

## **Fall Detection Using Computer Vision And Machine Learning**

Karthikeyan MP<sup>1</sup>, Vignesh S<sup>2</sup>, Sharvesh Kumar C R<sup>3</sup>, Santhanam R<sup>4</sup>

Assistant Professor, Dept. of CSE, RMK Engineering College, Thiruvallur, India  
Department. of CSE, RMK Engineering College, Thiruvallur, India  
Email: vign17331.cs@rmkec.ac.in

### **Abstract**

Monitoring the patient remotely, has always been a challenging issue in the health care domain. Especially, fall detection during monitoring, is a vital aspect. Progress in technology, has facilitated vision-based systems, and thereby detecting a fall and providing a timely help to the concerned person is possible. This paper mainly focusses on the implementation of a computer vision-based system, which also incorporates Machine Learning algorithms to learn the actions of a person, thereby detecting a fall, and notifying the primary caregiver during the situation, right away, so as to provide the help at the right time. The implemented system, is able to detect the actions of a user by classifying the broad range of activities into fall and non-fall actions.

**Keywords:** *Fall Detection, Machine Learning, Pose estimation*

### **Introduction**

With respect to the elderly community, fall detection has been a great challenge to be dealt with, by the health care industry. It is a known fact that, once a human body ages gradually, there is a great deal of changes in both physical and mental state of the body. Mainly, with respect to ageing, physical weakness become an un avoidable virtue. And due to this fact, there is a great deal of issues which come hand in hand. One such issue is the falls of a person, which completely creates a whole lot of consequences with respect to the health. These falls, which occur, tend to be one of the very common health related issue. Statistically speaking, almost 1 in 3 adults almost fall and sustain fatal injuries and sometimes severe grievous injuries. This can be prevented if timely attention is given to them, immediately once they meet with this terrible accident. The aftermaths of these kind of incidents, cause further complications. 1/3<sup>rd</sup> of the deaths faced by the elders, are from the category of falling. The one primary reason for this, is that, the lack of timely attention.

Usually, this fall detection can be done in many ways:

1. Systems that possess computer vision capabilities in addition to machine learning algorithms
2. Systems which employ wearable devices containing sensors

The main issue with wearable based systems is that they tend to trigger a lot of false alarms to the caregivers, because it is just based on a threshold value, which can be often reached by a person. This can be rectified with the help of vision based analytic systems. In this, vision based systems, Machine Learning algorithms can be employed and thereby, this can train itself overtime and eventually, the model gets better and better, giving close to accurate results.

### **Literature Review**

- 1) Fall detection algorithm for the elderly based on human posture estimation (2020): Zhongqi Wang of Beijing University, used open pose algorithm for fall detection and SSD mobile net framework for identifying humans whereas KNN algorithm the accuracy was low.
- 2) IoT-Based Fall Detection System with Energy Efficient Sensor Nodes: Sarker<sup>1</sup>, Amir M. Rahmani<sup>1</sup>, Igor Tcareenko<sup>1</sup>, Victor K. Tomi Westerlund<sup>1</sup>, Pasi Liljeberg<sup>1</sup>, used wireless sensor for monitoring the patients and based on their movements, actions are detected and the fall based on the threshold value and a triggering is done, when the value is reached.
- 3) IOT Enabled Human Fall Detection Using Accelerometer and RFID Technology (2018): Bharati Kaudki of Walchand College of Engineering Sangli, used RFID technology. Also using a tri-axial accelerometer sensor that returns a three physical axis including gravity force and also machine learning algorithm (KNN) and additionally used a few more sensors like Temperature sensor for automatic switching ON/OFF of lights and fans.
- 4) IoT fall detection system for the elderly using Intel Galileo Development Boards Generation (2016): Graciela E, De Luca, Esteban A. Carnuccio, Gerardo G. Garcia, Sebastián Barillaro, used an Intel board to monitor the patients based on the reading given by the accelerometer sensor and using the data, that is collected by the sensor, a predefined value is kept as a threshold, and whenever it is attained, fall is detected
- 5) Autonomic Fall Detection System (2017): Ahmet Turan Ozdemir of Erciyes University, Melikgazi, Kayseri, Turkey, used a wearable belt in the waist and using some sensor they

are reading the values and storing in the cloud and based on the values they noted, using the threshold, actions are classified.

### Datasets

- **Kinetics.** Deepmind Kinetics created a human action dataset comprising of various human actions, categorising into different action categories, which were retrieved from Youtube. It contains approximately 300,000 videos of humans performing their daily activities, where each video lasts 10-15 seconds.
- **Le2i Fall Dataset:** The dataset contains 191 videos (129 fall and 92 non-fall videos). The frame rate at which videos are captured are 25 frames per second and the resolution is in 320x240 pixels. The videos are taken from 4 different environments (home, office, coffee room and lecture room). The videos present in the dataset, have been captured under various lighting conditions.
- **COCO:** Microsoft's COCO is a large image recognition/classification, object detection dataset. Contains 330,000 images (200,000+ annotated); more than 2M instances in 80 object categories and 250,000 people with key points.

### Methodology

Our goal in this project is to create a web application, where the primary caregiver can login using the credentials and watch the person who is under monitoring via the camera. The person's actions will be monitored and the actions will be logged into the database. Whenever the action is classified as a fall, it will trigger a notification and sent to the primary caregiver. Immediately, timely help can be provided to the person under monitoring.

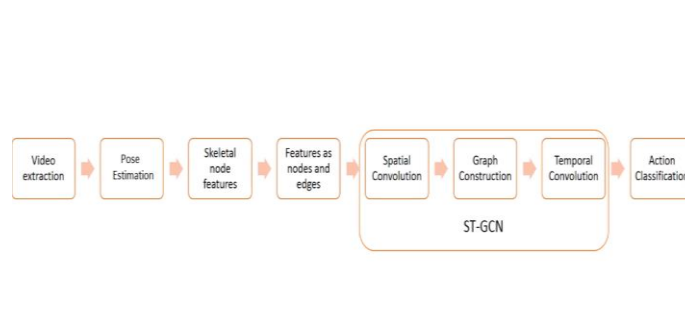


Figure 1 Pipeline of the project

#### **4.1 YOLO Object Detection Model:**

The first step of the project is to properly identify the person under monitoring. This is done using the Yolo model, which provides a boundary box, containing the person. This stands as the input in the further processes. Yolo, expanded as “You Only Look Once” is a real time object detection model, which can detect any object in the image/video in real time.

Since the project is dealing with humans, the only detection that takes place here, is the person who is being monitored. It is a Convolutional Neural Network, where the frames are divided into several regions, and primarily, bounding boxes, probabilities are generated. Later the boxes, combined with the predicted probabilities, results in the region, where the object is located.

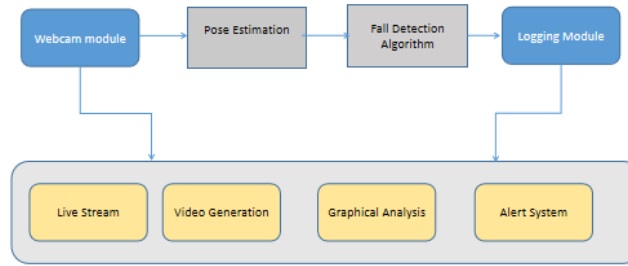
#### **4.2 Alpha Pose Estimation Model:**

The 2<sup>nd</sup> stage in the project is to, obtain the boundary box from the previous step and extracting the features in the frame, and mainly to predict a pose estimation, containing a skeleton of the human body. This remains vital to the project, because, only after this, the actions of the humans can be classified into various classes of actions.

Alpha Pose model is trained with input images of size 256x192 COCO dataset. This model undergoes a top down approach, while detecting the human pose. This is done with the help of generation of a heat map of each joint in the human’s body, and then generating a human skeleton properly and in real time. Once the inference of the heat map is created, it is mapped correctly with maximum value in the image, thereby resulting in a human skeleton, which remains as the input to the next stage of the process.

#### **4.3 ST-GCN Action Recognition Model:**

It is a convolutional neural network, which has a various class of actions pre-loaded into it. This employs a unique system, where using the pose estimation’s output, for a select window of 4-5 frames, the images are captured, and it tries to create a graph, for each frame. Using the images in the successive frames, nodes and edges are created. At the end, using the nodes and edges, a graph is plot, and using this plot, it matches with the available classes, where the action with highest score is detected and logged as output of the video.



**Figure 2. Overall project flow**

#### **4.4 Web based Portal:**

The primary caregiver can login the portal and using the credentials, he/she can view the live stream whenever he wishes to. Even when an alert is triggered using SMS/mail, he/she can immediately review the stream and take appropriate actions, thereby providing the timely help, which can save one's life.

In the portal, emergency contacts can be changed/updated, as on when the user wishes to change it. These updations can be accommodated using a database, where all these Edit operations can be done, seamlessly.

#### **4.5 Graphical Analysis:**

At the end of the day, the care taker can be able view the actions logged, and a graphical analytics of the person can be used in drawing conclusions with respect to the health condition of the person.

#### **4.6 Recognizing actions:**

Once the input video is fed in to the model, frame by frame capture of the actions performed by the humans, is logged as well as detected on the screen. This action logging can be used to generate video analytics of the person under monitoring.

#### **4.7 Alert system with SMS/Mail:**

Whenever a fall is detected using the model, a mail/SMS can be sent immediately to the primary caregiver. These mail and SMS details are provided by the user itself and can be changed in the database.

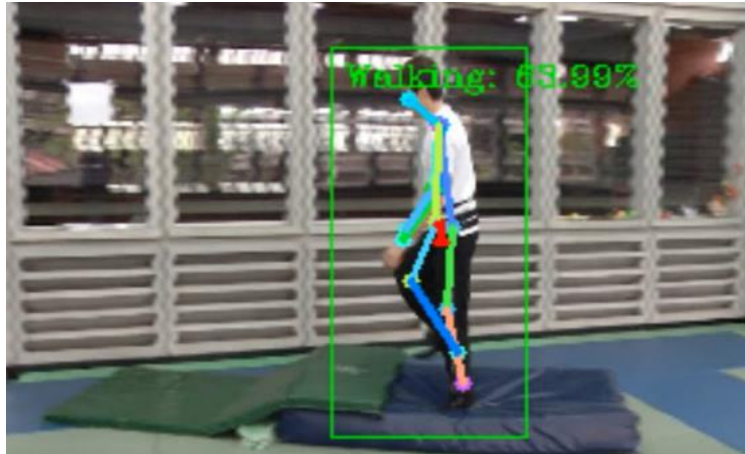


Figure 3 Walking action output generated from our model



Figure 4 Falling action output generated from our mode

#### 4.8 Logged actions of the video:

The actions which are logged can be written into the database, and using them, a graphical analysis can be provided which can be sent to the user, for timely review.

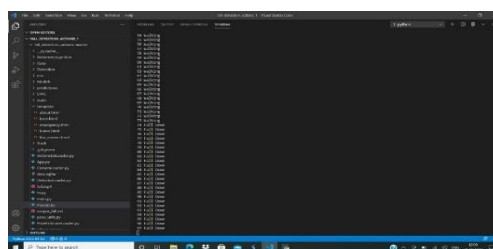


Figure 5 Frame by frame output of the actions



**Figure 6. Output video in the developed portal**

### **Conclusion**

To detect the falls encountered by persons, who are not in a situation, to be monitored by a caregiver, a remote monitoring system, based on computer vision and machine learning models, is used and a trigger system is enabled. Since, machine learning is involved, this model can learn and better, from time to time, giving close to accurate results.

### **References**

- [1] IoT-Based Fall Detection System with Energy Efficient Sensor Nodes: Tuan Nguyen Gia<sup>1</sup> , Igor Tcarenko<sup>1</sup> , Victor K. Sarker<sup>1</sup> , Amir M. Rahmani<sup>1</sup> , Tomi Westerlund<sup>1</sup> , Pasi Liljeberg<sup>1</sup> , and Hannu Tenhunen<sup>1</sup>
- [2] IOT Enabled Human Fall Detection Using Accelerometer and RFID Technology(2018): Bharati Kaudki Anil Surve Department of Computer Science and Engineering Walchand College of Engineering Sangli, India
- [3] IoT fall detection system for the elderly using Intel Galileo Development Boards Generation (2016): Sebastián Barillaro, Graciela E, Gerardo G, De Luca, Esteban A. Carnuccio, Garcia,
- [4] Autonomic Fall Detection System (2017): Ahmet Turan Ozdemir Electrical and Electronics Engineering Department Erciyes University Melikgazi, Kayseri, Turkey,
- [5] Jarree Chaicharn, Thammasat, Ekachai “A simply fall-detection algorithm using accelerometers on a smartphone.” The 5th Biomedical Engineering International Conference 2012.
- [6] Quoc T. Huynh, Uyen D. Nguyen, Kieu Trung Liem, Binh Q. Tran,” Detection of Activities Daily Living and Falls Using Combination Accelerometer and Gyroscope”, 5th International Conference on Biomedical Engineering - Vietnam.
- [7] Yun Seop Yu, Dongha Lim, Nam Ho Kim, Sang-Hoon Kim, Chulho Park,” Fall-Detection Algorithm Using 3-Axis Acceleration: Combination with Simple Threshold and Hidden Markov Model”, Hindawi Publishing Corporation Journal of Applied Mathematics, 2014.
- [8] Idalides Vergara-Laurens, Joseph Santiago, Luis G Jaimes, Eric Cotto,” Fall detection system for the elderly”, 2017 IEEE 7th Annual Computing and Communication Workshop and Conference (CCWC).

- [9] Yaniv Zigel, Litvak, Dima, and I. Gannot. "Fall detection of elderly through floor vibrations and sound." 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (2008): 4632-4635.
- [10] S. Yajaman, Kashyap, V. H., S. Agarwal, S. Gururaj, and Sara M. George, "Fall Monitoring System for Elderly People using ARM Cortex M3", Control and Data Fusion e-Journal: CADFEJL Vol. 2, No. 1, pp. 48-56, Jan-Feb 2018..