing technical challenges, ethical dilemmas, and practical concerns.

Problem Statement and Proposed Solution

The current model of surveillance systems primarily uses Closed-Circuit Television (CCTV) to review events after they occur, rather than detecting suspicious behaviour in real-time [19]. This reactive strategy has big problems when it comes to stopping crimes because it can't quickly find and report suspicious behaviour to the police [7]. Additionally, current systems store data in record formats, which requires personnel to constantly monitor them, resulting in a significant workload and potential for error. Therefore, there is a pressing need for a more effective surveillance system that not only detects crimes as they occur but also facilitates the analysis of data to enhance proactive security measures [13].

Our proposed solution leverages cutting-edge technologies in activity recognition and real-time alerting to address the issues with standard surveillance systems [8]. The system uses both sensor-based and vision-based activity detection technologies to fully monitor and analyse the environment. Using modern machine learning, deep learning, and data analytics techniques, sensor data from many sources is combined and processed to find useful information. The system also uses a camera-based method and the YOLO v3 algorithm for recognising activities based on vision [9]. The system can properly identify and classify actions occurring in the monitored area by processing and analysing video data in real-time. To make the system more responsive and useful, we add Twilio software, which sends rapid notifications to the police station and other necessary authorities when it detects criminal activity [16]. This seamless integration enables a rapid response and facilitates proactive measures to prevent crime, thereby significantly enhancing safety and security in the monitored area [3]. In general, our proposed solution is a comprehensive and proactive approach to surveillance. It addresses the issues with current systems by integrating advanced activity recognition techniques with the capability to deliver real-time alerts.

System Architecture & Design

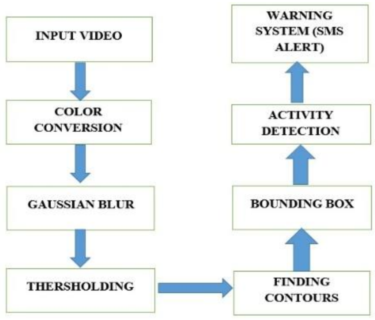

Figure 1. Use Case Diagram.

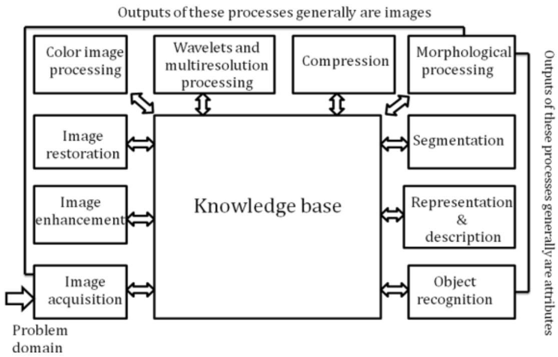

Figure 2. Sequence Diagram.

2. Materials and Methods

One technique to send video over the Internet is through video streaming technology. Streaming technologies enable the transmission of audio and video over the Internet to millions of users who access their personal computers, PDAs, mobile phones, or other devices that support streaming [67]. Here are some reasons why video streaming technology is growing: Broadband networks are being set up. More efficient are video and audio compression methods. The quality and diversity of audio and video services available on the internet are continually improving [89]. There are two main techniques to send audio and video over the Internet:

Download mode: The content file is fully downloaded before it is played [103]. This approach takes a long time to download the complete content package and needs space on your hard drive (Figure 1). In streaming mode, you don't have to download the entire content file; it plays as parts are received and decoded (Figure 2).

Pre-processing is a term that refers to working with images at the lowest level of abstraction, where both the input and output are intensity images. The goal of pre-processing is to enhance the image data by removing undesired distortions or highlighting certain visual elements that are relevant for future processing [71]. Our proposed approach utilises a deep learning network to detect suspicious activity in video surveillance. Deep learning architectures can provide more accurate results and work better with large datasets. Figure 3 shows a full design overview. The input movies are from existing datasets or those that have been created. As part of pre-processing, the recorded videos are broken down into individual frames [102]. Three labelled folders are created based on the videos, and the frames are placed inside them. The entire video is divided into 7,035 frames, and each frame is saved as a JPEG photo. After that, each frame is adjusted to 224 × 224 to fit the 2D CNN architecture and saved. The testing video is also split into frames, scaled to 224 × 224, and put in a folder [5]. The OpenCV library in Python is used to get videos ready for processing.

Blob Detection

Blob detection methods in computer vision look for areas in a digital image that differ from the surrounding areas in terms of brightness or colour [66]. A blob is an area of an image where some properties stay the same or are close to the same. In a blob, all the points can be thought of as being identical in some way. Convolution is the most common method for detecting blobs. There are two main types of blob detectors: differential methods, which use the function's derivatives with respect to position, and methods based on local extrema, which find the function's local maxima and minima [88]. In more contemporary terms, these detectors can also be referred to as interest point operators or interest region operators (see also interest point detection and corner detection). There are several reasons to investigate and improve blob detectors [49]. One primary purpose is to provide more information about areas that edge detectors and corner detectors cannot detect.

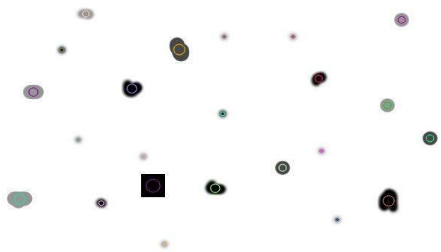

Figure 3. Blob Detection.

Darknet

The architecture it builds on is known as the dark net. The initial author of the Yolo study built a neural network architecture that splits a picture into a grid of cells. For each cell, it predicts bounding boxes, confidence scores, and class probabilities [56]. That means that we can separate whatever we observe into objects and buildings on the outside by applying these properties. This one is the best for categorising the picture correctly [90]. It makes everything clearer. We can also see more things in videos and pictures. For real-time applications, this will work with a web camera. These detect the most features in a face. This will be achieved through the classification of each pixel. C++ and Python are used to write it [72]. For this method, we're using the Caffe model dataset. It has taken the four steps. They are

Data Preparation: In this stage, you clean up the image and save it in a format that Caffe can use [101]. We will develop a Python script that will do both pre-processing and storage.

Model Definition: In this step, we choose the CNN architecture and set the parameters in a configuration file with the extension (Figure 4).

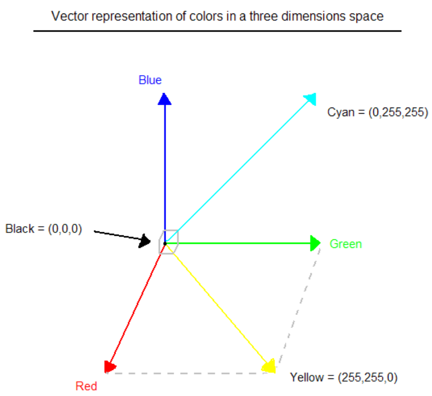

Figure 4. Vector representation of colours in a three dimensions space.

Deep Learning Classification

Deep learning is a type of computer software that works like the brain's network of neurons. It is a part of machine learning and is named deep learning because it uses deep neural networks. The layers in between are called "Hidden Layers." Deep denotes that the network connects neurons in more than two levels [87]. Neurons make up each Hidden layer. The neurons are linked to one another. The neuron will process the input signal it receives from the layer above and then pass it on to the next layer [73]. The weight, bias, and activation function determine how strong the signal is that the neuron in the following layer gets. The network processes a large amount of data through several layers. At each layer, the network can learn more complicated things about the data.

Types of Neural Networks: Shallow neural network: The Shallow neural network contains one hidden layer between the input and output. Deep neural network: A deep neural network has more than one layer. For example, the Google LeNet model for recognising images has 22 layers. Deep learning is being applied to a wide range of applications today, including driverless cars, mobile phones, Google Search, fraud detection, TVs, and more [91].

Feed-forward neural networks

The easiest kind of artificial neural network. This type of architecture only allows information to flow in one direction [86]. The flow of information starts at the input layer, proceeds through the "hidden" levels, and ends at the output layer. There is no loop in the network [100]. The output layers are where information terminates.

Recurrent neural networks (RNNs)

RNN is a neural network with many layers that can store information in context nodes [70]. This allows it to learn data sequences and return a number or another sequence. It's an artificial neural network with loops in the connections between neurons. RNNs are good at handling sequences of inputs. For example, if the job is to guess the following word in the sentence "Do you want a...?" The RNN neurons will receive a signal indicating where the sentence begins. The network takes the word "Do" as input and makes a vector of the number. The neuron gets this vector back so that the network can remember things. This step helps the network remember that it got "Do" and that it got it first. The network will also go on to the next words. It takes the words "you" and "want." Every time a word is received, the status of the neurons changes [55]. The last step happens when you get the letter "a." The neural network will give each English word that can finish the sentence a chance. A well-trained RNN probably gives a high chance to words like "café," "drink," "burger," and so on.

Common uses of RNN

Help stock traders make reports that analyse their trades. Find problems in the financial statement contract. Find fake credit card transactions. Give pictures a caption, Power Chatbot [92]. When people work with time-series data or sequences, such as audio recordings or text, they usually employ an RNN.

Convolutional neural networks (CNN)

CNN is a type of neural network with a unique structure that enables it to identify increasingly complex aspects of the data at each layer, ultimately determining the output [85]. CNNs are great for jobs that involve perception. When there is unstructured data (such as photos) and people using CNN need to extract information from it, it is mostly utilised. For example, if the job is to guess what an image caption is, the CNN gets an image of a cat. In computer terms, this image is a collection of pixels [65]. One layer for the black-and-white picture and three layers for the colour picture. During feature learning, which occurs in the hidden layers, the network identifies unique traits, such as a cat's tail or ear. Once the network has fully learnt how to detect a picture, it can give each picture it knows a chance. The network's forecast will be the label with the highest chance [74].

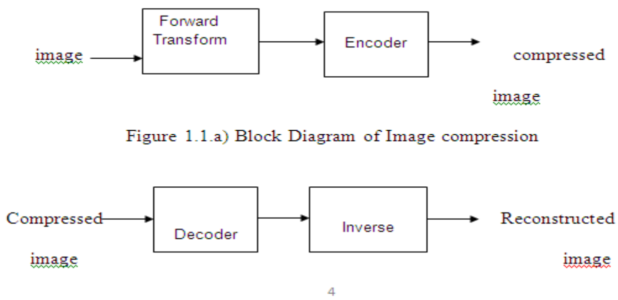

Figure 5. Image Compression.

Reinforcement Learning

Reinforcement learning is a type of machine learning in which computers learn by getting virtual "rewards" or "punishments." This is like learning by doing things wrong and then doing them right [64]. DeepMind, a Google subsidiary, has utilised reinforcement learning to beat a human champion in Go [57]. Video games also employ reinforcement learning to enhance the experience by providing players with smarter bots. Q-learning, Deep Q-network, State-Action-Reward-State-Action (SARSA), and Deep Deterministic Policy Gradient (DDPG) are among the most well-known techniques (Figure 5).

3. Results and Discussion

Testing of the results

Test1

Input: Package installation and loading of packages

Output: Successfully installed packages and loaded packages

Test2

Input: Start the input process with live video

Output: Started video streaming with live video

Test3

Input: Apply pre-process to the input video

Output: Done proper pre-processing with the resizing of the video

Test4

Input: Apply blob to find area

Output: Successfully got the area of each object

Test5

Input: Apply the algorithm and find the object

Output: Successfully found objects using deep learning

Existing methods

Object detection is the process of locating and recognising real-world objects, such as cars, bikes, TVs, flowers, and people, in pictures or movies [54]. An object detection technique helps you understand the specifics of an image or video by allowing you to find, recognise, and locate multiple items within it [93]. People commonly use it for tasks such as image retrieval, security, surveillance, and advanced driver assistance systems (ADAS). There are various techniques to accomplish object detection [63].

a. Feature-Based Object Detection
b. Viola Jones Object Detection
c. SVM Classifications with HOG Features
d. Deep Learning Object Detection

Disadvantage

a. Poor detection of objects
b. Fewer objects will be detected
c. Not getting a proper accuracy result
d. It can't work as a real-time video surveillance camera

Proposed Method

Depending on the parts of the system, activity recognition can be split into two groups: sensor-based activity recognition and vision-based activity recognition [94]. It may be necessary to integrate and combine data from multiple sensors to obtain important information. They are also used to teach the model how to apply different machine learning, deep learning, and data analytics techniques.

Vision-based activity recognition may use a camera-based system to find activities in an environment by processing and analysing video. These systems often employ digital image processing to extract useful information from video, which is represented as a series of images [75]. We employed a vision-based system using the Yolo v3 algorithm for this project.

Advantages

a. More object detection done with yolo
b. More accuracy with more gathering features.
c. Using yolo object detection is very fast.
d. Less time is required for object detection.

Block Diagram

Modules

Video streaming: One way to send video over the Internet is through video streaming technology. Streaming technologies enable the transmission of audio and video over the Internet to millions of users, who access these media on their own computers, PDAs, mobile phones, or other streaming devices [83]. Pre-processing: In this phase, we need to simplify the picture. Using resize and convert to make a license plate. We can adjust the size of the license plate by using these pre-processes.

Blob detection: A blob is a group of pixels in a picture that are related and have something in common, like their grayscale value [62]. The dark connected areas in the picture above are blobs. The purpose of blob detection is to find and mark these areas. Learning deeply: A Convolutional Neural Network, or CNN, is a sort of artificial neural network that is commonly used for recognising and classifying images and objects. So, Deep Learning uses a CNN to identify objects in an image.

The "You Only Look Once" (YOLO) family of models is a group of end-to-end deep learning models developed by Joseph Redmon and others, designed to quickly detect objects. The original one was called "You Only Look Once: Unified, Real-Time Object

Detection." Use post-processing methods on the model's results [68]. For instance, you may use non-maximum suppression or temporal smoothing on the findings for video sequences.

Neural networks with convolution [95]. It may seem like a strange mix of biology, arithmetic, and a bit of computer science, but these networks have had a profound impact on the field of computer vision. Alex Krizhevsky utilised neural nets to win the ImageNet competition in 2012, which was like the Olympics of computer vision [58]. This was the first year that neural nets became well-known. He dropped the classification error rate from 26% to 15%, which was a huge improvement at the time. Since then, several businesses have incorporated deep learning into the core of their offerings [76]. Facebook employs neural networks to automatically tag posts, Google uses them to search for photos, Amazon uses them to suggest products, Pinterest uses them to personalise your home feed, and Instagram uses them to build its search infrastructure (Figure 6).

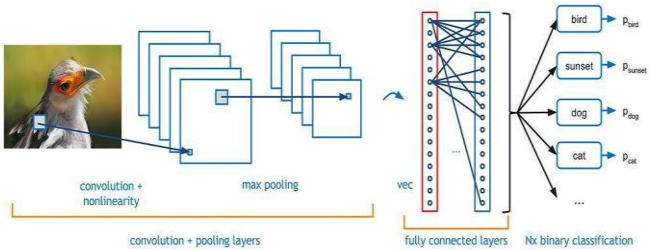

Figure 6. Modules.

The Problem Space

Picture categorisation involves assigning a class (such as a cat, dog, etc.) or determining the likelihood of the image being in a class that best fits it. This is one of the first things we learn to do as babies, and as adults, it comes naturally and easily. We can swiftly and easily figure out where we are and what is around us without even thinking about it [53]. Most of the time, when we look at a picture or the environment around us, we can quickly describe the scene and assign a name to each object without even thinking about it [100]. We don't possess the same talents as other machines when it comes to swiftly spotting patterns, utilising what we already know to make new connections, and adapting to diverse visual settings.

Inputs and Outputs

When a computer views an image, it sees a bunch of pixel values [82]. It will see a 32 × 32 × 3 array of numbers, where the three values represent the RGB colours. This depends on the image's size and resolution. To make my point clearer, let's imagine we have a colour JPG image that is 480 × 480 pixels. The representative array will be 480 by 480 by 3. For each of these numbers, a value between 0 and 255 is provided to indicate the brightness of the pixel at that location [77]. When we classify images, these numbers don't mean anything to us, but they're the only things the computer can use. You give the computer this set of numbers, and it will provide you with values that indicate the likelihood that the image is of a given type of animal (for example, 0.80 for a cat, 0.15 for a dog, and 0.05 for a bird).

What We Want the Computer to Do

Now that we know what the problem is and what the inputs and outputs are, let's think about how to solve it. We want the computer to be able to distinguish between all the pictures it receives and identify what makes a dog a dog or a cat a cat. This is also what happens in our minds without our knowledge [59]. We can tell that an image is of a dog if it contains recognisable traits like paws or four legs. Similarly, the computer can sort images by scanning for simple shapes, such as edges and curves, and then progressing to more abstract ideas through a sequence of convolutional layers [84]. This is a general idea of what a CNN performs. Let's get into more detail.

How Computer Vision Works

One of the most important topics in both neuroscience and machine learning is: how do human brains operate, and how can we use our own algorithms to approximate this? The truth is that there aren't many good hypotheses on how the brain works, so even though Neural Nets are intended to "mimic the way the brain works," no one is sure if that's accurate. Jeff Hawkins wrote a whole book about this called On Intelligence [51]. The same dilemma applies to computer vision; because we don't know how the brain and eyes perceive images, it's challenging to evaluate how well the algorithms employed in production align with our own mental processes [81]. For instance, research has demonstrated that certain functions previously believed to occur in the frog brain actually transpire in the eyes [96]. We are not amphibians, but there is still a great deal of mystery surrounding how humans think [61]. To machines, images are just a series of pixels, each with its own set of colour values. Look at the simplified picture below and how the grayscale values are turned into a simple list of numbers (Figure 7).

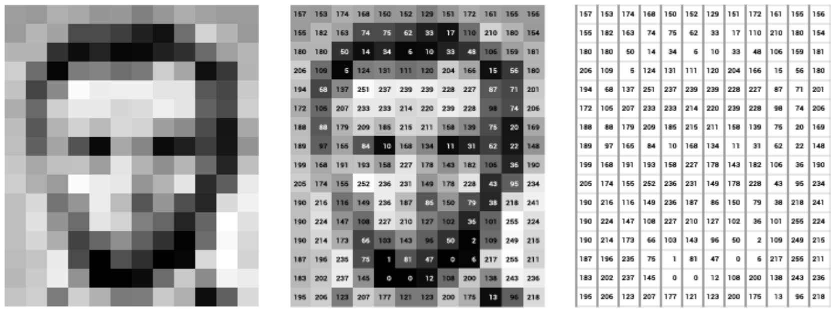

Figure 7. How Computer Vision Works.
Source: Open frameworks

An image is like a big grid of squares or pixels. This picture is a simple depiction that resembles either Abraham Lincoln or a Dementor [69]. A number, usually between 0 and 255, can be used to show each pixel in a picture. When you add an image to the program, it sees the numbers on the right. There are 12 columns and 16 rows in our image, which implies there are 192 values that can be entered for it [60]. Things grow more challenging when we start to add colour. On the same 0–255 scale, computers commonly perceive colour as a set of three values: red, green, and blue (RGB). Now, in addition to its position, each pixel has three values that the computer may store [80]. If we were to colourise President Lincoln (or Harry Potter's worst fear), we would get 12 × 16 × 3 values, which is 576 numbers (Figure 8).

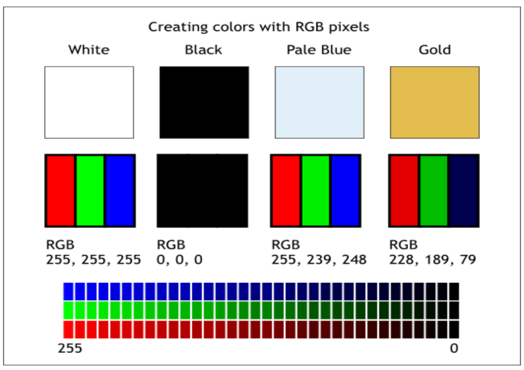

Figure 8. Creating Colours with RGB Pixels.
Source: Xaraxone

For some perspective on how computationally expensive this is, consider this tree:

a. Each colour value is stored in 8 bits.
b. 8 bits x 3 colors per pixel = 24 bits per pixel.
c. A normal-sized 1024 x 768 image x 24 bits per pixel = almost 19M bits, or about 2.36 megabytes.

That's a lot of RAM required for one picture and a large number of pixels for an algorithm to process. But to train a model with real accuracy, especially when it comes to Deep Learning, you usually need tens of thousands of photos [50]. The more, the better. You would still need a few thousand images to train your model on, even if you used Transfer Learning to leverage what you learned from an already trained model [97]. It's not hard to see why Machine Learning has come so far in the last few years, given the significant computational power and storage required to train deep learning models for computer vision.

Computer Vision Algorithms

An algorithm makes it easy to deploy computer vision applications as scalable micro services [79]. Our marketplace has a few algorithms to help get the job done:

a. SalNet automatically identifies the most important parts of an image
b. Nudity Detection detects nudity in pictures
c. Emotion Recognition parses emotions exhibited in images
d. DeepStyle transfers next-level filters onto your image
e. Face Recognition… recognises faces.
f. Image memorability refers to how memorable an image is.

For example, you could use Emotion Recognition to identify any hostile emotions in images from a security camera, or Nudity Detection to restrict unsuitable profile pictures on your online app [98].

Packages and Frameworks

OpenCV: "OpenCV was made to be fast and efficient, with a strong focus on real-time applications." OpenCV is used worldwide and has over 47,000 users and more than 14 million downloads [99]. People use it for everything from interactive art to checking mines, sewing maps together on the web, or using advanced robotics. SimpleCV – "SimpleCV is an open source framework for building computer vision applications [52]. You can use it to access several powerful computer vision libraries, such as OpenCV, without needing to learn about concepts like bit depths, file formats, colour spaces, buffer management, eigenvalues, or the differences between matrix and bitmap storage beforehand. Mahotas: "Mahotas is a library for Python that helps with computer vision and image processing." It features numerous algorithms written in C++ for speed, which work with NumPy arrays and have a very clear Python interface [78]. Mahotas now offers over 100 functions for computer vision and image processing, with more being added.

4. Conclusion

The results of this model are promising and accurate. If the camera detects movement, it draws a green frame around the area of movement, as illustrated in the picture below. In today's world, almost everyone is aware of the importance of CCTV footage. In most cases, however, this material is only used to investigate a crime or incident after it has occurred. The suggested model has the advantage of stopping crime before it happens. We are monitoring and analysing the real-time CCTV footage. The analysis informs the appropriate authorities to take action if the outcome indicates that something adverse is likely to occur. So, this can be stopped. The proposed technique is limited to academic settings, but it can also be used to forecast more suspicious behaviour in public or private spaces. The model can be utilised in any situation where the training needs to include the right kind of suspicious behaviour for that situation. You can improve the model by identifying the suspicious person based on their suspicious conduct. The primary objective of the research is to utilise a convolutional neural network to identify the item in the video. For training, we used yolo and CNN. CNN did the classification.

We provide YOLO3, a single model for finding objects. It's easy to build our model, and you may train it directly on full photos. YOLO3, on the other hand, is trained on a loss function directly related to detection performance, and the entire model is trained simultaneously. YOLO3 is the fastest general-purpose object detector in the literature, and it excels at detecting objects in real-time. We also use TWILO Software to send messages from the Sender to the Receiver. It is free to use and open source. The TWILO Software has an API that makes it easy for us to connect the messages.

Future Scope

The suggested activity detection system, which combines sensor-based and vision-based approaches and utilises Twilio for instant alerts, provides a good starting point for numerous potential applications. Here are some possible future goals for this project:

Improved Security Systems: The system might be expanded to work with home security systems, smart locks, and other IoT devices to make homes, offices, and public places safer overall. This may involve monitoring entry points in real-time, identifying unauthorised personnel, and automatically securing the building. Smart Cities and Urban Planning: Applying this approach in cities could help make them more intelligent. City planners can make informed decisions about building new infrastructure, public transportation routes, and resource allocation by analysing activity patterns, traffic flow, and crowd behaviour.

Health and wellness monitoring: The same technology used to recognise activities can also be used to track health and wellness. For example, keeping an eye on the movements of older or disabled individuals to ensure their safety, tracking physical activity levels for fitness monitoring, or even detecting early symptoms of health problems through changes in activity patterns. Retail Analytics: The technology can be used to analyse how customers behave and what they prefer in stores. Retailers can enhance the shopping experience and boost sales by tracking how people move around and interact with one another in-store. They could then use this information to enhance store layouts, product placement, and marketing strategies.

Environmental Monitoring: The system can be utilised in natural settings to monitor wildlife, support conservation efforts, and conduct environmental studies. Researchers can gain valuable insights into ecosystems, migration patterns, and how animals utilise their habitats by studying their movement and behaviour. Human-Computer Interaction: Combining activity recognition with augmented reality (AR) or virtual reality (VR) systems could make user experiences more immersive and engaging. Gesture recognition could enable people to control virtual worlds or engage with digital content in innovative and intuitive ways.

Autonomous Vehicles and Robotics: Adding activity recognition to self-driving cars and robots could help them better understand and navigate complex environments. These systems could work more safely and efficiently if they could determine the locations and routes of walkers, bicycles, and other vehicles. Privacy and Ethical Issues: As with any system that involves monitoring people and collecting data, there are crucial issues to consider regarding privacy, data security, and ethical use. For users and communities to trust and adopt future advances, they should prioritise transparency, consent, and responsible data handling.

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