AI enabled smart surveillance system

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Abstract. The conventional household door locking system has lot of drawbacks and it is still yet not resolved. Most of the security systems so far in our markets includes video surveillance or vigilance system. In order to improve security level facial recognition and object detection technique using CNN algorithms can be used which is also provides remote proctoring facilities to owners. The proposed system detects the object and identifies the anomalous activity near the door by applying Convolutional Neural Network. Electric door lock solenoid is used to unlock the door. An ultrasonic sensor is utilized to measure the distance between a person and door through the facial recognition when it reaches a certain threshold value that has been kept to detect the person reaching the doors and it tries to capture the human image only if it is mismatched from database. When a stranger try to access the door an alert message might be triggered to registered mobile number and he proprietor would be able to control the door locking system and inspect the image of person which has been mailed.

Keywords: IoT, latch, face recognition, security, CNN.

1. Introduction

Nowadays, the safety and security are most challenges issues in modern time society to stop people life and their valuables assets from illegal handling. As a result, the safety and security extending to personal social security to protect every individual’s personal information, valuable things and their day to day activities. Hence, the private security services moving towards to integration of video surveillance, door lock access conflicts in personalized monitored areas [1, 2]. The personal authorization or network based remote authorization or smart devices based on local authorization, or the illegal access risk within the building facility.

In recent era, the network based centralized electronic access system developed for security gate and control and door access control in smart buildings with different user authorization interfaces like wireless communication technology like Near-Field communication (NFC), Contactless Communication Technology like Radio-Frequency Identification (RFID), fingerprint recognizer, and face recognizer, etc. [3-7] to limit the physical access of the people within the buildings or assets.

The building facility localized electronic access system receives the user specific authentication and authorization information from a centralized access system server and performs the automated gate or door lock open or close control for the precise individuals to access control system user authentication interfaces are subject to the security compromising by exposing the password or digital keys to strangers. Also, the RF-based available user interfaces are susceptible to security threats. However, the
installation cost of remote proctored system would be high and also has the weakness of access distance, security and network access efficiency issue.

Recent advancement in IoT plays vital role in remote monitoring and security systems. These security systems can be improved by providing intelligence to the hardware components. AI based Jetson Nano device supports to integrate intelligence to detect anomalous activities by enabling deep learning concept. It will increase the efficiency of the security system [8].

2. Literature survey

The existing smart door system has lots of drawbacks such as in RFID system which has disadvantage losing access code readers, NFC system, Fingerprint system, remote access system can be hacked by techy-burglars and by adding intelligence to these surveillance systems most of the drawbacks can be solved. Some those systems which can be improved are:

Automated Door access system with face recognition has been previously developed in 2013 [9] to provide automated door access using facial recognition and this system had been implement using Eigen faces techniques and triggering message alert to respective mobile numbers with help of GSM network. The reliability and robustness of this system can be improved.

Smart Door Lock system using Bluetooth technology has been proposed and developed in 2017 for proprietor’s to remotely access the door using an android application and also helpful for disabled persons but the Bluetooth system has the network access delays which had to improve in this system [10].

Advancement in technologies had been improving in years and also had dealt with security issues likewise an object in a picture is classified and detected wisely. This deals with Neural networks and its ultimate utilization in computer vision has been developed in 2020 and this system can be utilized in smart doors [11].

The Neural networks is an initiative to make a machine to act like human which could make huge difference in today’s world and deals with many algorithms and this article deals with initial version of Neural Network [12].

The object detection techniques have been widely concentrated and various detection algorithm associated with object detection has been analyzed and concludes the disadvantages of algorithms and highlights the efficient algorithm [13].

CNN comes into deal while performing object detection. CNN algorithm differentiates pictures by assigning weights and bias for various classes. This could be utilized by embedded system which has low resolution input and complexity has been proposed by Wang [14].

Deep Learning algorithms has been utilized to detect object which has various models like R-CNN, SSD and YOLO to deal with wide variety of applications and also has the capability to detect a moving object in video scenes. However, these algorithms differ with accuracies and utilizes Gaussian mixture along with background subtraction in video scenes had been discussed in this article [15].

In article [16] they have proposed a system which is desired to have accuracy and fewer computations to detect people due to low speed this system fails real-time detection.

While dealing with static crowd when an individual stay for a specific time in same place can be detected by using support vector machine with extracted text features from patches that has been categorized [17]. However, it is not possible for moving individual in crowd.
Improving technologies and algorithms provides us the ability to detect the person in video surveillance through the behaviour of person which has been trained to system to detect according [18] but this system fails to identify individual in crowd.

This paper [19] proposed a solution to detect the individual in moving crowd with utilization of low-resolution camera along with extracting techniques and classifies it in real-time.

3. Computer vision based intelligent door locking system

The proposed system uses YOLO Deep Learning model for object detection since it provides fast recognition and accuracy than other detection since it provides fast recognition and accuracy than other detection models. As the name suggest here the image is looked only once to predict and inspect objects whereas other R-CNN models need to generate bounding boxes and required to select regions within bounding boxes for prediction and this process needed to be repeated for every prediction which leads to recognition delay.

In YOLO model, a single convolution Neural networks would be able to predict multiple bounding boxes and classes of each object in those boxes. YOLO involves in training on entire images and optimize the detection performance directly. Since it utilizes recognition algorithm it doesn’t need complex procedures.

YOLO can achieve the latency of 2 milliseconds which is the faster version of all and it is possible with real-time detection and also achieves higher precision rate than traditional ones. It also deals wisely in making predictions as it looks into whole image to avoid low contextual information about classes.

YOLO can be trained on all natural images and tested to improve the prediction performance and it is generalizable which can be added to many domains.

The below figure 1 have a detailed view of YOLO measuring algorithm image captured is taken as input and a bounding box is made which has S*S grids. Each grid within bounding boxes has certain features whose confidence score is calculate to find the class. The score determines the confidence level object that is to be predicted within the box.

![YOLO Measuring Technique](image)

**Figure 1.** YOLO Measuring Technique

The proposed system also makes use of JETSON NANO NVIDIA system. It is an embedded device which has powerful computational capability and it also supports various Deep Learning and Machine Learning frameworks. It is suitable for various real-time applications which includes high definition video streams.

The memory of Jetson Nano is 4GB and it also incorporates processor like QUAD CORE ARM processors and Graphical Processing Unit of about 12-core Maxwell. It also supports camera module and here 8m pixel resolution module is interfaced with camera serial interface. YOLO detection model has been deployed through deep learning toolbox in Jetson Nano since it supports various Neural Network Models. GPU role in Jetson Nano is to enable communication of target hardware remotely. It
also incorporates many developer tools to make code generation easier and it is also beneficial. It supports CUDA libraries to utilize accelerate primitives in Neural networks.

Thus, by using the object detection technique it’s easy to spot if the stranger is quite burglar or normal one and since other CNN techniques takes much time to predict it.

**Neural Network Design**

Jetson Nano platform supports neural network algorithm that has been build using ma labs and ported to devices thus it provides low-cost real-time implementation. The traditional CNN has three layers and includes input, middle and subnetwork of YOLO layers. The input layers have the input image provided for detection and size can vary but width and height should be mentioned. There are group of middle layers which includes convolutions, batch normalization, ReLU (Rectified Linear Unit) and Maxpooling layers. The convolution is utilized to define the height and width of input image and extract the features within the specified dimensions. ReLU is to provide nonlinearity to neural networks. Batch normalization is used to remove the overfitting position within in image and Maxpooling layers provides the pooling regions. These layers had been utilized during YOLO detection work. It also has transform layer which is responsible for object localization balance and transforms the raw output layers provides bounding box to the image that is detected along with accuracy level.

**Systematic Diagram**

![Figure 2. Block Diagram of Computer Visioned based Intelligent Door Locking System](image)

Thus the above figure 2, explains the proposed system where the sensor is used to detect continuously and when it detects the stranger it automatically triggers the Jetson Nano which is small microprocessor, it captures the image of the person in front of the camera and checks with predefined database which is also continuously monitors strangers activity if it found it as stranger or abnormal or if the stranger is not matched with database then it triggers the camera which captures the image of the person in front of the camera and triggers the alert to the proprietor of the device through the popular communication systems like WIFI. Thus, authorized user can decide to latch or unlatch the door remotely. Since there is predefined trained dataset it can easily find the difference between people and burglars.

**4. Implementation and result**

In this paper, the system starts after detecting strangers and YOLO object detection model has been utilized since it has high resolution than other detection algorithms where the model is trained with certain set of datasets and it is tested against new images and this leads to generation of bounding boxes for all individuals in the new images.
There are certain detection algorithms to detect objects and has two methods to implement which includes Classification algorithm and Regression algorithm. Under Classification algorithm desired regions in an image is selected and then it is classified using CNN techniques but it is slow because it would require to select position in each prediction. Hence YOLO came into play for fast and accuracy concerns which uses regression algorithm since it predicts the entire image in single instead selecting regions in image.

You only look once algorithm takes the input image and bounding box contains descriptors like center, width, height and class of each image. In YOLO the image is splitted into cells which is typically 19*19 grid. If the cell has more than one object, then the bounding boxes is extended to five more and reaches large number of bounding boxes for an image. Figure 3 explains after these process, non-max suppression comes into deal where we remove boxes with low probability and high shared area in the bounding box is taken into consideration.

![YOLO Algorithm](image)

**Figure 3.** Image detected using YOLO algorithm which is trained and determines the accuracy of trained data.

To determine the accuracy level of YOLO algorithm detection and recognition accuracy can be considered where number of objects of total number of objects are detected is utilized to determine the detection accuracy and number of correct labels provides the recognition accuracy.

![YOLO Accuracy](image)

**Figure 4.** The accuracy level of YOLO detection algorithm
The above figure 4 determine the accuracy which increases with increasing the level of trained data and it can accurately plot the persons because of trained data. The below figure 5 shows better results with real-time environment.

**Outcome**

![Image](image_url)

**Figure 5.** Shows the result of image mailed to owner when it detects as stranger.

5. **Conclusion and future enhancement**

Our proposed system is to provide safety and security. This proposed system helps people to secure house from an unauthorized person. To lock and unlock the smart door we don’t need any keys it will open only for an authorized person and it doesn’t open for an unauthorized person. In bounding boxes an algorithm was implemented and its process is to distinguish the authorized and unauthorized person. The bounding boxes marking green and red for detected person. In future we can enhance the execution time delay which is useful for identifying the burglars quickly and taking action according to the situation.

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