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Detection of Helmet Wear from Surveillance Videos for ATM Centre Security

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ABSTRACTInthemoderneconomy,thedeployment andusageofAutomatedtellermachines(ATMs)areincr easingmanifold, when they left unattended, they pose a serious security risk. ATM machines are widely used for banking services such as deposit and withdrawal of funds nowadays. Despite the fact that ATM centres are equipped with surveillance cameras, there is still a security risk. Fraudulent may wear a helmet to concealtheirfacesfromsurveillancecameras,allowing them to engage in illegal activities. ATM machines providing bankingservicesfor24x7foreasyofdepositsandwithdr awals. Although monitoring cameras are used for automatic surveillance in remote places also, but security threat still exists. Fraudsters may wear helmets to conceal their faces from surveillance cameras, allowing them to engage in abnormal activities. The investigations will be more complicatedbythefactthattheFraudster'sfaceiscompl etely hidden. To overcome this problem, proposed system used combinationofdeeplearningwithartificialintelligence model todetecthelmetwearinATMcenter.Thesedays,thecon cepts of artificial intelligence is growing in all real world applications,objectdetectionbyYOLO,andimagepro cessing techniques, makes it possible. YOLO model is used as it can detect helmet as object with high accuracy in the incoming video stream. Then Region of interest (ROI) is used for detecting whether person is wearing helmet. If a person wearingahelmetisdetected,analertissenttotheATMce ntre control centre. The experimental setup demonstrated high accuracy in detecting helmetwear.

KeyWords: ArtificialIntelligence,Imageprocessing, Objectdetection model, RCNN algorithm, YOLO, Region ofInterest

I. INTRODUCTION

Withgrowingpaceofeconomicrevolutionincountry,li quidityofcurrencyflowalsoincreases,onlybankscann otservepeople for transaction. Thus smart way of banking is developed for convenienceandusedeverywhere.ATMaretheone,wh ichare very simple to use and provides services to most of banking services including deposit, withdrawals, cheque deposits, printingtransactionsonpassbooketc.Tousetheservice s,users areprovidedwithsecuritypinsfortransaction.TheseA TMsare monitored through surveillance camera round the clock to preventrobberyandfraudulentactivities.Surveillance camerais positionedtocaptureuser'sentirefaceformonitoringpu rposes. Fraudstermayconcealtheirfaceswithmaskorhelmetth ustheir facecannotbeshowntothemonitoringcamera.Whense curity threats go unnoticed, the surveillance system's goalfails. Widespreaduseofbankingservicesareaccessiblethrou ghATMcenters,whichisavailable24X7facility.Digita ltransactionsaregrowingenormousindevelopingcoun trieslikeIndia,hashigherdemandforsmartATMservic es.Asthenumberofoutletare

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large,itisdifficulttomanagewithsecuritypersononeachATMoutletandthemaintenancecostwillbehuge.Thusmanybanks deployed surveillance camera to monitor theoutlets.
ATMsarevulnerableformanytypesofattacksincludingmaninmiddleattack,datasniffing,spoofingattacks,etc.According to reports, crime and illegal activity are increasing year after year. These problems are arising due to lack of high security measures.Accordingtoexistingstudy,5500fraudactivitiesare reported in eachyear.
Artificial intelligence is backbone for many real world applications utilizing computer vision, like object detection, monitoringservices.Artificialintelligenceisgrowingareaunder image quality improving, haze etc. Helmet detection through pre-trained YOLO model can be used for detection of unusual activities in ATMoutlets.

Figure: 1 Helmet Wear Detection

The primary goal of proposed work is to detect safety helmet wear by use of surveillance camera in ATM outlets. This is possible by combining machine vision and deep learning models. The model employed is YOLO pre-trained object detection, which can detection more than 3000 classes of objects. This pre-trained model is through Region Based Convolutional Neural Networks (R-CNN). Live stream of surveillance is accomplished as input for the system. When a person is found be wearing helmet and SMS alert message is giventothecontrolcenterormonitoringteam.Themain motive of work is avoid unusual activity or robbery in ATMoutlets.

Theworkimplementationisdividedintothree majorphases,thefirstoneconsistsofdetectingHelmetobjectusingYOLOmodel and segment detected object for further processing. In the next phaseofwork,segmentedimageisidentifiedwhetherth euserin ATM outlet wearing helmet, by find the skin color inside the detectedobject.Inthefinalphase,ifanypersonisdetected,then an SMS alert given to the monitoringteam.

In the following chapters, existing work on helmet detection is discussed in detail. In chapter 3, implementation of Helmet detection is proposed with its methodology and algorithms. In chapter 4, the experimental set up and results are explained. In chapter 5, this helmet detection is given conclusion andfurther enhancements are discussed.

II. RELATED WORK

This chapter provides a short discussion of research works handled authors on Safety Helmet detection and its usage for ATM security. In automated monitoring, machine vision and deeplearningareimportanttechniquesandfoundtobegrowing with its usage. Thus more research on this field makes the problem achievable.

Automateddetectionofbikeridersonroadswithouthelmetwasproposedin[1].Imageprocessingtechniquesarehandled,then applied feature extraction to segmented object with person regionproposal.HistogramofOrientedGradients(HOG),Local Binary pattern (LBP) and scale-invariant feature transform (SIFT) are the three feature extraction techniques used, in this the author experimented that HOG gives better results. Person with bike is classified for detection and remaining are omitted. Person with bike is applied SVM (Support vector machine) classifier to identify person wearing helmet and it is omitted, person not wearing helmet is identified and givenoutput.

Motorcyclist without helmet was proposed in [2], the author used wavelet classification for vehicle classification, this classifies only motorcycles. For helmet detection, author used circular Hough transform (CHT) and HOG feature extractions for detection and multi layer perceptron for classification. The authorhandlemotorcyclistwithouthelmetintwostages,thefirst stageforidentifyingthevehiclesandclassifyonlybikes.

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Region of proposal was arrived and segmented and applied Random forest (RF) classifier, it given better performance on 50*200 imagepixels.

Crime scene detection in ATM outlets through video surveillance was reviewed by authors in [3]. There were numerous research on this study was prefaced, of which abnormaleventdetectionthisisanalyzedbyactivityvariations on the input. Some of the study elaborated with skin detection, occulted face detection for robbery threats and illegal objects like weapon detection were studied. Moving objects detection through different image feature extraction algorithms such as HOG,MOG,Distancetransforms,werestudied.Facedetection handlingwithAdaBoost,Viola-Jonesalgorithmwerereviewed.

SafetyHelmetdetectionthroughmodifiedHoughtransformwasstudiedbyauthors[4].Onthedetectionfront,thevideoorimage capturedinfrontofATMmachineisdetectedacirculararcircle kind of object on the images through Hough transform technique,asthecircularshapedobjectsaremostlyhelmetsare used to occult the face of frauds. Hough transform gives better resultsonpatternidentificationonspecificallyshapes.However, the detection of helmet takes large computations, thus in our work, we proposed with YOLO detection model for accurate detection of Helmetobjects.

Automatic detection of safety helmets by deep learning algorithm was proposed in [5]. The deep learning algorithm CNN Convolutional neural network was proposed with architectureVVGNET16andALEXNET.Thedataset wasused on work, which used 1880 still images, out of which, 1000 are wearing helmet and 880 still images person without helmet. RCNNalgorithmusedfortrainingtheseimagesandtrainedmodelisgenerated.Thepre-trainedYOLOmodelisconsidered in RCNN. This can identify the Helmet accurately on the still images.

Safety Helmet detection on construction sites are identified through YOLO v3 model was proposed in [6]. This approach used Gaussian fuzzy augmentation process to the unbalance data to improve the accuracy of Helmet detection. Unbalanced data with sample images of different sizes were considered for thestudy,thuspre-processingandfeatureextractionsareapplied beforedetection.However,thissystemcanbeappliedforhelmet detection for construction site, whether employees wearing helmet or not can beidentified.

It is inferred from above researches that, there are highly suitable models available for Helmet detection. The method of implementationoftobeimprovedforconsideringtheaccuracy ofdetectionandscopeofdetection.Manyoftheexisting studied were proposed for safety helmet detection on traffic surveillance. However, there are criminal activities at ATM outlets wearing Helmet or mask was unattended. Thus our proposed study, considered this as major problem and given solution with YOLO and deep learningalgorithms.

III. PROPOSED WORK

HelmetweardetectiononATMoutletischallengingasthelivestreamofvideoinputisconsideredfordetection.Thedetection systemshouldbespeedandquickenoughtofindthefraudulent. This is achieved by implementing machine vision concept in Python Language. Implementation used Python 3.6 as programming with mandatory libraries namely OpenCV, requests etc. Python application is designed with TKinter for user interface design. Through this interface, the number to which alert to be sent has been given by user input. When the wear detection is identified an alert sent to theuser.

Web camera captures input stream of video, is taken as image framesforprocessing.Imagepre-processingstepsarecarriedto findtheSafetyHelmetweardetectionbyfeatureextractionand skin portion identification.

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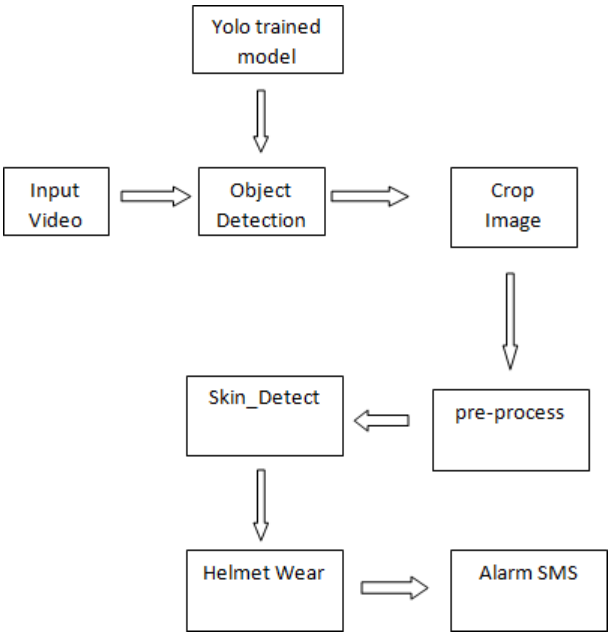

Figure 2: Architecture of proposed work

Theabovearchitecturerepresentsproposedsystem'sarchitecture with all working modules of the system namely camera input, object detection, image pre-processing, skin portion detection and helmet wearmodules.

Helmet wear detection follows below mentioned modules

a. Helmet Detection throughYOLO
b. Localizing Object
c. Imagepre-processing
d. Skin Identification
e. Weardetection
f. SMS alertsystem

DATA INPUT

Thereisnospecificdatasetforimplementationsthedetection is considered for real world surveillance camera data as input. Thus in our implementation, web camera input has been taken for the detection as we used the pre-trainedmodel.

HELMET DETECTION THROUGH YOLO

Inmotiveistofindtheobjectwhethercat,bike, human,helmet,mobilephonefromtheimageframes.Thisdetectionpavedway for localizing and detection of multiple objects in the scene images. Image fame from web camera input is taken for object detection, the class of object identified in this work is Helmet throughYOLO,pre-trainedmodelusingalgorithmRegionbased Convolutional Neural Networks (R-CNN). Once the object is detectionisdone,itislocalizedandsegmented.Selectivesearchmethodisusedtosearchgivenobjectintheregionofproposalisdone.Oncetheobjectdetectedaregionproposalisconvertedto fixed image by resizing it. The model search for where thereis largechanceofpresenceofanobject.Thismodelcansearchfor multiple objects in the given image frames and all the objects can be recognized with highaccuracy.

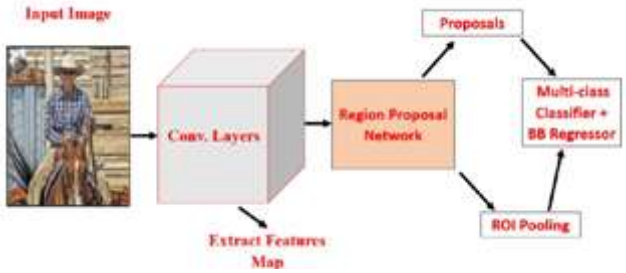

Figure: R-CNN architecture

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Proposed work gets input from web camera. This is converted into still images continuously with specified time duration. Classification application and manual feature extractions are eliminated in this model. Object recognition and localizing is doneineachgridontheimage.Thehighestconfidenced etected valueonthegivenregionproposalisgivenasobjectclass .The above architecture represents R-CNN working model. In the given input, safety helmet is detected by running forward propagation in the algorithm. High confidence value of more than 95% is considered for thestudy.

LOCALIZING OBJECT

Following object identification, localizing object in image is performed, then localized object is grab cut and stored asfixed image. Image is re-sized with predefined size, foregroundandbackgroundofimageisidentifiedandb ackgroundsubtractionis done. Object localizing is done with Opencv grab cut module, theregionofproposalisdetectedtosegmentthehelmeto bject.

Backgroundmodelandforegroundmodelareprovided wellwith bounding boxes. Detected ROI of Background model and foreground model is stored as temporaryarray.

Numerous iterations to the above input is provided, as the number of iterations increased, detection of foreground and background is done with highest accuracy. Grabcut is used to identifyRegionofInterest(ROI)andinitializedwithbo unding boxes. The following image shows the segmented image from object localization results.

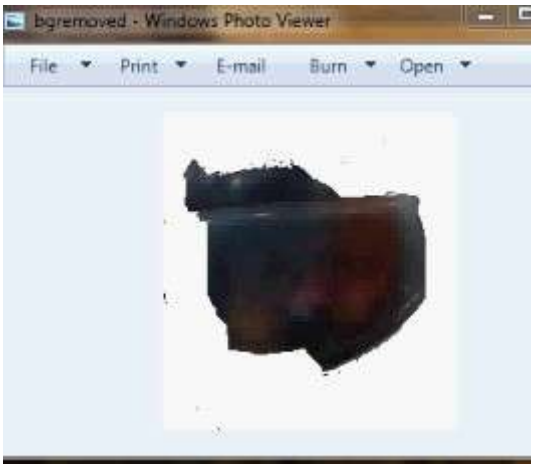

Figure 6: Localized Object IMAGE PRE_PROCESSING

Localizedobjectimagefromabovemoduleis pre-processedfor detecting skin portion. This module must be performed to identify whether person wearing or holding helmet on hands. This module is performed after backgroundsubtraction.

Backgroundsubtractedresultantimageiscon sideredforinputinthismodule,HueSaturationcolourco nversionfunctionisused BGR images are converted to HSV images. This assists in detection of skin portion in specified region of proposal. With someexperimentsconductedondevelopmentpart,the heightX width while wearing skin can be identified. This acts as threshold value and fixed for detection of safety helmet. Once the detected skin HXW value is equal or higher the threshold limits,itisconsideredthatpersonwearingandalertisge nerated to users as a textsms.

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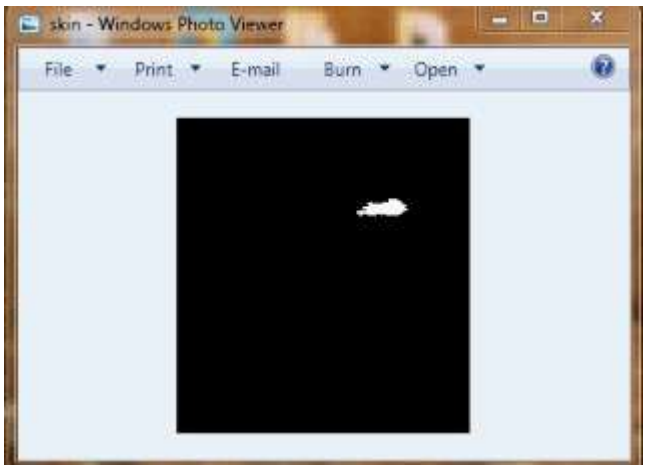


Figure 5: Skin portion detection

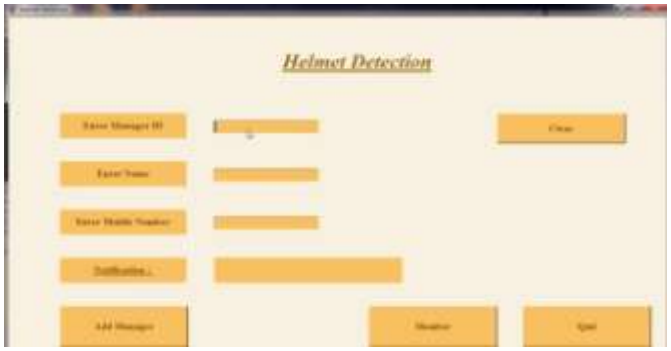
Above screen represents output of Hue Saturation converted image,inwhichwhitecolouredregionshowsskinportion.TheapplicationisintegratedtoSMSgatewayusingthirdpartySMS API (Application programming interface). Based on safety helmet wear detection, this integrated gateway send alert message to user registered to the application. OpenCV library hasafunctioncalledcontour,whichcanabletodetectboundary ofimageobject,thisboundarydrawnonHSVconverted image to identify the skin region of proposal.

Algorithm: Detection of Human Wearing Helmet

Step 1: Pre-trained model YOLO with weight and class file is imported with class for detection ='Helmet'
Step2:WebCameravideoiscapturedthroughOpenCV andget still images forprocessing
Step 3: Object performed using RCNN
if confidence value >= 0.92
Object = 'Helmet'
else
no helmet object
Step 4: Object segmentation on region of proposal is done
Step 5: Background subtracted image is processed for HSV color value detection
Step6:UpperandLowerboundaryrangesareidentified forskin
Step7:Drawaboundingrectangletomeasureheightand width
if height & width >thresholds skin detected
Step 8: Alert message is triggered for helmet wear detection

IV. RESULTS AND DISCUSSIONS

Safety Helmet wear monitoring for ATM security has been proposed as real time monitoring application considering web camerainput.Thelivevideostreamastakenasstillimagesand on every images, objection detection through R-CNN is proposed. This can detect multiple objects on input frames,the only object proposed for work is Helmet is identified and extracted with region of proposal. This is further processed for wear detection. Experimental results shown good accuracy of detection of safety helmet when a person is wearing. Deployment and maintenance cost of this application is less comparing other system.



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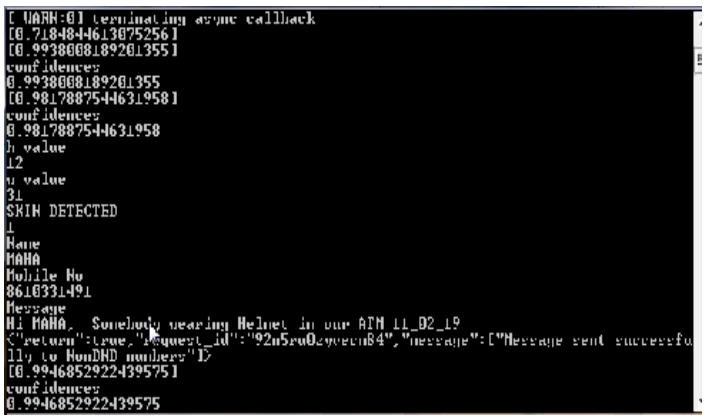
Theabovescreendepictstheapplicationhomepage,wh ereuser can enter their details to store in our application database for sendingalertSMS.ThisinterfacedesignedinTKinteris easeforpeople to handle. When the application is started, camera window opens and start to monitor continuously.

Following picture represents detection of Safety helmet on application background while executing with input image frames.



Confidence for object detection for finding Safety Helmet is given 90%, whenever the system detects the helmet with confidence 90 or above, the image cropped for further processing. Similarly, with experimental study, skin region of proposalheightandwidtharemonitoredfor10experim ents,to setthethresholdforskindetectioninapplication.Thisco nfirms person wearing helmet with highaccuracy.

Detection	Parameter	Value	Result
Object (Helmet)	Confidence	>= 0.92	Helmet detected
Object (Helmet)	Confidence	<0.92	No detection
Skin Detection	Height X Width	>=10	Skin detected
Skin Detection	Height X Width	<10	No detection

Table: Confidence Value for Object and skin detections

Safety helmet detection outperforms when the standard model Helmet is used by users. The detection latency may increase over the time period, as the infrastructure to be well built to handle the live stream of video cautiously. The system latency can be reduced on detection part in further study.

V. CONCLUSIONS

With the growing economy, liquidity increased among people, thus banking services needy among people for 24X7 and for quickaccessofmoney.However,securityofATMoutle tarebig threatsandneedtomonitoralltimefromfraudulentandr obbery activities. The proposed work considered ensemble model combining machine vision and image processing for providing ATM security surveillance. The proposed system can be implemented and maintained low cost, safety helmet wear detection can be accurately identified. YOLO pre-trained R- CNN object detection technique. Experimental results are demonstratedtoshowthedetectionandanalertmessage sentfor controlcentre.

The proposed system can able to identify only Safety Helmet wear, but the fraudulent robbers can use mask, this can beextended as future work.

Some more illegal activities and weapondetectionsuchasholdinggunorknifecanbeadded on the surveillancesystem.

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