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Design and Development of Citizen Surveillance and Social-Credit Information System for Bangladesh

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***Abstract*— Most of the areas of Bangladesh face a wide range of threats, ranging from terrorism and civil unrest to kidnapping, rape, and murder. To reduce the impact of these threats, the authorities must capture real-time information on what is happening in and around the city. Therefore, there is a growing requirement for utilizing new and emerging technologies to make the cities safer. The development of the monitoring system in the technological field has become a blazing topic in the milieu of scholars, and AI techniques have become an essential part of the future era. With the help of AI & deep learning, people's social behavior (Action Recognition) can be evaluated. By implementing the social credit score system, authorities can mark the citizen's activities and analyze them. To detect and recognize the actions of a human, YOLOV2 architecture was used and incorporated the SQL database (SQLite) to record the social credit score. A citizen can visualize their credit score from an HTML-based website.**

***Index Terms*—YOLOv2, deep learning, Darknet-19, Citizen Surveillance, Social Credit Information System, Machine learning, Action Recognition.**

I. Introduction

The cities around the world are upgrading faster with the advancement of technology. Criminal activities are rising, which leads to the destruction of public assets and life [1] [2] [3]. By considering all the problems like terrorism, kidnapping and murder have emerged as a new security problem. By utilizing the new emerging technologies, the cities can be safer by capturing real-time information on what is happening around the city. The closed-circuit television cameras (CCTV) already play a vital role by ensuring day-to-day surveillance. Then the addition of artificial intelligence techniques such as detection and recognition of real-time actions of humans will give groundbreaking advancement in a video surveillance system in this country. This paper gives a technical idea about human action detection and recognition using the information and data from the processing of images from the captured video. This research aims to detect and recognize different actions, persons, objects, and reports to law enforcement commissions of special interests during unexpected things. In this paper, a new idea named "Social Credit Score System" is implemented and discuss. Through this system, authorities can assess individuals by the citizen's actions.

There are other researches ongoing on this topic that is related to this research. Many researchers are applying different approaches to detect the action of a human. In 2012 two Stanford University students KIM and Popoola, proposed a method [4] to detect abnormalities in a video sequence based on the space-time Markov random field model, and it consists of unpredictable variations. It also presents the unusual behavioral pattern detection crowded scenes which is a mixture of dynamic textures. The dataset contains low-resolution sequences of crowds with occlusion. Another two students of Peking University, in 2018, Dang and Wang, also proposed a method [5] that automatically recognition behavior and detects the abnormalities with the help of artificial intelligence. Gong used a processor tool by thresholding a motion filter that integrated the prototype videos of an object and classified a group of individual behavior patterns. Djahel in 2009 suggested detecting usual human behavior by motion and limb orientation in surveillance videos [6]. A 2014 research group of the University of Liverpool worked on neural network processing on CCTV surveillance to understand the citizens' social ordering strategies [7]. They worked on the efficiency of understanding abnormal behavior of social ordering practices in terms of video processing and face recognition. Feature learning, highlight detection, graphics interchange format generation, video face detection and verification, person identification, location tracking, place

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reorganization, metric learning, and image processing techniques were used to detect a person's abnormal behavior in a crowded area [8]. Thiel, G. (2000) programmed a system using dark basic programming to analyze the movement of individuals, and the system used computer-controlled Pan tilt zoom cameras to obtain close-up video recordings for analysis and to detect the vehicles that come across in the video scenes [9]. Toderici, G. (2007) worked [10] on "Experimental Analysis of Face Recognition on from Still Image to Video Image. The author compared the performance of this algorithm using CCTV frames versus passport quality images. This technique proved that PCA based method had problems as the gallery and probe images do not come from the same type of camera. This algorithm performed better when the multiple frames from the video are used for face recognition.

In the term of the historical event, it represents the various implementations and approaches to detect a person and their different activities. The CCTV surveillance system focuses on something new from conventional technological technologies. The task through the algorithmic operation provides the familiar regarding different helpful mechanisms. Implementing the social credit score concept in Bangladesh is an innovative feature. This innovative concept will help the government and law enforcement authorities to detect a criminal and judge every person's behavior so that the police can easily reach out to the actual criminal in the shortest time. Under other conditions, the citizen will behave themselves to maintain the social score, and the crime rate of this country will dramatically decrease. The roadmap of this paper is as follows. Section 2, the system's architecture, and Section 3, the YOLOV2 architecture, are discussed in detail. Then, in Section 4, a brief discussion of the datasets. After that, the result & analysis is talking through in section 5. Later, in Sections 6 and 7, the findings and limitations of the results and possible threats to validity are discussed, respectively. And lastly, the conclusion of the work.

II. System Architecture

Surveillance through the camera is not new to the recent world trend, but applying different algorithms and techniques for different types of recognition is new as a real-time human action recognition system. So, through this system, authorities can assess individuals by the citizen's good and destructive behaviors. The social score based on citizen's behavior patterns will be stored by mapping it into positive and negative markings on the website. At first, the video will be captured and analyzed through the Darknet-19 model using YOLOV2 [11] framework based on google net architecture. It will be sent data to the database to store the result of the behavior pattern of the citizens. YOLOV2 framework a custom network. By evaluating the result, a score will be published on the social credit score system website. People can access this website anytime to know their evaluation. The CSS design approach will be implemented to develop the website, and PHP & HTML will be used to make the website more user-friendly. As a computer vision technique in video surveillance applications is a challenging task to detect and recognize human action with the help of the YOLOv2 framework. Through this system, a static camera is allocated to capture the live scenes and take data of the sequential frame of videos. The block of diagram of the system as follows,

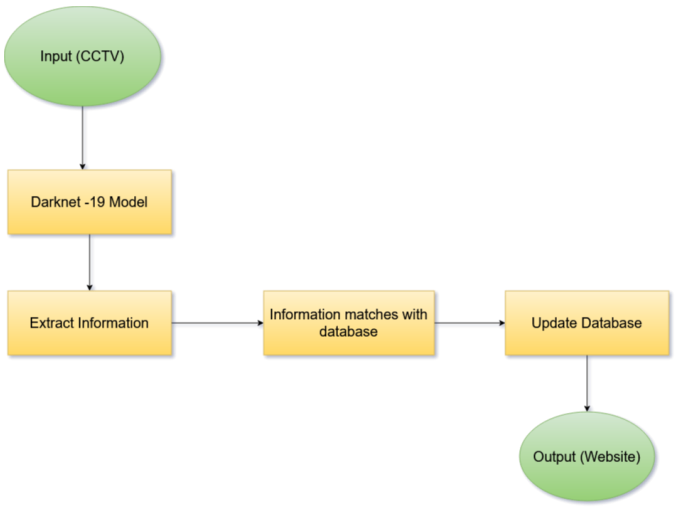


Fig. 1. Block diagram of the system.

In the detection process, the YOLOv2 model is to analyze the data from the given dataset. At first, the frames of the user's actions from CCTV cameras are collected. Then the YOLOv2 model extracts the information such as which type of action the user is performing or personal identification. Then the extracted information will be matched to the dataset. If the model catches any citizen performing any action, then it will identify the person, and simultaneously it will update the information of the database of the social credit score system. Lastly, anyone can visualize their social score through the website.

III. Methods

The main challenge of this system is to detect human action swiftly and better. YOLOV2 proves [11] that it is fast, better, and stronger than other methods. In Table 1, it is mentioned that YOLOV2 has much higher average precision and fps. That why the YOLOV2 480x480 framework was chosen in the proposed system.

TABLE I
Detection Frameworks on PASCAL VOC 2007 [11]

Detection Frameworks	**mAP**	**FPS**
Fast R-CNN [12]	70	0.5
Faster R-CNN VGG-16 [13]	73.2	7
Faster R-CNN ResNet [14]	76.4	5
YOLO [15]	63.4	45
SSD300 [16]	74.3	46
SSD500 [16]	76.8	19
YOLOv2 288x288	69	91
YOLOv2 352x352	73.7	81
YOLOv2 416x416	76.8	67
YOLOv2 480x480	77.8	59
YOLOv2 544x544	78.6	40

A. *YOLOV2 Framework*

YOLO (you only look once) is a real-time object detection method. In Pascal Titan X, it works to train the images at 30 FPS & also, in COCO test-dev, the mAP is 57.9%. YOLOv2 is relatively faster & give accurate result than other detection method used to process hundreds or thousands of images for detection purpose. The mAP counted at 0.3 IOU, maintaining balance with Focal Loss having 3X faster. By changing the model's shape, the speed and accuracy can be raised & in that case; retraining is not required. In this model, the dataset is used COCO. The interference time (ms) is more significant in correspondence with the COCO mAP. In this project, the YOLOv2 608X608 model is used to train the COCO trainval with the test of 48.1 mAP. There are 62.94 Bn flops with 40 FPS. In other detection systems, the classifiers & localizers are refreshed every time to perform new detection. In different locations & scales, the model was used to detect multiple objects. The regions which are high scored are considered as the detection. Nevertheless, in the YOLOv2 model, the whole algorithm is applying in full image. In this project, the YOLOV2 480x480 framework was used. The image is separated into various regions, and for each region, the bounding box and probabilities are assumed. For classifier-based systems, the advantage of using this model is enormous. While on-time trained the videos, it processes each frame by going through the whole image at a time, and the global context is the predicted values while informing the images of a single frame which makes the system faster. In YOLOv2, different tricks are introduced to improve training performance and accuracy. To get a higher confidence value in this project YOLOv2 network model is used & this is the improved version of the YOLO network. To palliate some defects of other software & other detecting algorithms, the precision level is higher than the other.

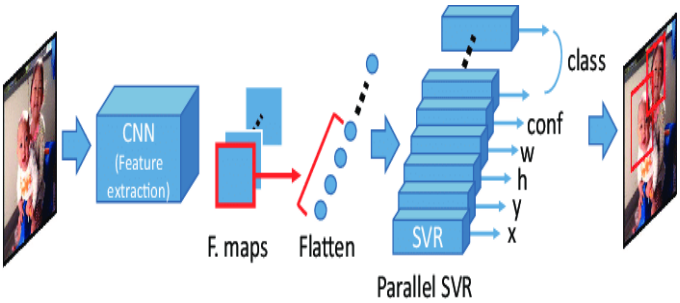


Fig. 2. Working principle of the YOLOV2 framework [15].

B. *Website of the social Credit system*

The language used to build the software is PHP, and for background design, the CCS was used. The XAMPP control panel was implemented to get access to the webserver from the local computer. The web server is integrated with the SQLite database to store information. For every person, some rows are filled with information so that whenever running any SQL command, the corresponding information will also show up. When the score is updated for every activity, the updated result will be shown on the website. Through the social credit website, people can check their social credit score to check for which reason the last time the score is increased or decreased.

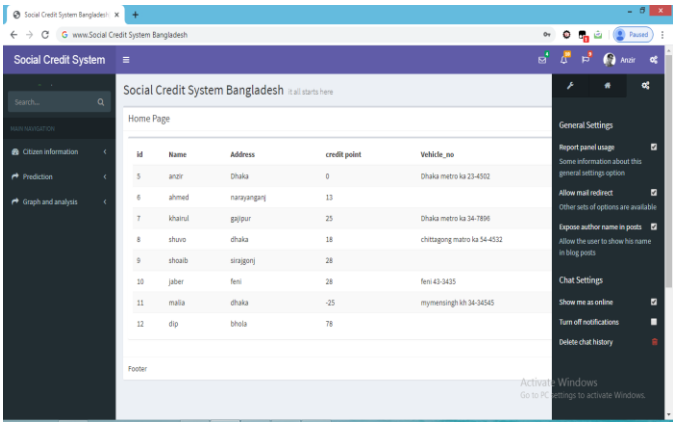


Fig. 3. Website of the social credit system.

C. *SQLite Database*

SQLite is mainly a relational database management system that is also contained basically in the C library. It is usually equipped with an end program not having a relatively client-based database tool. In this project, all the databases are stored in an SQLite management system. Here the information of user-id, address, and names was recorded in the database. It implements the SQL standard with the ACID compliant. Establishing the connection with the server & the source code generates PostgreSQL. In this project, an average score was set for every end-user & the updated score will be saved in the database management system. Using this system, whenever anyone calls the user id, it will show the user's updated information with an updated score.

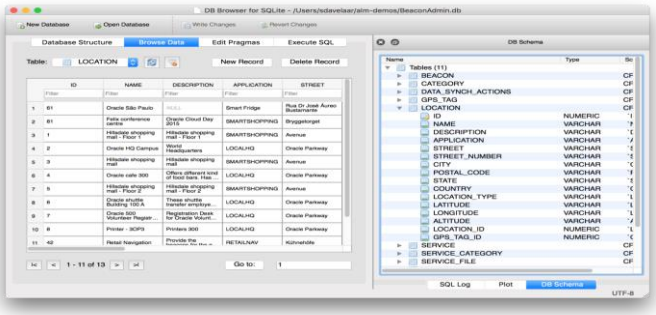


Fig. 4. SQLite Database Management system.

D. *Hardware and Software*

The implementation of the framework is not from scratch. For implementing the YOLOv2 model, the official GITHUB repo [17] was downloaded and implemented as the CNN network, which is custom. Python 2.7 and other packages like NumPy, Matplotlib, OpenCV, and pip are used as additional packages. All the processes are performed in the Linux operating system. The hardware had Intel core i5 4th generation processor with a 3.20 GHz clock speed. It has 16

GB of DDR3 Ram and a 6GB NVIDIA GTX 1060 graphics processing unit.

IV. DATASET

Recent classification and tagging datasets are boundless compared to datasets for object detection. Most of the well-known detection datasets contain approximately thousands of images with dozens to hundreds of ground truth [18] [19] [20]. Four human actions have to detect and recognize through the system. So, the images of all actions were combined and create one colossal dataset where all four human actions are present. The four human actions are detecting a citizen publicly smoking or not, any citizen carries a lethal weapon or not, any citizen bullying any other citizens or not, and citizens are throwing their trash at the right place. Based on that action, the citizen will get a plus or minus social score. Additionally, the dataset has been gathered from other available sources to make it a more extensive dataset. For detecting whether a person smokes or not, an available online dataset [21] was selected. In this dataset, 1200 images are for categorizing the smoker and 1200 Images for Non-smokers. With this dataset, 600 more images were additionally added to the dataset of smoker and non-smoker action. For detecting whether a person carries a lethal weapon or not, this [22] dataset was applied. This dataset is made of movie clips where a person carries a lethal weapon. In this dataset, around 3000 movie clips are there, adding more than 500 images to the dataset. For detecting bullying or fighting action, three datasets were selected. The first one is UCF101 [23] which consists of 101 actions of a human. In this case, fighting images were separated, and only 1843 images are for fighting action. Then another dataset [24] consists of 200 video clips where fights were extracted from action movies. Lastly, the throwing garbage action, for this action, there is no such online available dataset is present. The dataset has to be made externally. Seven hundred twenty-eight images of throwing garbage were capture manually. In Fig. 5, the whole dataset can briefly visualize.

(a)

(b)

(c)

(d)

Fig. 5. Images of a) Smoking action [21] b) carrying lethal weapon [22] c) Fighting action [23] [24] and d) throwing garbage action.

All images are RGB and the resolution of the images are 128x128. After gathering all the images of four human actions, the dataset is still not enough to feed in the deep learning model. So, some data augmentation techniques are used to avoid overfitting and improve the mAP.

A. *Standard Augmentation*

The whole dataset consists of 9271 images and applying standard augmentation of the whole dataset from 11 different angles. Data Augmentation is a technique to increase data by slightly modifying the data as rotation or mirroring the images. After augmentation, the dataset contains 101,981 images, and the dataset is like Fig. 6.

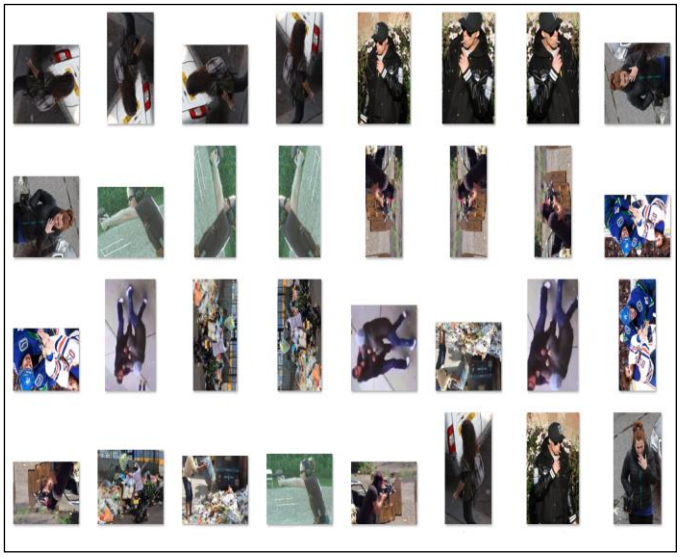


Fig. 6. Dataset after augmentation.

B. *CutMix Augmentation*

Random patches were cut and pasted between the training images in CutMix augmentation. The ground truth labels are proportioned to the patch region in the photos. CutMix improves localization by instructing the model to concentrate on more minor discriminative parts of the object categorized, making it suitable for tasks such as object detection.

C. Mixup Augmentation

Two samples are combined using linear interpolation of their images and labels in Mixup augmentation. Mixup samples produce unrealistic results and have ambiguous identifiers, making them unsuitable for image localization and object detection.

D. Cutout Augmentation

Cutout augmentation is a regional dropout strategy that involves zeroing out a random patch from a picture (replaced with black pixels). The knowledge and regularization capacity of cutout samples is reduced.

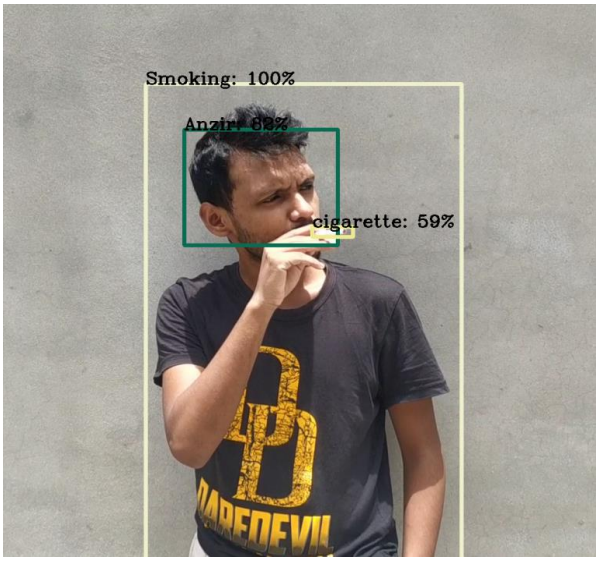
V. Results

K-fold cross-validation is a prevalent resampling method [25] to evaluate the machine learning model trained on a limited dataset. In terms of K-fold cross-validation, 'K' is a parameter that means the number of each group after splitting the complete dataset. In this case, K = 4. The dataset was randomly split into K no groups, and one group of the dataset is unknown to the model for testing. For evaluating an object detection model such as R-CNN and YOLO, the mean average precision (mAP) was used. The mAP calculates a score by comparing the ground-truth bounding box to the observed box. The higher the score, the better the model's detection accuracy. Table 2 summarize the results of each human action in terms of average precision.

Table II
K-Fold cross-validation results

Actions	K=1 (mAP)	K=2 (mAP)	K=3 (mAP)	K=4 (mAP)	Testing (mAP)
Smoking	0.81	0.79	0.83	0.82	0.74
Carry Lethal Weapon	0.83	0.81	0.78	0.80	0.73
Fighting	0.85	0.83	0.80	0.82	0.78
Throwing Garbage	0.78	0.77	0.78	0.75	0.71

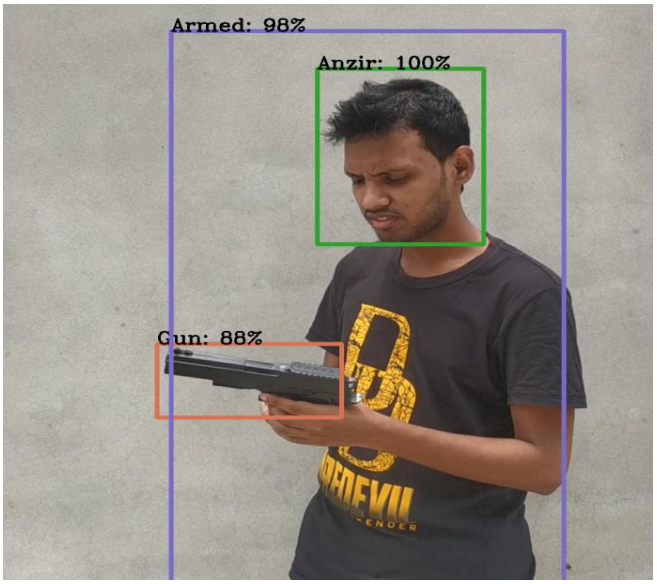
From the above table, each action's test mAP is between 0.71 to 0.78. Carrying lethal weapon action has the highest mAP compare to others, and throwing garbage has the lowest mAP. The detection threshold is set to 50%, and outputs of the model with a bounding box were given below. In fig 6 (a), the model is detecting whether the person is fighting or not. On the other hand, in Figure 6 (b), the model successfully detects the person who smokes publicly, particularly that frame with 0.73 mAP. Figure 6 (c) and (d), other remaining actions are detecting with 0.71 and 0.78 mAP, respectively. Overall the performance of the model is moderately satisfactory.



(a)

(b)

(c)



(d)

Fig. 6. Detection results with bounding box a) Fighting human action b) Smoking action c) Throwing trash action d) Carrying lethal weapon action.

For improving the mAP score, different augmentation techniques were tried, and results were given in Table III.

TABLE III
RESULTS OF DIFFERENT AUGMENTATION TECHNIQUES

Augmentation Techniques	Testing (mAP)	Improvements
Standard Augmentation	0.74	0
Cutmix Augmentation	0.71	-0.03
Cutout Augmentation	0.69	-0.05
Mixup Augmentation	0.70	-0.04

From above table depicts that standard augmentation techniques give the best results than other techniques in this research.

VI. DISCUSSION

In this system, YOLOv2 detects and recognizes human actions. Table II shows scopes to improve the average precision by increasing the raw data or using other techniques like transfer learning to improve the model's mAP. Human action recognition is always a challenging task. There are so many actions similar to each other that it becomes difficult for the model to identify the correct action and get a lower mAP value. The mAP detection model is satisfactory as the Darknet-19 architecture has the highest mAP among other architectures. Nevertheless, overall the detection and recognition are satisfactory, and according to detection, the overall system performance is also satisfactory though the test did not perform with a large number of people.

VII. THREATS TO VALIDITY

There are some mentionable threats to the model and the system as well. Many more actions are very similar to other actions. In some cases, the model will fail to recognize the action correctly. Another challenge the model will face is fake action. Sometimes people are acting some actions which detect as criminal activities. For example, if two friends are fighting out of fun and two persons are fighting out of violation, the system may not be distinguished. The model will fail to detect those specific fake actions. For the system, person identification is a crucial part of the model. If the system incorrectly identifies the person, then the score will deduct or add incorrectly. So, all the threats depend on how well the model was trained. However, if one action becomes legal, then the whole model needed to change to map with the current government laws; for instance, if smoking becomes legal, then change in the database that if this action detects in the frame, then not decrease the social score. In addition, this system will not violate any citizen's privacy as the model will only be implemented in public areas. It is possible that the model can reduce the threats by more training.

VIII. CONCLUSION

The purposes of the project are successfully done according to the results of the model. The process that follows right now in this country is not fully technologically based. Still, police enforcers use the manual way to find a criminal person. And that cost time & life. However, implementing this advanced detection system will help people increase the security of their lives. The authorities will get the most benefitted one to monitor from a remote location. They can easily detect human actions from training those images and clips. So, all these human activities that need to monitor people for surveillance are assured. Again, implementing Social Credit Score System will help create a positive mentality among the people & also help them to obey the rules. By following the rules, they get a positive score and get different services from the government. So, implementing advanced technology will help to monitor people efficiently & help to maintain a balanced life by obeying the government rules.

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