An Efficient Human Activity Recognition with Improved Accuracy Using Advanced Deep Learning Techniques

Sajitha TM

VLSI and Embedded Systems Department
B.S.Abdur Rahman Crescent Institute of Science and Technology
Chennai, India
sajithasulaiman266@gmail.com

Dr.P.K.Jawahar

Professor

Department of Electronics and Communication Engineering

B.S.Abdur Rahman Crescent Institute of Science and Technology
Chennai, India
jawahar@crescent.education

***Abstract*--In the current technological developments humans are greatly dependent on machines and in particular robotic operations are increasing rapidly. When considering the robotic system, a combination of machine learning process and artificial intelligence programs are required in generating logical decision-making task to the robots. Through Human activity recognition models, robots or machines could predict human actions from images or videos. The existing Human activity recognition models are costlier which cannot be afforded for real time application. In this project, we will be using a LSTM algorithm to train the dataset and generate a model for human pose estimation which is real time deployable. It demonstrates an intelligent method of detecting human poses and automatically identifies human activity based on skeletal joint movements. This is an inexpensive method and is highly accurate. An independent mobile application is also developed to monitor the condition of the people and its surroundings when they are alone. A Notification API integration facilitates sending alert notification during abnormal condition can also implemented as a mobile application for future use. Thus, our project provides a way to help identify the human activities. This activity recognition is also demonstrated as an application for ATM security proving it suitable for real time application. In this way, our project provides an opportunity to help the elderly and children with all kinds of breakdowns and health problems.**

Keywords--Human Activity recognition, Data preprocessing, API, etc.

I. INTRODUCTION

HAR is a difficult time series classification task. This includes predicting human movements using detailed signal processing knowledge and methods, and correctly constructing features from raw data to fit machine learning models. Recently, deep learning techniques such as convolutional neural networks and recurrent neural networks have proven to be powerful, and can even achieve results by automatically learning features from collected data. .. In this post, I'll show you the problem of human activity detection and a good deep learning method for this problem.

Deep learning is a PC programming that imitates the association of neurons that are present. It is known as a part of AI and thus is called deep learning since it uses deep neural associations.

Each hidden layer is made up of neurons. Neurons are related to each other. The neuron then quantifies the data signal it receives and multiplies it in the upper layer. The strength of the sign given to neurons in the companion layer depends on weight, tilt, and activation work.

The organization burns-through a lot of information and works them through various layers; the organization can adapt progressively complex highlights of the information at each layer.

Deep learning is an inconceivable resource for make gauge a huge result. Deep learning rules in model disclosure (independent learning) and data based estimate. Colossal data is the fuel for deep learning. Right when both are joined, an affiliation can acquire marvelous results in term of productivity, bargains, the board, and advancement.

II. EXISTING METHODOLOGY

HAR is one of the most important application in AI and deep learning applications. Because of day to day technology development, the requirement for proper activity recognition without any physical wearable devices is the need of the hour.

The problem with the traditional HAR is that, it uses more number of sensors to identify the activity of the person. Usually accelerometer sensor known as angle sensor will be used for this kind of application. The accelerometer

sensor gives out 3 angle outputs namely x, y and z. these three angle values are recorded for each activity and it will be used for the training. But the problem here is, many activities sometimes will have same kind of angle changes. It finally reflects in wrong prediction of the activity.

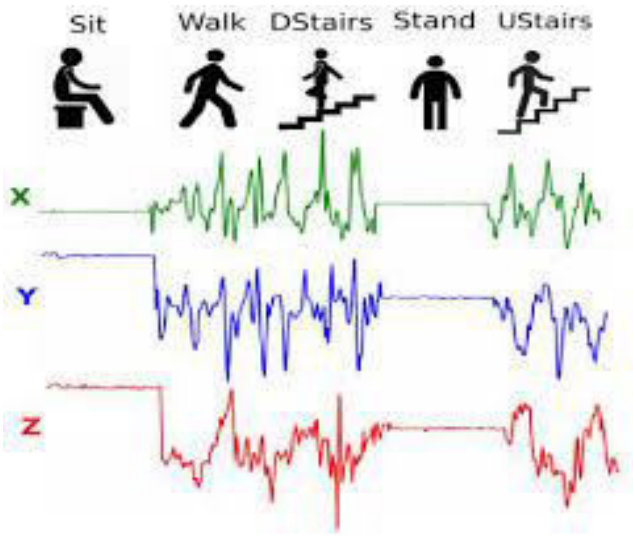

Fig. 1 Existing system working flow

As we can see in above diagram, it clearly shows the angle difference for each kind of motion in waveform format. And also the main problem in existing system is, it will create an uncomfortable feel for the person who wears it. So in practical scenario, predicting the human activity with the help of sensors and physical devices will only suitable for project level prototype and demonstration. But it is not suitable for real time day to day use as an industrial grade product or solution. So the need of developing new solution for HAR without any body connected sensors will be the proposed solution for this problem.

III. Literature Review

Yilin Dong al [1], have proposed a work based on hesitant fuzzy trust structure (HFS) with hesitant fuzzy set theory. They also presented a new rule of HFS used and evaluated the working in a wearable system with extreme machine learning (EML). This approach is been evaluated and verified using two datasets which proved to be effective enough from other types of wearable human action recognition systems available.

Jinqxiao Zheng et al, proposed a video-based recognition of face, that is used to restrict the person authorization based on the verified recognition. In most of the case, they used multi-scale face authentication. The perceived presence of faces are then brought together through painstakingly masterminded face association procedures.

Cheng et al[3], presented a work on face segmentor to parse the face into the neighborhood and to study their inward affiliations, which will make it more effective in the discriminability to see characters. Mainly, they adjusted a semantic parsing module with important pixels with a semantic part mark. This module makes a huge load of parsing maps, where other things looks for the probability obtained with the pixel data for the facial region.

Zhao et al [7], uses S2S distance to get the features of CNN pooling which is fetched from the distribution of human over the entire image and increase the prediction of distance in between the points where the features are combined than typical portion regular pooling and other standard score-standard pooling.

X. Guo et al[29] Robots ethical thinking Framework is developed here. The author presented a system in which deontic logic that can be modelled to find the ethical codes of multi agent systems of robots. Paper discussed automated Robotics solutions for standard deontic Logic. The goal of the work is to incorporate the ethical decisions of robot within a short span of time. It has been clearly depicted that around less than 3 seconds of time duration is taken by the robot to make the ethical decision.

Amiri et al[28] Automated reasoning platform for explainable Artificial Intelligence Framework is developed here. The author expanded the explainable artificial intelligence framework to develop the challenges in automated reasoning. Investigations of root of negative judgments in humans and cultural changes affect the robot decision-making process. The automated reasoning using explainable artificial intelligence predicts the rituals with higher transparency.

X. Guo et al[29] The activity recognition Framework is developed using Recurrent Plot. The usage of residual neural network architecture in image classification finds significant result comparing with the state-of-the-art approaches in terms of efficiency and accuracy. The proposed model determines the perspectives of human action recognition as a pattern of analysis provided by the trained inputs. Three-dimensional axial accelerometers are utilized here for the confusion problem. The modifying accelerometer reading determine the human activity automatically and that can be incorporated with the robotic system.

Erdem et al[27] The author presented a robotic system that captures the cash quality based planning and diagnostic reasoning. In a factory in case of multi-tasking robot is embedded with the system it needs to be planted with Diagnostic cause of failures after ask for are failed assistance. The system is embedded with execution and monitoring of given supervised frameworks that allow the computers to monitor the robots all the time. In case of failure occurs self-repairing system is nothing but the self-

automated reasoning system is developed inside the module to make the casual ATI effect immediately. [12] discussed about diabetic retinopathy from retinal pictures utilizing cooperation and information on state of the art sign dealing with and picture preparing. The Pre-Processing stage remedies the lopsided lighting in fundus pictures and furthermore kills the fight in the picture.

R. Klimek et al[31] Slam robots are one of the intelligent robotic localization system used in industries. The main problem of virtual multi-robot platforms are efficient localization and improved accuracy. Especially in large scale environments the Slam blue points need to be accurately mapped to stop the presented system focused on achieving the efficient Slam in both homogenous and heterogeneous robots. The system achieves the accuracy of 95% for global localization while comparing with the state-of-the-art approaches.

D.B.Martino et al[32]Due to lack of transparency between the humans and robotic systems an interactive human- robot communication system is developed. A novel system propose the perception mechanism that incorporate the teleportation frameworks and human activity combine to form an environment to give the visual feedback. Imitating the human behaviour the robot can understand the things quickly. Using hidden semi-markov model and Russian mixture method robot trajectory mechanism is developed. Using EMC data the robot understand the behaviour of the humans and learn the stability factors quickly.

L Sun et al[36] Discuss the network robots operations and controls the usage of synthetic intelligence. The hassle fixing abilities of Robotics are genuinely mentioned within side the given paper and the author awards the robotic cognitive operations in accurate location. The location formulation is achieved only by the iterative learning frameworks.

R. Bamdale et al[34] Presented paper speak the commercial Robotics for probabilistic networks with subject matter the usage of Visual identity and rapid independent trajectory function for given robotic version the probabilistic networks are analyzed. The robotic operation abilities are keenly mentioned on reasoning issues and hassle fixing abilities. The network assignment is important for robot localization.

IV. Proposed Method

In this project, we are going to determine the human activity recognition by which we can overcome the existing disadvantage and provide a real time feasible human activity recognition model. So, the first step in the project will be collecting the dataset. Skeletal joint features are collected in real time using video collection and two activities such as breaking the machine and a normal action is collected which is suitable for ATM application. 2D feature extraction is carried out in which the skeletal joint points features are extracted and stored as a excel file which is suitable for the training process. OpenPose algorithm is used to extract the features of the activity. Data in the excel sheet with each action is named a specific keyword to identify the action after training such as 0 for normal action and 1 for abnormal action such that if the trained action is detected it will show the result as 0 or 1. Based on this we can predict the normal and abnormal activity. Machine learning algorithm such as LSTM is then used to train the dataset and generate the model file which will have all the features trained. When real time recognition is carried, whichever activity is recognized is been compared with the features of the model file and we get the output when trained normal and abnormal activity is determined. As the abnormal activity is determined, a notification is sent to the mobile app via Firebase integration. As the app is opened live streaming can be seen along with 2 button options. Using those button option one can trigger the gate closing and alarm on command. MQTT protocol integration which is a wireless data transfer protocol via which the data is transferred between hardware and mobile app.

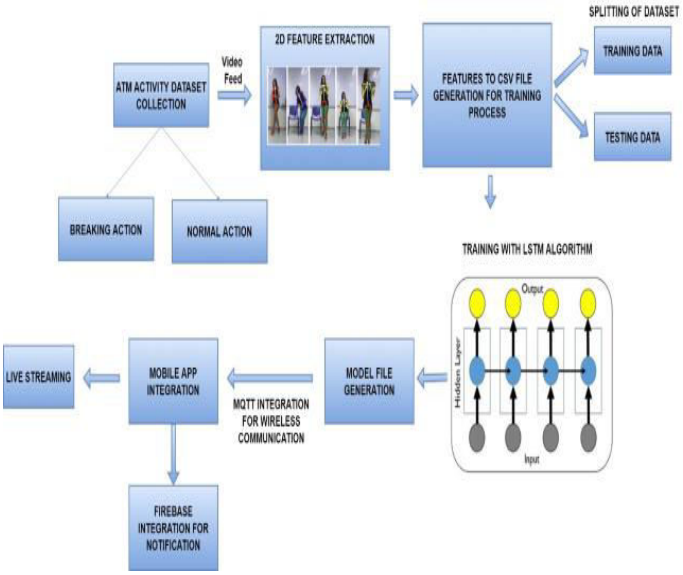

Fig. 2 Proposed Architecture

A. *Dataset Collection*

A dataset file is a collection of data. The skeletal joint based dataset is used for the proposed system. Dataset search was conducted through kaggle website. Important learning received a Goto system for handling many certified test questions. This is certainly by far the most powerful system for PC Vision efforts. Manual data is also collected in forms of videos to differentiate between normal and abnormal activity in an ATM as this project demonstrates an application developed for ATM. Walking is considered a normal action whereas breaking action is considered to be

abnormal. The below table provides the details about the activities collected,

TABLE I. ACTIVITY COLLECTION

Intermediate frames of an action	Predictions	Ground Truth
	Breaking	Breaking
	Walking	Walking

B. Data Labelling

Data set labeling is just a process by which each dataset is given a label of its own such that during the training process, the machine is capable of identifying it. When the machine learns the dataset with its labels mentioned it extracts the features of a particular data with its labels which makes it easy for the machine to predict the process. Thus, this helps in training the model effectively. [2] proposed a secure hash message authentication code. A secure hash message authentication code to avoid certificate revocation list checking is proposed for vehicular ad hoc networks (VANETs).

C. Training with LSTM

To train the human activity dataset efficiently, a LSTM algorithm is used as it has proven its high accuracy. The LSTM model is suitable for a simple bundling of layers where each and every layer has one input and one output. LSTM is the easiest way to create a model in Keras. It makes to obtain the model layer by layer. Each class has weights according to the layer which is following it. The below figure shows the LSTM sequential algorithm used.

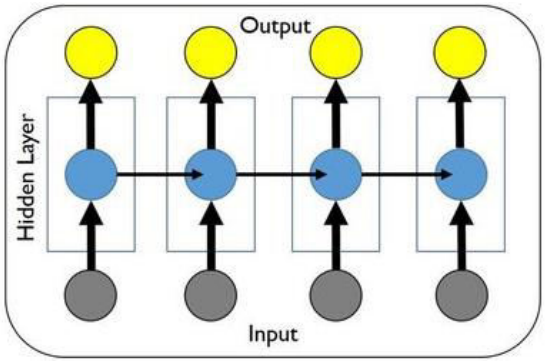

Fig. 3 LSTM

From the model file obtained after the training process prediction is done to find out the performance of the model as well as improve it by repeating the training process with modifications. [4] proposed a novel method for secure transportation of railway systems has been proposed in this project. In existing methods, most of the methods are manual resulting in a lot of human errors. This project proposes a system which can be controlled automatically without any outside help. [10] discussed that Helpful correspondence is developing as a standout amongst the most encouraging procedures in remote systems by reason of giving spatial differing qualities pick up.

D. Performance Analysis

The accuracy obtained via the trained model seems to be good enough for real time usage. The current system is tested with few activities collected and trained whereas including many activities may lead to inefficiency. In order to overcome that disadvantage more training and change/enhancement of algorithm may be needed. From the obtained results, it is seen that we can efficiently use it for abnormality prediction. [8] discussed because of various appealing focal points, agreeable correspondences have been broadly viewed as one of the promising systems to enhance throughput and scope execution in remote interchanges.

E. Mobile App Integration

A mobile app is been independently developed for this application where it can be applied for ATM machine protection. The hardware which consists of jetson nano and camera as well as the mobile app are integrated using the firebase technology. As an abnormal action is been predicted in front of the camera, it automatically sends notification to mobile app and live streaming is enabled. [6] discussed that the activity related status data will be communicated consistently and shared among drivers through VANETs keeping in mind the end goal to enhance driving security and solace.

V. RESULTS OBTAINED

To begin with, the project is splitted into number of modules and step by step implementation results can be seen as follows.

Dataset collection is a process by which Activity Recognition Dataset are collected.

The dataset has been collected for the project in form of videos and the below figure can be seen as follows:

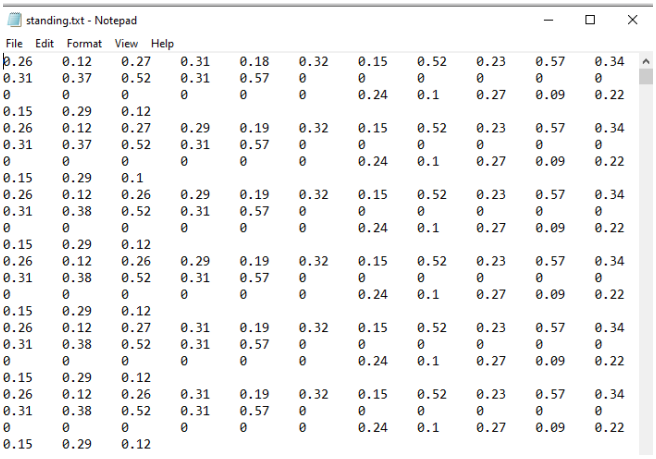

Fig. 4 Dataset Collection – Standing Activity

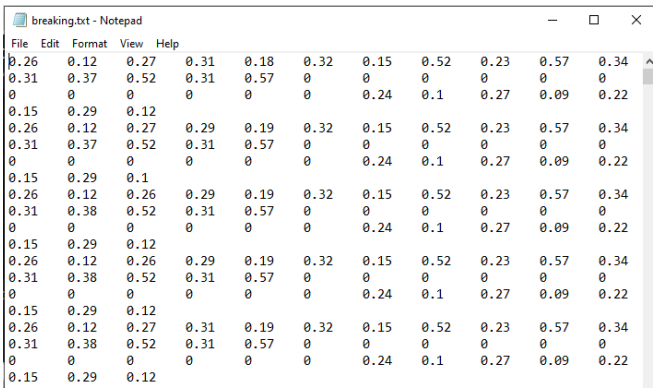

Fig. 5 Dataset Collection – Breaking Activity

After that, extracting skeletal joint features from the dataset using OpenPose algorithm. The below Fig. 6 shows, the process by which the features are extracted.

Fig. 6 Feature extraction

After extracting features, these features are stored in csv file. The below figure shows the stored features.

	nose_x	nose_y	neck_x	neck_y	Rshoulder_x	Rshoulder_y	Relbow_x	Relbow_y	Rwrist_x	RWrist_y
0	0.26	0.12	0.27	0.31	0.18	0.32	0.15	0.52	0.23	0.57
1	0.26	0.12	0.27	0.29	0.19	0.32	0.15	0.52	0.23	0.57
2	0.26	0.12	0.26	0.29	0.19	0.32	0.15	0.52	0.23	0.57
3	0.26	0.12	0.26	0.29	0.19	0.32	0.15	0.52	0.23	0.57
4	0.26	0.12	0.27	0.31	0.19	0.32	0.15	0.52	0.23	0.57
...	...	...	...	...	...	...	...	...	...	...
4696	0.34	0.10	0.32	0.36	0.20	0.35	0.00	0.00	0.00	0.00
4697	0.34	0.10	0.32	0.36	0.20	0.33	0.00	0.00	0.00	0.00
4698	0.34	0.10	0.32	0.36	0.20	0.33	0.00	0.00	0.00	0.00
4699	0.34	0.10	0.32	0.35	0.20	0.33	0.00	0.00	0.00	0.00
4700	0.34	0.10	0.32	0.35	0.20	0.33	0.00	0.00	0.00	0.00

4701 rows x 37 columns

Fig. 7 Output of stored features

The LSTM algorithm is used for training the features extracted. The below figure shows the LSTM training output.

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 81)	2997
batch_normalization (BatchNormalization)	(None, 81)	324
dense_1 (Dense)	(None, 27)	2214
batch_normalization_1 (BatchNormalization)	(None, 27)	108
dense_2 (Dense)	(None, 9)	252
batch_normalization_2 (BatchNormalization)	(None, 9)	36
dense_3 (Dense)	(None, 2)	20

Total params: 5,951
Trainable params: 5,717
Non-trainable params: 234

Fig. 8 LSTM training output.

The below figure shows the LSTM classification report and it can be seen that we have achieved an accuracy of 100%.

[INFO] evaluating network...

	precision	recall	f1-score	support
normal	1.00	1.00	1.00	248
abnormal	1.00	1.00	1.00	223
accuracy			1.00	471
macro avg	1.00	1.00	1.00	471
weighted avg	1.00	1.00	1.00	471

Fig. 9 LSTM classification report.

The below figure shows the LSTM model loss during the process of train and validation.

Fig. 10 Decrease in loss during training and validation of LSTM

The below figure shows the LSTM accuracy during the process of train and validation.

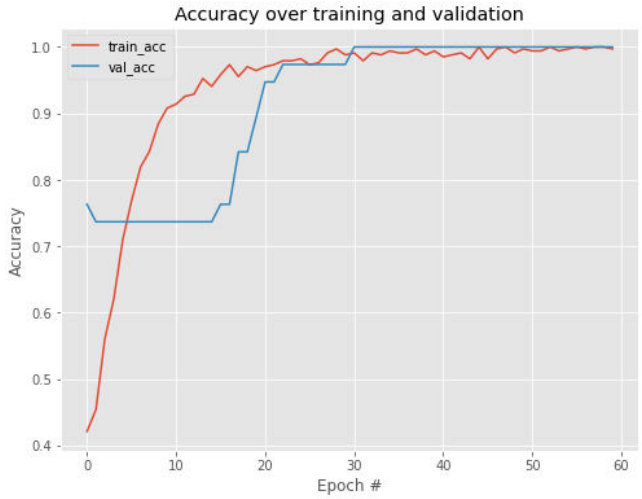

Fig. 11 Increase in accuracy during training and validation of LSTM

As the above results with accuracy is obtained it can be compared with the existing methods and the accuracy comparison can be seen in the below TABLE II

TABLE II. ACCURACY COMPARISON

Methods	**Accuracy**
Yilin Dong al [1]	95.45
Jinqxiao Zheng et al [3]	95.34%
Chhavi Dhiman et al	87.3%
Cho Nilar Phyo et al[14]	97%
Lei Wang et al[18]	96.5%
X. Guo et al[29]	95%
Proposed Method	100%

The hardware kit developed with the help of Jetson Nano, Logitech camera can be seen in the below given figure

Fig. 12 Hardware Kit

The prediction of Normal and Abnormal activity using LSTM model is shown in the below figure.

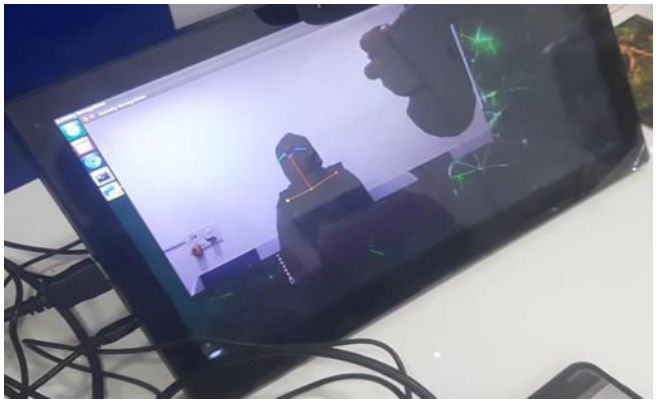

Fig. 13 Prediction of Normal activity using LSTM Model

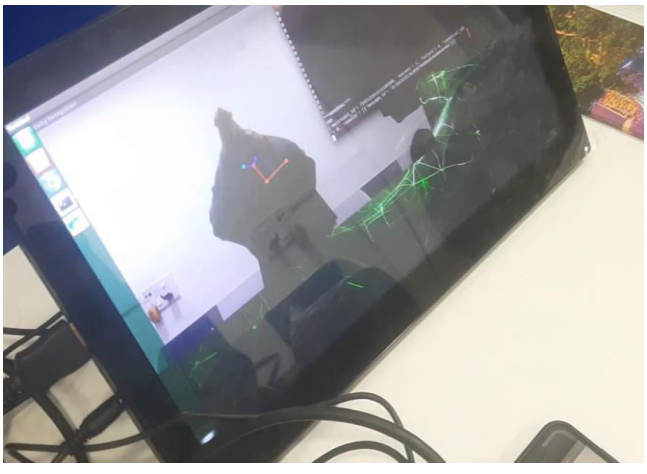

Fig. 14 Prediction of Abnormal activity using LSTM Model

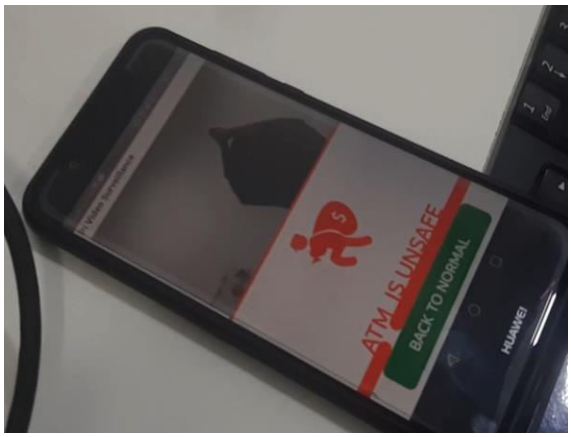

Fig. 15 LiveStreaming in the MobileApp

As the abnormal activity is predicted, notification is sent to the mobile app via firebase integration and live streaming is initiated. The mobile app also allows taking actions to stop the theft.

From the above results we can see that the LSTM algorithm has been successfully implemented to automatically recognize the human activity.

VI. Conclusion

Thus, in this project a human action recognition system which is helpful in recognizing the daily human activities uses the currently prevailing deep learning approach. We developed an effective skeleton based HAR. The algorithm such as LSTM is used for determining as well as classifying the activities of a human. This approach overcomes the disadvantage of the existing system and provides more accuracy in activity determination than the usage of sensor based technology. Using which we have developed a system to effectively protect and secure the ATM. We have developed a react native application so that we can view the live streaming with a notification when an abnormal activity in an ATM is detected. There is lot of scope to improve the technology and it is cheap and effective solution for real time ATM surveillance.

VII. Future Work

In the future we can even make this system suitable for many such applications such as elderly people monitoring in homes, anomaly monitoring in required areas and much more. It can be tested for various activity prediction and use efficient algorithms to accurately predict the activities in any given field. Thus this project finds a huge scope in the future with more advancements and real time testing.

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