FALL DETECTION AND ALARM SYSTEM FOR ELDERLY

Mansi Chaudhari[1], Shreya Pawar[2], Vaishnavi Kalal[3], Bharti Sahu[4]

[1-3]Student, Dept. of Computer Engineering, Dr. D.Y. Patil Institute of Technology, Pimpri, Pune, India
[4]Assistant Professor, Dept. of Computer Engineering, Dr. D.Y. Patil Institute of Technology, Pimpri, Pune, India

---

Abstract - *Falls are a serious health concern for the elderly who live in the neighborhood. For more than two decades, medical institutions have conducted substantial research on falls in order to attenuate their impact (e.g., loss of freedom, fear of falling, etc.) and minimize their consequences (e.g., Cost of hospitalization, etc.). However, the subject of elderly people falling has piqued the interest of scientists as well as health experts. Indeed, falls have been the subject of several scientific investigations as well as the aim of numerous commercial products from academia and industry. These studies have addressed the issue by employing fall detection algorithms that have exhausted a range of sensor methods. Recently, researchers have moved their focus to fall prevention, with the goal of detecting falls before they occur. The chief contribution of this study in this matter is to offer a thorough outline of elderly falls and to recommend an all-purpose solution of fall-related systems based on real time posture estimation. Based on this common ground classification, an extensive research plan ranging from fall detection to fall prevention technologies was also carried out. Data processing techniques are also featured in both the fall detection and fall prevention courses. The goal of this effort is to provide medical technologists in the field of public health with a good understanding of fall-related systems.*

***Key Words*: Deep Learning, CNN Algorithm.**

1.INTRODUCTION

Ageing population has caused an increasing number of elderly individuals to live alone in the previous decade. The dependency ratio of the elderly thus increases. Because of the emergence of a seriously ageing society during the last decade, an increasing number of old individuals have had to live alone. The old-age reliance ratio will rise naturally from the year 2022. In the United States of America, falls are the tenth superior reason of passing away. We routinely make mistakes in our daily work. In addition to falling while walking, many people fall while sitting or resting. Patients are more prone to losing their balance and falling than healthy people, hence human falls occur frequently in medical settings.

Accidental falls that do not result in immediate medical attention can cause fractures, strokes, disability, and even death. Previous systems are unable to detect falls in complex situations due to the presence of furniture and other belongings on the floor. To save patients from such fatal accidents, a system can be developed which estimates the person's position based on his bodily movements. If the result of estimation is positive, that is, the person falls to the ground, the system informs required authority whose contact information is provided. So, the neighbor or relative is made aware of the incident and immediate care or action can be taken.

1.1 OBJECTIVES

- To limit the time the elderly remains on the floor after falling.
- The ultimate goal of the detector system is to realize a fall event and manage to notify a relative or caretaker immediately.
- An authentic fall detector should be able to classify the falls as positive and the non-falls as negative in real life condition because people sometimes intentionally stand up or sit fast, which can confuse the system and cause false alarm.

2. LITERATURE SURVEY

For the help of elderly people to walk, a cane-style walking-aid robot with a ball joint is being constructed. Taking into account both robot overturn and human user stability, this research introduces a new term of Human-Robot Coordination Stability (HRCS), which may define the stability of the combined human-robot system as the user operates the cane robot. When the human-robot system leaves the stability region, the fall tendency is noticed.[1]

A scenic evaluation based on deep learning and activity features is used to tackle the concern of human fall detection on furniture. The suggested method initially analyses a scene using a quicker R-CNN deep learning method to detect humans and furniture. Meanwhile, the human-furniture space relationship is identified. The observed person's activity characteristics which are discovered and tracked are human shape aspect ratio, centroid, and motion speed.[2]

In this study, a fall detection system is proposed which comprises of an inertial unit consisting of a triaxial accelerometer, gyroscope, and magnetometer, in addition to fast data fusion and fall detection algorithms. The implemented orientation filter offers the correct orientation of the subject in terms of yaw, pitch, and roll

angles based on the raw data. The findings obtained using regularly used methods demonstrate good accuracy, sensitivity, and specificity.[3]

According to the CDC (Centers for Disease Control and Prevention), one in every three adults over the age of 65 is at risk of falling. Twenty to thirty percent of these persons are injured, resulting in fractures, loss of independence, and even death. Fall detection is an active research area that seeks to improve people's lives through the use of pervasive computing. A method which uses the data collected from a smartphone is described in this study.[4]

This paper proposes a machine learning approach to falling detection and avoidance for biped robots. The machine learning algorithm used in this system is Support Vector Machine (SVM). The algorithm finds out the declining state of the robot on the basis of acceleration value of upper-body and centre of pressure value of the robot.[5]

A promising solution for detection of human falls can be achieved by using Computer Vision. A combination of convolutional neural networks RetinaNet and MobileNet are used for detection together with self-designed features. Shape features such as aspect ratio and head position and motion feature used is motion history image of the detected human in the frame. Both of these features are used to generate the feature map. The training of MobileNet network is done using the feature map mentioned above to classify the motion of detected human into fall or stable condition.[6]

In this system, the first step is background subtraction. Background subtraction is performed using Improved GMM (Gaussian Mixture Model) to find the foreground objects. To classify the human and non-human object, contour based human template matching is applied in the next step. It helps to detect fall incident by providing sudden change in generated score after matching.[7]

This study aims to develop a low-cost prototype device that produces an alarm when elderly people and people with disabilities need help or have zero movement for longer duration of time, perhaps due to unconsciousness. This device proves beneficial for people who stay unaccompanied at home. And with the help of this device, dependent people and their caregivers can contact each other at times of emergency.[8]

3. PROPOSED METHODOLOGY:

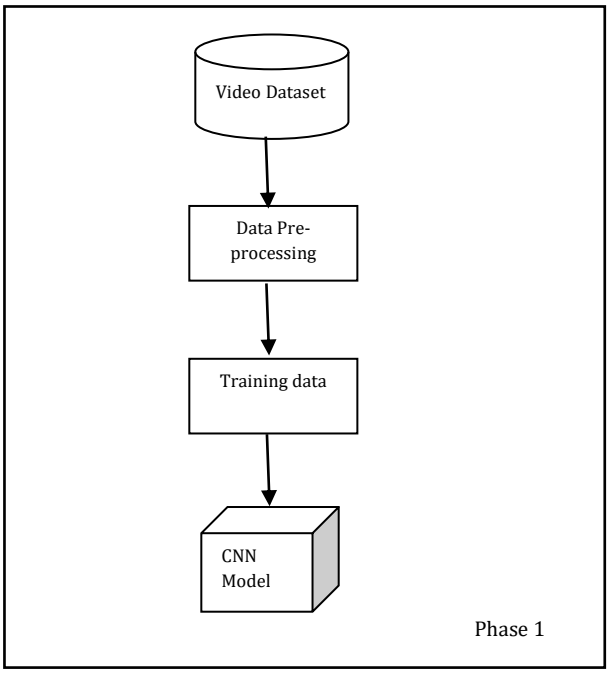
3.1 Algorithm:

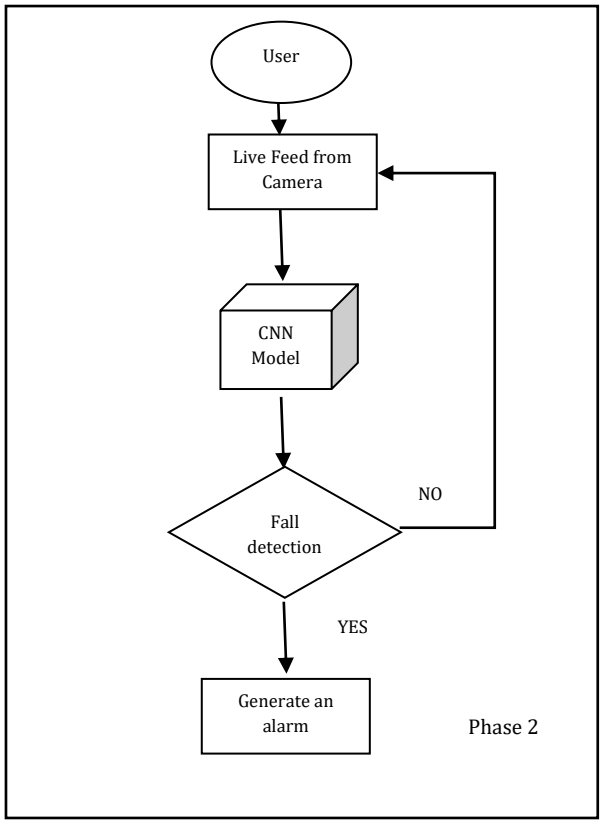
Convolutional neural networks (CNNs) are used in image and video recognition, recommender systems, image classification, image segmentation, medical image analysis, natural language processing, brain-computer interfaces, and financial time series analysis, to name a few applications.

CNNs are a special sort of regularized multilayer perceptron. The phrase "multilayer perceptron" refers to completely linked networks in which each neuron in one layer is connected to every neuron in the next layer. CNNs are liable to overfitting data because of their “complete connectedness”. To avoid overfitting, two regularization procedures that are extensively used are punishing parameters during training (such as weight decay) and eliminating connectivity (skipped connections, dropout, etc.). CNNs tackle regularization differently: they leverage the hierarchical structure of data to assemble patterns of increasing complexity by embossing smaller and simpler patterns in their filters.

CNNs require significantly less pre-processing than other image categorization methods. This means that the neural network learns to optimize the filters (or nodes) through computerized learning, on the other hand traditionally developed systems require these filters to be self-created. This freedom from former information and human intervention is helps in faster and better feature extraction.

3.2 Architecture:





In phase 1, for the fall detection system firstly, a dataset with images and videos is created to train the model. The data in the dataset created is pre-processed and used to train the model. The pre-processed training data is passed to the input layer of the convolutional neural network.

In phase 2, the user's personal information such as name, address, email id, as well as, the personal and contact details of acquaintance who needs to be informed in times of emergency are collected for later use. The model needs to be provided with a live feed from camera such as CCTV as input. The CNN model will continuously work on the recognition of live human posture. If falling posture is detected (positive result), an alert is sent to the caretaker and an alarm is generated. Else the detection process is carried on.

4. CONCLUSIONS

Aging is unavoidable; whether it results in no, mild, or severe disorders, it is always preferable to age with a high quality of life. Efforts to achieve this goal do not fall solely on the medical force; accordingly, addressing public health challenges needs a collective effort between health professionals and scientists. From this vantage point, we have addressed in this review paper how different technologies are combined to detect falling postures and sending alerts to people after fall identification. Due to this, emergency medical service can be provided, which helps in saving lives. The fundamental contribution of this paper is a two-level common ground classification as falls and the non-fall. As non-falls in real time is a case where people sometimes intentionally up stand or sit rapidly, which could confuse the system. Even in such cases, Convolutional Neural Network algorithm will be proved beneficial by providing more faster and accurate results than any other algorithms. Moreover, this will also help in reducing death rates in future.

5. REFERENCES

[1] Jian Huang, "Human-robot coordination stability for fall detection and prevention using cane robot" [2016] International Symposium on Micro-NanoMechatronics and Human Science (MHS) doi:10.1109/MHS.2016.7824171

[2] Weidong Min1, Member, IEEE, Hao Cui1, Hong Rao1, Zhixun Li and Leiyue Yao, "Detection of Human Falls on Furniture Using Scene Analysis Based on Deep Learning and Activity Characteristics." [2018] IEEE Access {Volume:6} doi:10.1109/ACCESS.2018.2795239

[3] P. Pierleoni, A. Belli, L. Palma, M. Pellegrini, L. Pernini and S. Valenti, "A high reliability wearable device for elderly fall detection" [2015] IEEE Sensors Journal (Volume: 15, Issue: 8) doi:10.1109/JSEN.2015.2423562

[4] Luis N. Valcourt Colón, Yueng DeLaHoz, Miguel Labrador, "Human fall detection with smartphones" [2014] IEEE Latin-America Conference on Communications(LATINCOM) doi:10.1109/LATINCOM.2014.7041879

[5] Jeong-Jung Kim1, Yeoun-Jae Kim2, and Ju-Jang Lee, "A Machine Learning Approach to Falling Detection and Avoidance for Biped Robots" [2011] SICE Annual Conference (SICE), 2011

[6] Ahmad. M Ahmad, "Fall Detection Based on RetinaNet and MobileNet Convolutional Neural Networks"[2020] 15th International Conference on Computer Engineering and Systems (ICCES) doi:10.1109/ICCES51560.2020.9334570

[7] Subhash Chandra Agrawal, Rajesh Kumar Tripathi, Anand Singh Jalal, "Human-fall detection from an indoor video surveillance" [2018] International Journal of Applied Pattern Recognition doi:10.1504/IJAPR.2018.090520

[8] Supawadee Putthinoi, Peerasak Lerttrakarnnon, and Patima Silsupadol, "Development and Usability Testing of an Emergency Alert Device for Elderly

People and People with Disabilities" [2020] The Scientific World Journal, vol. 2020
doi:10.1155/2020/5102849

[9] Yangsen Chen, Rongxi Du, Kaitao Luo, Yuheng Xiao, "Fall Detection based on Real Time Pose-Estimation and SVM" [2021] IEEE 2nd International Conference on Big Data, Artificial Intelligence and Internet of Things Engineering (ICBAIE)

doi: 10.1109/ICBAIE52039.2021.9390068

[10] Kripesh Adhikari, Hamid Bouchachia, Hammadi Nait-Charif, "Activity recognition for indoor fall detection using convolutional neural network" [2017] Fifteenth IAPR International Conference on Machine Vision Applications (MVA)

doi: 10.23919/MVA.2017.7986795

[11] Mohamed Maher Ben Ismail, Ouiem Bchir, Ghada Khaled Hader, "Automatic fall detection using region-based convolutional neural network" [2020] International Journal of Injury Control and Safety Promotion 27(4) doi: 10.1080/17457300.2020.1819341

[12] Ricardo Espinosa, Hiram Ponce, Sebastián Gutiérrez, Lourdes Martínez-Villaseñor, Jorge Brieva, Ernesto Moya-Alborb, "A vision-based approach for fall detection using multiple cameras and convolutional neural networks: A case study using the UP-Fall detection dataset"

doi: 10.1016/j.compbiomed.2019.103520

[13] Xiaogang Li, Tiantian Pang, Weixiang Liu, Tianfu Wang, "Fall detection for elderly person care using convolutional neural networks" [2017] 10th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI)

doi: 10.1109/CISP-BMEI.2017.8302004