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Fall Detection of Elderly People and Alert System

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Abstract: The fall detection system has grown in importance within the homecare system in recent years. Among the elderly, accidental falls are a common source of damages, fatalities, and loss of control. Accident falls also significantly affect the costs of the national health system. Therefore, there is a need for in-depth research and the creation of fall detection technology to save elderly people. This article offers a thorough analysis of contemporary fall detection methods taking into account the most potent deep learning technique yolo algorithm which uses convolutional neural network (CNN) layers in recognizing persons and detects fall based on height and width dimension analysis of a person. This fall detection technique uses neural networks, open source human detection dataset, yolo v3 pre-trained model which make more reliable and accurate than the conventional fall detection methodology.

Keywords: Convolutional neural networks, bounding box, yolo, Gaussian blur.

I. INTRODUCTION

Falls are one of the major causes of death for elders. The ability to recognise the fall is vital for lifesaving. Wearable, ambient sensor, and vision-based approaches are three of the more popular types of fall detection [1]. The biggest cause for concern is health, whose risk grows as we become older. Accordingly, caring for the elderly is a huge responsibility. In this situation, technology aids people by giving them living guidance. Falling is one of the leading causes of health problems or elder death [2]. Population ageing is the movement of a nation's population toward older ages, and it is becoming more prevalent day by day. Falls are one of the many health-related issues facing an ageing society. Fall-related injuries are among the major problems facing the elderly. Falls can cause critical injuries such head trauma, bone fractures, and cuts and bruises, all of which pose a significant risk to one's health. It is necessary to identify falls so that help can be given right away and injuries can be prevented. A bigger danger exists for elderly people who live alone, and they require medication support. If falls go unrecognized for a while, there may be a greater risk to one's health. In the case that supportive procedures are employed, a signal of alarm will be conveyed to caretakers via some kind of communication, and the caregivers will then aid the elderly. An excellent fall detection system is useful for keeping an eye on the elderly people as monitored in hospitals or home, sometimes saves precious lives too. The fall detection framework is proposed using video, camera, as well as other image processing algorithms in computer vision-based systems. Since the old person does not need to wear any equipment, this is much more convenient for the people. Because an aged person's daily activities alter with time, even tiny changes must be validated. Therefore, we use automatic video segmentation in this case, where footage is automatically separated without operator intervention, allowing even minute actions to be seen and making it simple to categorise postures.

II. LITERATURE SURVEY

The identification of elderly falls by the analysis of the rate of change of motion relative to the ground point has been proposed by a real-time vision-based fall detection system. This technique combines ground point estimation based on texture segmentation using a Gabor filter with an angle change rate calculation. Using a Kalman filter, it is possible to follow a person's movement and determine the angle in between measured points and a reference point on the ground. They examined factors for experimental analysis using two open source datasets [1].

A machine learning-based fall detection system which provides comparitive study of decision tree and SVM algorithms to recognize falls and notifies a family member or other caregiver of the elderly person in an emergency. The decision tree algorithm achieves superior accuracy of 95.87% and very less prediction time over SVM with 84.17% accuracy in detecting falls using the dataset SisFall, which includes a range of activities performed by numerous people. The models are evaluated by using parameters such as: sensitivity, specificity, accuracy and confusion matrix [2].

Using a sole tri-axial accelerometer sensor and software that continually detects, records, and notifies falls, an IoT-based wearable fall detection device has been developed for seniors to recognise falls [3].

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With the help of the SVM algorithm and the UR fall dataset, a camera-based real-time automatic fall detection system for indoor contexts is developed. The frames are analysed in real-time, and after background subtraction is applied to detect moving people in an interior environment, pertinent geometric features are extracted to categorise falls and other behaviours from a person's regular daily activities [4].

The change in the human shape provides information on human activities, and uses correlations factor to identify falls and low motion at the conclusion of the fall in an effective fall detection approach that is proposed. This method is evaluated using the URF (University of Rzeszow Fall detection) dataset [5].

Based on an SVM classifier, human movements are detected using a smartphone acceleration sensor. Data on human motion is broken down into common activities (walking, running, climbing and down stairs, and standing still), falling, and other dangerous motions. The median filter is used to remove background noise and smooth the motion data since the motion noise created during data gathering contains some interference. Principal component analysis and singular value decomposition are also used to collect and evaluate common multi-group features in order to reduce dimensions [6].

To identify falls, a human characteristic matrix built on SVM is used. A more realistic outline is first produced using background reduction and morphological processing. Two human characteristic matrices are then created using the Hu-moment invariant and the body posture data acquired from the human outline. These matrices are then utilised as data to build an SVM classifier for fall detection. Other movements such as squatting, sitting, and turning one's back, can be used to identify falls [7].

In order to identify falls, surveillance camera data is processed using deep learning and transfer learning algorithms. The National Center for Scientific Research's Laboratory of Electronics and Imaging in Chalon-sur-Saone provided an open dataset that was utilised. The classifier was built using the CNN AlexNet architecture, which was modified to address the fall detection issue. A dataset of 30 records with a single fall occurrence in each record was used to evaluate the suggested approach. For the fall-non-fall classification under known and hypothetical classifier environmental conditions, respectively, we obtained Cohen's kappa values of 0.93 and 0.60 [8].

The human body is precisely identified by a system that uses the Vibe algorithm to detect human falls in interior environments. Following that, an observation feature called the Gabor feature of a human is retrieved. Incidents are discovered as transitions from the standing state to the falling state in the feature space based on the extracted feature. The characteristic, which is useful and efficient, may be shown in a single photograph. Comparatively, the person falling is detected by the feed-forward network that combines biologically inspired motion information across photos [9].

Through the division of each video into various shots, which are then turned into grey-level images, a Computer Vision fall detection methodology based on a sample of videos featuring fall actions has been used. Then, the foreground is first identified in order to recognise motion information in videos, after which noise and shadow are eliminated. In order to detect the presence of falling, several classifiers are employed together with a variety of features, namely aspect ratio and falling angle. In this study, the Linear Discriminant Analysis (LDA) classification algorithm outperformed Knearest neighbour (KNN) and support vector machines (SVMs) in terms of accuracy using 10-fold cross validation [10].

III. PROPOSED SYSTEM

The proposed methodology can save lives in life-threatening situations by using cameras to monitor elderly people. The activities of the persons are followed, and falls are only identified whenever there is abnormal behaviour. An alert is then sent through buzzer and e-mail to the elders nearest caretakers, as is normal in hospitals and at-home care. We make use of yolo algorithm to detect the person based on convolutional neural networks (CNN) layers and his/her position like standing or fallen is based on width and height dimension of a person detected within the appearing bounding box.

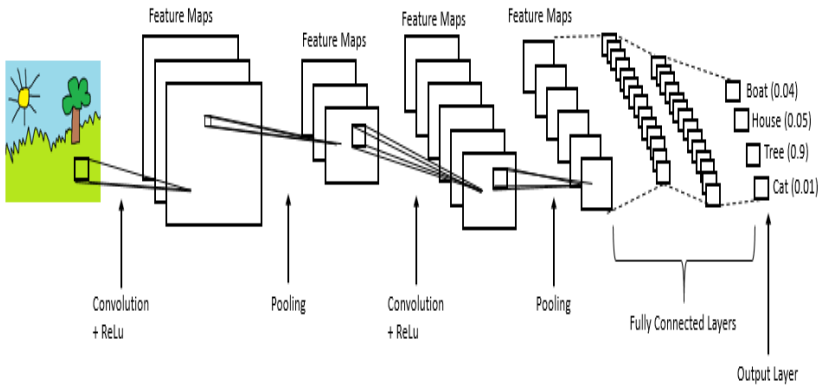

Fig. 1 Working of CNN layers

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There are several common layers in the CNN structural system: Convolutional layer is first in the hierarchy. Each region in this layer that has feature maps is related to the extracted features of a particular region in the innermost layer it by evaluating weights called kernels (filter banks). The total estimated weights are processed by a non-linearity function, such as Relu.

The second most prevalent layer of CNNs is the pooling layer, which is utilized to reduce the spatial dimension of the convolutional layer's output while maintaining the same depth. The benefit of utilizing a pooling layer is that it reduces overfitting during the training process by reducing the number of computing processes. Min, Max, and Average functions can be performed in the pooling layer. I n the most of cases, max pooling layer has delivered accurate result.

Fully connected layer is the third essential layer. Every neuron in this layer is not only connected to every other neuron in the layer above, but this layer also presents the expected class scores for the dataset. Moreover, the softmax function is commonly used in the last convolutional layers to predict the probable probability using class labels.

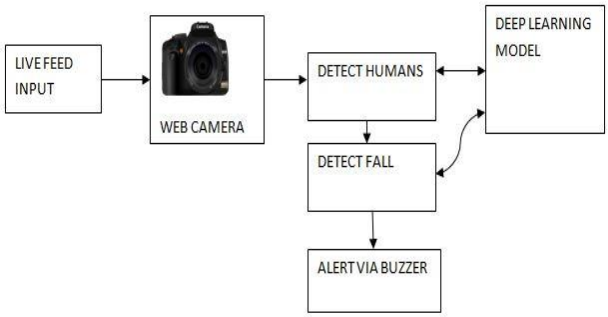

Fig. 2 System Architecture

The video is recorded using the web camera while it is set up in a room environment and is then used as an input for additional processing. When video is processed, it is automatically segmented and divided into frames. Converting macro blocks is done in the frames. It is simple to identify every movement by breaking the frames into blocks. We are extracting the elderly person's features through feature extraction. The noise surrounding the items is reduced via gaussian blur. Yolo is a tool for tracking human anatomy. This requires separating the human body's shape from other items. The elderly person's posture is observed, and it is then classified further. The extracted feature is classed in classification, which is utilised to distinguish between fall and non-fall behaviours of the old person based on the person's height and width that are detected in the bounding box. With regards to forecasting human classes, a comparison is made based on the characteristics height, width, and centre of the bounding box. Based on previously established numerical thresholds, the system identifies a fall if the width grows while the height drops. An alert message (notification) will be issued in the event of a fall, and the caretaker will also receive an email alert.

IV.DATASET

To achieve fall detection of humans in our proposed system we have to identify humans first so we have made use of open source kaggle Human detection dataset which contains 921 images divided into two directories consisting of 559 images with persons and 362 images without persons which are CCTV indoor and outdoor footage images.

Images with persons are identified as class label 1 in prior to coco pre-trained class label names to detect persons and images without persons are identified as class label 0 which makes it help to classify humans and their actions rapidly and efficiently.

V. CONCLUSION

In this paper, we have proposed a fall detection system in concern with healthcare of elderly people based on Convolutional neural networks (CNN), yolo algorithm and publicly accessible dataset to detect humans accurately. Our system is detecting human fall fast and accurately based on a vision sensor which is cost-effective without using any wearable device to detect fall detection. A depth image has been used to extract the features of human posture. The features are mapped and are used to identify that the human is standing or has fallen. The fall is detected by the system based on the width and height dimension of the person detected. The proposed model is delivering an excellent accuracy of 97.05% in identifying falls. In case of human fall the model detects the human fall and triggers the buzzer in order to

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alert the nearby persons for the emergency help and also an e-mail alert is sent to the caretakers to rush and help their elderly persons to save their precious lives.

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