A New CNN Based Fall Detection Method

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Abstract— Nowadays, empty nest problems are becoming more and more severe. In the busy life most of the Seniors are alone In home. in addition, fall is very dangerous for the seniors and may lead to death. Sensors are used for the fall detection. Also fall detection using machine learning algorithm is more accurate and faster. In the upcoming era of Artificial inelegance world to improve the performance of the fall detection implement a CNN model. Major algorithms in machine learning that used in fall detection was support vector machine, decision tree, k-means clustering. CNN provide much more accuracy.

Keywords: Fall detection, Artificial inelegance, Machine learning, Support vector machine, decision tree, k-means clustering, CNN

I. INTRODUCTION

Many seniors live alone so if they fall down, their families cannot find out. However, with the alarm system which can automatically send messages when falls are detected, their families or hospitals can react quickly to save lives or reduce the severity of injuries. Therefore, automatic fall detection for seniors is required in smart home and smart healthcare system. Currently, there are three methods for fall detection, including wearable sensor, ambient sensor and video-based detection.. In this paper proposed a CNN. This is a 2D Video-based detection. It provides higher accuracy and reliability. Human pose estimation is done using the openpose. The pose data is to be the input of the CNN. Using the CNN features are extracted and find the probability of the fall. If the fall is detected alarm is rang

II. MOTIVATION

Fall is a frequently happened event. Concretely, one-third of seniors fall down each year . Fall is not a big deal for teenagers, but is very dangerous for seniors because it may cause some severe disease such as hip fractures, head injury and heart attack.

Due to the physical weakness associated with aging, the elderly suffer high ratios of falls which frequently imply negative consequences for their health. Falls are one of the major causes of mortality in old adults. This can be explained in part by the high incidence of falls in adults over the age of 65: one in three adults falls at least once per year. In addition, the impact of these falls is a major concern for health care systems.

It has to be noted that falls lead to moderate to severe injuries, fear of falling, loss of independence, and death of the third individual of the elderly who suffer these accidents. Moreover, the costs associated with these health problems are not negligibl

In reality, many seniors live alone so if they fall down, their families cannot find out. However, with the alarm system which can automatically send messages when falls are detected, their families or hospitals can react quickly to save lives or reduce the severity of injuries.
Currently, there are three methods for fall detection, including wearable sensor, ambient sensor and video-based detection. Wearable sensor: Wearable sensor can provide high sensitivity and specificity while it also has some drawbacks.

Seniors may forget to wear their sensors or forget to recharge. To overcome this problems implement a deep learning method. It will overcome the existing problems in fall detection and provide ,ore accurate results

III. LITERATURE SURVEY

Much work has been done in the area of fall detection systems. I did a literature survey with respect to the following aspects, and the survey results are presented below. The current research on the wearable system design for a geriatric healthcare monitoring system for detecting falls can be classified into

1) Infrared sensor based
2) Microphone based
3) Accelerometer based and
4) Smartphone based systems.

The parameters monitored by such existing fall detection systems include the following: HRV, Electrocardiogram (ECG), biosensor readings (Mean RR, SDNN, pNN50, LF, HF, LF/HF ratio), RMS of acceleration as measured by accelerometers, gyroscope readings (angular velocity), and magnetometer readings. Such systems can broadly be classified into threshold-based and machine learning based systems

Timc-Imag et al. proposed A Smart Sensor For The Remote Follow Up Of Activity [1] system for Home health care sounds to be a convenient solution for the elderly person not willing to abandon her natural environment for a living in a hospital. But as most of the older subjects leave alone on their own and because of the isolation, it is necessary to guarantee **a** more precise follow up of the health and security status of the person.

The new device is being evaluated with the same protocol, and already it gives better results, even with the side fall which is detected. Improvment the algorithm with data fusion and decision making based on fuzzy logic. The main problem to address now is to be sure that the person will be wearing the device.

Already I can be informed when it is not the case as I detect the “physiological body vibrations”. Another way is to integrate the fall sensor in a garment. Actually I are working on this last solution in collaboration with textile engineers

Paola Pierleoni et al. proposed A High Reliability Wearable Device For Elderly Fall Detection [2]. Falls are critical events among elderly people that requires timely rescue. In this paper propose a fall detection system

consisting of an inertial unit that includes tri axial accelerometer, gyroscope and magnetometer with efficient data fusion and fall detection algorithms.

The orientation sensors are integrated within a compact module allowing the owner to move unrestricted and data are transmitted wirelessly. The fall detection algorithm was validated through experimental tests including simulated falls, simulated falls with recovery and ADL. The experimental tests were conducted according to both the protocols proposed by Noury and Kangas. Performance of the proposed monitoring system were evaluated by computing sensitivity and specificity of algorithm and then compared with those obtained from three detection algorithms proposed by Kangas.

An ideal fall detector should exhibit 100% average accuracy, sensitivity and specificity. Results show that proposed monitoring system performed better than Kangas algorithms. In particular, taking into account the protocol proposed by Kangas, obtained 100% average accuracy, sensitivity and specificity.

Ahmet Turan Özdemir et al. proposed Detecting Falls With Wearable Sensors Using Machine Learning Techniques [3]. To reduce the computational complexity of training and testing the classifiers, focus on the raw data for each sensor in a 4 s time window around the point of peak total acceleration of the waist sensor, and then perform feature extraction and reduction. Most earlier studies on fall detection employ rule-based approaches that rely on simple thresholding of the sensor outputs. Successfully distinguish falls from ADLs using six machine learning techniques (classifiers): the k-nearest neighbor (k-NN) classifier, least squares method (LSM), support vector machines (SVM), Bayesian decision making (BDM), dynamic time warping (DTW), and artificial neural networks (ANNs).

The performance and the computational complexity of the classifiers and achieve the best results with the k-NN classifier and LSM, with sensitivity, specificity, and accuracy all above 99%. These classifiers also have acceptable computational requirements for training and testing. employ six classifiers based on machine learning to distinguish between falls and ADLs using previously proposed, standardized experimental procedures. compare the performance and computational requirements of the machine learning techniques based on the same dataset and achieve accuracies above 95%. The repeatability of the results over the 10 runs indicates the robustness of the classifiers. The k-NN and LSM methods do not miss any falls; thus, consider them reliable classifiers. These classifiers also have acceptable computational requirements for training and testing, making them suitable for real-time applications.

The fact that use standardized experimental procedures to perform a comprehensive set of fall experiments sets an example in the fall detection area. This also makes approach more applicable to real-world scenarios where data records of indeterminate length, containing multiple activities in sequence, are recorded. plan to test the system with continuous data streams acquired from falls and ADLs. To enable comparison among the algorithms developed in different studies, intend to make dataset publicly available at the University of Irvine Machine Learning Repository.

Daily and sports activities dataset is already available at the same website. In current work, are investigating which of the six motion sensor units and which axes of these sensors are most useful in activity and fall detection incorporating information from biomedical sensors for vital signs and audio sensors may further improve the robustness of fall detection system. ongoing work considers embedding fall detection algorithms to a mobile device (e.g., a smartphone) to be worn around the waist level.

Luca Cattelani et al. proposed Frat-Up, A Rule-Based System Evaluating Fall Risk In The Elderly [4]. About one-third of persons over 65 are subject to at least one fall during a year, and many of them are subjected to health, psychological and financial consequences. A requirement to improve the effectiveness of preventive interventions is to timely identify subjects at higher risk. In this work introduce the Farseeing Fall Risk Assessment Tool (FRAT-up), a software tool for evaluating the fall risk of a subject, based on known risk factors. The tool is based on probabilistic rules, generated automatically from a light ontology capturing the scientific findings about risk factors. FRAT-up has been tested on the InCHIANTI dataset, showing performances comparable with state-of-the-art tools. An innovative web-based methodology for fall risk estimation in the elderly was presented, that combines scientifically validated sources of fall risks already present in the literature and transforms them in a single risk factor value by using statistical methods and logic programming. There is no use of data sets for training purposes: all the model parameters are generated starting from widely available scientific references.

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Pranesh Vallabh et al. proposed Fall Detection Using Machine Learning Algorithms [5]. In this paper, the recognition of and the differentiation between fall activities and activities of daily living (ADL) was performed using the MobiFall dataset. A large database was constructed to train and validate the model. Feature selection methods were implemented to reduce dimensionality. Five different classification algorithms were implemented and evaluated based on their accuracy, sensitivity, and specificity achieved. The k- Nearest Neighbors' algorithm obtained an overall accuracy of 87.5% with a sensitivity of 90.70%, and a specificity of 83.78%. In this paper, different classification methods were implemented for fall detection and they were able to distinguish between ADL and fall activities in the "MobiFall" dataset. The data was pre-processed by a median and low-pass filter.

A filter rank based system was implemented to extract the top five features in order to optimize algorithm's dimensionality. The five classification methods that were

implemented are: Navie Bayes, k-NN, ANN, SVM, and LSM. The k-NN with k equal to 5 achieved an 87.5% accuracy The versatility of the presented solution will allow to combine clinical information with other sources of data, like wearable sensors recording physical activity.

Kabalan Chaccour et al. proposed From Fall Detection To Fall Prevention: A Generic Classification Of Fall-Related Systems [6]. Falls are a major health problem for the frail community dwelling old people. For more than two decades, falls have been extensively investigated by medical institutions to mitigate their impact (e.g. lack of independence, fear of falling, etc.) and minimize their consequences (e.g. cost of hospitalization, etc.). However, the problem of elderly falling does not only concern health-professionals but has also drawn the interest of the scientific community. In fact, falls have been the object of many research studies and the purpose of many commercial products from academia and industry. These studies have tackled the problem using fall detection approaches exhausting a variety of sensing methods. Lately, researcher has shifted their efforts to fall prevention where falls might be spotted before they even happen. Despite their restriction to clinical studies, early-fall prediction systems have started to emerge. At the same time, current reviews in this field lack a common ground classification. In this context, the main contribution of this article is to give a comprehensive overview on elderly falls and to propose a generic classification of fall-related systems based on their sensor deployment.

An extensive research scheme from fall detection to fall prevention systems have been also conducted based on this common ground classification. Data processing techniques in both fall detection and fall prevention tracks are also highlighted. The objective of this work is to deliver medical technologists in the field of public health a good position regarding fall-related systems. Aging is inevitable, whether it ends with no, mild or severe pathologies, it is always decent to age with good quality of life. Efforts to reach this objective do not lie on the medical force alone; it is therefore the joint effort between health professionals and scientists to address public health issues. From this standpoint, we have tackled in this review article an old-recent problem in the field of public health: the problem of elderly falls. The subject was undertaken according to two research tracks: (1) fall detection and (2) fall prevention. The article gave a basic understanding on elderly falls, their intrinsic and extrinsic causes and their consequences. The main contribution of this paper is a four-level common ground classification where fall related-systems were categorized into wearable, non-wearable and fusion according to their sensor deployment. The proposed common ground scheme provides a global overlook over the systematic studies related to elderly falling which hasn't been seen in previous reviews with an emphasis on fusion systems. Smartphone based solutions were also considered in this classification.

Arkham Zahri Rakhman et al. proposed Fall Detection System Using Accelerometer and Gyroscope Based on Smartphone [7]. Most of people likes living independently at home. Some activity in daily life is prone to have some accidents, such as falls. Falls can make people in fatal conditions, even death. A prototype of fall detection system using accelerometer and gyroscope based on smartphone is presented in this paper. Accelerometer and gyroscope sensors are embedded in smartphone to get the result of fall detection more accurately.

Automatic call as an alert will be sent to family members if someone using this application in fatal condition and need some help. It can also distinguish condition of people between falls and activity daily living. Several scenarios were used in these experiments. The result showed that the proposed system could successfully record level of accuracy of the fall detection system till 93.3% in activity daily living and error detected of fall was 2%. In this paper, a fall detection system prototype for smart phones was proposed. Sensor data was sampled from a smart phone user who had it placed on their left chest. Falling detection based on threshold detection algorithm was modified.

The prototype system gave promising results, the results of tests that were conducted obtained an accuracy of 93.33% of the 120 trials fall, and an average accuracy of 98% of the ADL 2 10 times the total experiment. The moment a person fell, the system will detect and activate an alarm system. However, further work is still needed in order to handle different types of falling situations that could happen. This research is still limited to detection. Future development can be done with the addition of several features such as sending short messages (SMS) and position determination using GPS

Young Sook Lee et al. proposed Multiple Object Tracking for Fall Detection in Real-Time Surveillance System [8]. In this paper, present multiple object tracking to detect falls using a low-cost single and un calibrated camera in real-time environment. Until now, existing studies for faU detection only presented their methods for a single person tracking. Occlusion problem is one of the main challenges in health care surveillance systems. For occlusion handling, 2D modeling tracking to multiple object tracking is not enough. The algorithm using 3D spatio-temporal templates is applied to occlusion problems for detecting and tracking people accurately. use 2D trajectory information obtained in order to distinguish fall activities from normal daily activities.

The experimental results show robust multiple object tracking and a good detection rate of falls in real-time. In this paper, a novel algorithm for real-time multiple object tracking of fall detection in the elderly using a static USB Ibcam is proposed.

The proposed system is able to track people individually and accurately after occlusion. The experimental results show the successful fall detection rate of 96.3 % even though the low quality video sequences obtained by a USB PC camera. Efforts to reach this objective do not lie on the medical force alone; it is therefore the joint effort between health professionals and scientists to address public health issues.

Nabil Zerrouki et al. proposed Combined Curvelets and Hidden Markov Models for Human Fall Detection [9]. Fall events detection is one of the most crucial issues in the health care of elderly people. This paper proposes an innovative approach for reliably detecting fall incidents based on human silhouette shape variation in vision monitoring. This mission is achieved by: (i) introducing the

curvelet transform and area ratios for identifying human postures in images; (ii) reducing the feature vector dimension using differential evolution technique; (iii) identifying postures by a support vector machine, and (iv) adapting a hidden Markov model for classifying video sequences into non-fall and fall events. Experimental results are obtained on several "Fall Detection" datasets. For evaluation, several assessment measures are computed. These evaluation measures demonstrate the effectiveness of the proposed methodology when compared to some state-of-the-art approaches.

Pattern recognition techniques and video camera monitoring are both used to design reliable fall detection strategy. The human body characterization was performed by the introduction of curvelet coefficients and body area ratios as attributes. First, a posture identification was performedusing an SVM classifier. Then, to discriminate fall events from other daily activities, an HMM model with reject decision was applied.

The experimental validation was applied on real frame sequences of consisting of daily activities and falls. The obtained result showed that the algorithm allows reliable fall detection with a reduced error rate. The complete system, comprising human body segmentation, feature extraction and selection, posture classification and fall identification is working in real time. This system can be applied to home care emergency detection when old people suddenly fall or remain in the lying posture.

Shengke Wang et al. proposed Human Fall Detection In Surveillance Video Based On PCANet[10]. Fall incidents have been reported as the second most common cause of death, especially for elderly people. Human fall detection is necessary in smart home healthcare systems. Recently various fall detection approaches have been proposed, among which computer vision based approaches offer a promising and effective way. In this paper, proposed a new framework for fall detection based on automatic feature learning methods. First, the extracted frames, including human from video sequences of different views, form the training set.

Then, a PCANet model is trained by using all samples to predict the label of every frame. Because a fall behavior is contained in many continuous frames, the reliable fall detection should not only analyze one frame but also a video sequence. Based on the prediction result of the trained PCANet model for each frame, an action model is further obtained by SVM with the predicted labels of frames in video sequences. Experiments show that the proposed method achieved reliable results compared with other commonly used methods based on the multiple cameras fall dataset, and a better result is further achieved in dataset which contains more training samples.

New framework for fall detection based on automatically feature learning methods. extracted features with PCANet, and trained two SVM classifiers to detect fall incidents. With the two models, the experiments show that proposed method can achieve a nearly equal performance in the Multi-Camera Fall Dataset compared with other state-of-the-art methods. Moreover, obtained a better performance when increasing the training samples in dataset. believe the performance can be further improved if a larger scale dataset is used and more number of camera views is involved.

IV. PROPOSED SYSTEM

Automatic fall detection using deep learning. A computer model learns to perform classification tasks directly from images. In proposed system use some more features – Height, Angle, Pose data. Feature extraction becomes an integral part of classification and is no longer considered as a separate, independent processing step. Considering the Video as the sequence of images. Calculate the probability of the fall. Architecture diagram shown in figure 1.

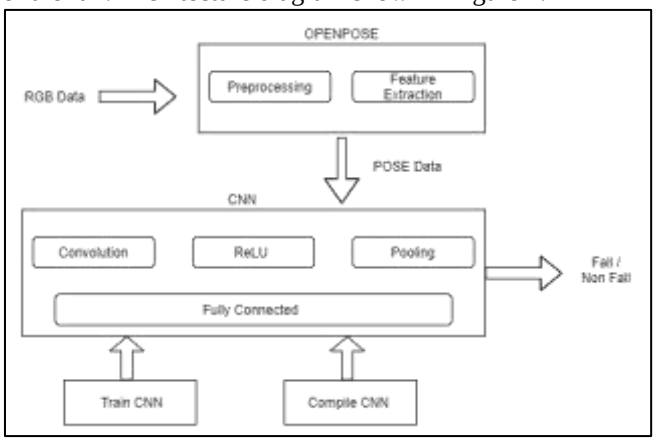

Fig. 1: Architecture diagram

Propose a novel 2D video-based fall detection pipeline with human pose estimation. Firstly, the video is spits in to the sequence of images. I used OpenPose to extract the positions of human joints in raw data. Extract 14 key joints. Then the human body is detected in the image. For better accuracy remove the background and covert to the contour format. The image is resized then Secondly, these data with augmented features became the input of a CNN - convolution neural network so that I can extract multi-layered features. Key joints, angle, height are extract with the CNN Ii used VGG-16 Format of CNN. the Thirdly, a binary classification was conducted through neural network.

V. IMPLEMENTATION

The training is done by the FDD dataset and validation data is shuffled. Process the training and validation data according to the batch size.Fall Detection Dataset is the dataset have Realistic video surveillance data recorded by a single camera With 25 FPS and 320x240 resolution. It contain 191 videos and labels Multiple scenarios, including home, coffee room, office and lecture room Convolutional neural network model training with transfer learning.

Key point detection can be done with the openpose The video is coveted into sequence of images. OPENPOSE is used for key point detection. It is Built by Perceptual Computing Lab at CMU. Openpose is a Built-in function in OpenCv. Images is append to the tf_pose.estimation function and detect the key joints.

Need only 14 pure key points it include onlu on the main joints of the body.Detect the 14 key points. Each key point act as a node. Nodes form a dense connection graph. It figure out the Skelton like model of the human body.

The images are loaded into the image column and resized so Tensorflow can handle the size. The image is converted into 128x128x3 size by use image resize function from skimage.transform . Each image is represented by n crops. The crops are then encoded. Use image. Crop function from PIL . Cropping type is box it pass as a parameter Function parameters are input image and fixed size value. Then the image is converted into Gray scale then to contour format this will be the input of CNN.

Cnns are composed of several convolutional layers, each involving linear and nonlinear operators. Cnns are a supervised learning method and are therefore trained using data labeled with the respective classes. Cnns learn the relationship between the input objects and the class labels. The hidden layers in which the features are extracted. At the end of the processing, the fully connected layers that are used for the actual classification task.

The hidden layers of a CNN have a specific architecture Each layer is formed by a set of neurons and one neuron of a layer is connected to each neuron of the preceding layer. Cnn can directly learn the relationship between the raw pixel data and the class labels through end-to-end learning. The front layers of a CNN contain more generic features (eg, edge or color-blob detectors) that are useful for many tasks. The back layers of the cnn become increasingly specific to the details of the classes contained in the original dataset.

Construct sequential convolutional model with VGG-16. Create convolutional layer of 13 convolutional layers and 3 fully connected layers. fall dataset to train the last fully connected layer. It help to reduce number of iterations. Line up the feature and the image. Multiply each image pixel by corresponding feature pixel. Add the values and find the sum.

Divide the sum by the total number of pixels in the feature Create pooling layer here use maxpooling layer of size 2. Using the convolutional and pooling layer perform feature learning. In convolution layer use rectified linear unit function as activation function. Creating the model and it saved in hdf format Using this model predict the probability of fall. If the probability is higher than .8 fall is detected then the alarm is rang

VI. Result

The results are shown below. On testing it shows 98% accuracy.100 input are given and predict 98 of them correctly.

Figure 2: This Situation is detected non fall and alarm status is off.

Fig. 3: This Situation is detected fall and alarm status is on.

VII. Conclusion

Proposes a novel 2D video-based fall detection pipeline with human pose estimation as the method of feature augmentation.

First used OpenPose to extract 14 human body keypoints. Then, these data with augmented features passed as the input of a convolution neural network it can extract multi-layered features.

Finally, a binary classifier soft-max function calculate the probability of the fall. Provide 96.3 of accuracy in the testing.. In the future, researchers may conduct more experiment difficulty of fall detection in dark environment at night and outdoor environment, currently no many papers discussed those situations.

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