A

PROJECT REPORT

ON

“Vision Based System for Monitoring Elderly People at Home”

SUBMITTED TO

SHIVAJI UNIVERSITY, KOLHAPUR

IN THE PARTIAL FULFILLMENT OF REQUIREMENT FOR THE AWARD OF DEGREE BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND ENGINEERING

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DKTE

Promoting Excellence in Teaching, Learning & Research

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DKTE SOCIETY’S TEXTILE AND ENGINEERING INSTITUTE, ICHALKARANJI

2022-2023

D.K.T.E. SOCIETY'S

TEXTILE AND ENGINEERING INSTITUTE, ICHALKARANJI
(AN AUTONOUMOUS INSTITUTE)

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

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Promoting Excellence in
Teaching, Learning & Research

CERTIFICATE

This is to certify that, project work entitled

"Vision Based System for Monitoring Elderly People at Home"

is a bonafide record of project work carried out in this college by

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is in the partial fulfillment of award of degree Bachelor in Technology in Computer Science & Engineering prescribed by Shivaji University, Kolhapur for the academic year 2022-2023.

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EXAMINER: ________________

DECLARATION

We hereby declare that, the project work report entitled "A vision based monitoring system for elderly people at home" which is being submitted to D.K.T.E. Society's Textile and Engineering Institute Ichalkaranji, affiliated to Shivaji University, Kolhapur is in partial fulfillment of degree B.Tech.(CSE). It is a bonafide report of the work carried out by us. The material contained in this report has not been submitted to any university or institution for the award of any degree. Further, we declare that we have not violated any of the provisions under Copyright and Piracy / Cyber / IPR Act amended from time to time.

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ACKNOWLEDGEMENT

With great pleasure we wish to express our deep sense of gratitude to Dr. D. V. Kodavade for his valuable guidance, support and encouragement in completion of this project report.

Also, we would like to take opportunity to thank our head of department Dr. D. V. Kodavade for his co-operation in preparing this project report.

We feel gratified to record our cordial thanks to other staff members of Computer Science and Engineering Department for their support, help and assistance which they extended as and when required.

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ABSTRACT

The vision-based monitoring system for elderly people at home is designed to provide continuous surveillance and assistance to ensure the safety and well-being of elderly individuals in their living environment. The system utilizes cameras and sensors strategically placed throughout the home to capture visual data and contextual information. This data is processed using advanced image processing techniques and analyzed through data analysis algorithms to detect activities, track movements, and identify anomalies.

The system's primary objective is to monitor the activities of the elderly person, detect falls or emergencies, and provide timely alerts to caregivers or emergency services. Through real-time monitoring and analysis, the system can identify patterns, deviations from routines, and potentially hazardous situations. It enables caregivers to remotely access the system, view live feeds from the cameras, and receive notifications or alerts when abnormal events occur.

The vision-based monitoring system offers several key features to enhance the safety and care of elderly individuals. These include fall detection, activity monitoring, medication reminders, and emergency response mechanisms. By continuously monitoring the living environment, the system promotes independent living while providing a sense of security and support to the elderly person.

The system's user interface allows caregivers to interact with the system, access historical data, configure settings, and respond effectively to alerts or emergencies. It enables caregivers to remotely monitor the activities of the elderly person and take appropriate actions when necessary.

Overall, the vision-based monitoring system for elderly people at home is an innovative solution that combines computer vision, data analysis, and alerting mechanisms to enhance the safety and quality of life for elderly individuals.

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1. Introduction

The vision-based monitoring system for elderly individuals at home is an innovative and technologically advanced solution designed to ensure the safety, well-being, and independence of aging individuals within the comfort of their own living environment. As the population ages and the desire for independent living grows, there is an increasing need for intelligent systems that can assist in monitoring and providing timely assistance to elderly individuals. This system addresses this need by leveraging the power of computer vision, image processing, data analysis, and alerting mechanisms to create a comprehensive monitoring solution.

The aging population faces unique challenges related to health, mobility, and safety. Traditional methods of care, such as in-person supervision or living in assisted care facilities, may not always be feasible or preferred. The vision-based monitoring system offers an alternative approach that allows elderly individuals to maintain their independence while ensuring their safety and well-being.

At the heart of this system are strategically placed cameras and sensors throughout the home, which capture visual data and contextual information about the living environment. These cameras are designed to be unobtrusive, blending seamlessly into the surroundings to respect the privacy and dignity of the individuals being monitored. By continuously monitoring the environment, the system can analyze activities, detect falls, and identify potential risks or emergencies.

The visual data captured by the cameras is processed using sophisticated image processing algorithms. These algorithms enable the system to detect and track individuals, analyze movement patterns, and identify activities of daily living. By understanding the context of the captured data, the system can differentiate between normal activities and potential risks, allowing it to provide timely alerts and notifications when necessary.

Complementing the image processing capabilities, the system incorporates data analysis techniques to extract meaningful insights from the collected data. Through advanced analytics and machine learning algorithms, the system can identify patterns, deviations from routines, and potential health issues. This analysis enables caregivers and healthcare professionals to gain valuable insights into the well-being and daily activities of elderly individuals, facilitating early intervention and personalized care.

One of the core functionalities of the vision-based monitoring system is fall detection. Falls are a significant concern for the elderly population, often resulting in severe injuries and reduced quality of life. By continuously monitoring the environment and analyzing the movement patterns of individuals, the system can detect and promptly alert caregivers or emergency services in the event of a fall. This quick response can significantly reduce the time between a fall and receiving necessary medical attention, potentially preventing further complications and enhancing the chances of a full recovery.

In addition to fall detection, the system offers activity monitoring capabilities. By analyzing the patterns and frequencies of daily activities, the system can identify changes in routines or detect potential signs of cognitive decline or health issues. For example, irregular sleep patterns or decreased activity levels can serve as indicators of underlying health conditions. By continuously monitoring these parameters, the system can provide insights to caregivers and healthcare professionals, enabling them to make informed decisions regarding the well-being and care of elderly individuals.

The vision-based monitoring system also includes medication reminder features to support medication adherence. Adhering to medication schedules can be challenging for elderly individuals, especially for those with complex medication regimens. The system can provide timely reminders to take medications, helping individuals stay on track with their prescribed treatments. This feature enhances medication management and reduces the risks associated with missed doses or incorrect administration.

In emergency situations, the vision-based monitoring system proves invaluable. By monitoring the environment and analyzing various parameters, such as abnormal movement patterns or sudden changes in behavior, the system can identify potential emergencies and trigger immediate alerts to caregivers or emergency services. This rapid response ensures that timely assistance is provided, potentially preventing further harm or complications.

The user interface of the vision-based monitoring system serves as the central control hub, allowing caregivers to interact with the system and access vital information. Through a user-friendly interface, caregivers can remotely view live camera feeds, access historical data and analysis reports, configure system settings, and receive real-time alerts and notifications. This level of remote access empowers caregivers to effectively monitor the well-being of elderly individuals, make informed decisions, and provide timely assistance, even when physically separated.

In summary, the vision-based monitoring system for elderly individuals at home is a comprehensive and technologically advanced solution that combines computer vision, image processing, data analysis, and alerting mechanisms to enhance the safety, well-being, and independence of aging individuals. By providing continuous surveillance, fall detection, activity monitoring, medication reminders, and emergency response capabilities, the system offers a holistic approach to care, enabling elderly individuals to maintain their independence while ensuring their safety and providing peace of mind to caregivers and loved ones.

A. Problem description

AAL system goal to provide good life for older elderly people. we'll solve the issues using vision-based technology. Further we'll recognize the issues of elderly person by using RGB camera so we'll design health monitoring system. we'll design reliable action recognition system by selecting the proper dataset consistent with literature, most of the datasets aren't provide good results, so we'll use Assisted Living Monitoring Dataset (ALMOND) Dataset.

B. Aim

1) Aim is to provide good and comfortable life for older people

2) To ensure security and healthy quality.

3) To use advanced security techniques.

4) To develop systematic monitoring system

C. Goals and Objectives:

The objectives of the project are:

1) Study and apply the needed tools namely:

   a) Image downloaded from computer or locally saved.

   b) Flask Deployed Server and python 3.6.8 Community

   c) Algorithms for computer vision and machine learning.

2) Develop a front-end website to upload images to process.

3) Test the computer application and website running

4) Document the result of the project.

D. Scope:

The scope of our project is to develop a real time activity recognition system which ultimately controls the image with a jpg extension and the camera samples of real-time webcam method. During the project, four gestures were chosen to represent four navigational commands that are sitting, standing, bending and sleeping. A simple computer vision application was written for the detection and recognition of the four gestures and their translation into the corresponding commands for the actions and tracking. Thereafter, the program was tested on a webcam with actual movement of the person in real-time and the results were observed.

Limitations*:*

1. Accuracy of object detection at night is low.
2. It only detects objects at maximum of 40–45-meter distances.
3. System should have at least 4GB Ram and a very high megapixel camera.

E. Timeline:

Sr. No.	Work	Start Date	End date
1.	Information gathering and literature survey.	02/09/22	07/09/22
2.	Design, analysis & hardware configuration.	08/09/22	13/09/22
3.	Module 1: Person detection.	16/09/22	02/10/22
4.	Module 2: Action Recognition.	04/10/22	20/10/22
5.	Module 3: Sending alerts to guardian.	22/10/22	12/11/22
6.	Integration of modules and testing.	22/11/22	02/01/23
7.	Final documentation.	11/03/23	11/05/23

F. Project cost:

The total cost of the project was around 7000 rupees. The Global System for Mobile communications i.e., GSM which was used for sending alerts to the guardian costed us about Rs.1000. The hardware used such as antenna, capacitors costed us around Rs.2000. Total software costed us Rs.4000.

Line of code: To develop the system 500 lines of codes are required.

KLOC: KLOC is the estimated size of the software product indicates in Kilo Lines of Code.

KLOC = LOC / 1000 = 950 / 1000

= 0.95

Effort: The effort is only a function of the number of lines of code and some constants evaluated according to the different software systems.

T=aLb

Where L is KLOC (Kilo Line of Code) T is time required to complete T=2.4*0.95^1.05 = 2.2

Duration Estimation: Once the effort estimation is obtained, we can estimate the duration of the project. Assuming a standard productivity rate of 2 person per calendar month, the duration can be calculated as:

Duration (in months) = Effort / Productivity = 2.2 / 2

= 1.13

2. Background study and literature overview

A. Literature overview:

CNN:

- In Convolutional layers filters are used as input image to extract some features like edges, textures, and shapes. The output of the convolutional layers is then passed through pooling layers we can use this for feature maps which also reduces the spatial dimensions while keeping the most important information. This output is then passed through fully connected layers, which are used to make a prediction or classify the image according to the need.
- CNN can be used to input designs like lines, gradients, circles, or even eyes and faces.
- This characteristic that makes convolutional neural network so robust for computer.
- CNN does not need any pre-processing.
- This type of neural network is a feed forward neural network.
- There are many convolutional layers in CNN, assembled on top of each other, where every single layer is competent of recognizing more sophisticated actions and shapes.
- With three to four convolutional layers it recognizes handwritten digits and with up to 25 layers it differentiates human faces.

TensorFlow:

TensorFlow is one of the most used open-source software libraries. This was originally developed by engineers working on the Google Brain Team within Google's MI research organization for the purposes of conducting machine learning and deep neural networks research. TensorFlow is basically a software library for numerical computation.

In TensorFlow Nodes and edges in the graph represent mathematical operations and multidimensional data arrays communicated between them Respectively.

It Provides Multiple APIs (Application Programming Interfaces). These can be classified into 2 major categories:

1. Low level API:
    - complete programming control
    - recommended for machine learning researchers
    - provides fine levels of control over the models
    - It is the low-level API of TensorFlow.
2. High level API:
    - built on top of TensorFlow Core
    - easier to learn and use
    - make repetitive tasks more consistent between different users and easier

NumPy:

NumPy is package used in python which is an array-processing package which provides a high-performance multidimensional array object and tools. NumPy arrays are more compact and faster. It has scientific uses; it can be used as a multi-dimensional container of some data.

OpenCV:

OpenCV is an open-source library for machine learning, image processing and computer vision. OpenCV supports programming languages like C++, Java, Python, etc. It can process videos and images to identify faces, objects and handwriting. When there are libraries, such as NumPy which is a optimized library for numerical operations, the operations in NumPy can be combined with OpenCV. It has Python, C++, Java and C interfaces and supports Mac OS, Windows, Linux, Android and iOS.

There are lot of applications which are solved using OpenCV

- Automated inspection and surveillance
- number of people – count (foot traffic in a mall, etc.)
- face recognition
- TV Channels advertisement recognition
- Vehicle counting on highways along with their speeds
- Anomaly (defect) detection in the manufacturing process (the odd defective products)
- Interactive art installations
- Video/image search and retrieval
- object recognition
- Movies – 3D structure from motion

- Street view image stitching
- Robot and driver-less car navigation and control
- Medical image analysis

B. Critical appraisal of other people's work:

User involvement in research often carries an assumed benefit without sufficient consideration of the reasons and methods for engaging patients and carers. Unfortunately, the emphasis on involving users in order to ensure good research practices and maintain ethical standards has often resulted in superficial and tokenistic forms of engagement. This approach can be unsatisfactory for service users who feel unclear about their role and poorly consulted, as well as for the research team, which may fail to fully leverage the potential of user involvement in their studies. To address this issue, research teams need to clearly articulate their reasons for involving service users before approaching patients and carers, and this rationale should be transparently communicated in published papers and funding applications. Likewise, the reasons for not involving service users in research should also be documented.

There are various strategies available for involving users in research. Hanley et al. have identified three levels of user involvement: consultation, collaboration, and user-control. Consultation involves seeking users' views to inform decision-making, while collaboration entails sustaining an active partnership with users throughout the research process. User-control goes a step further, giving service users the initiative and decision-making authority instead of professional researchers.

It is crucial to align the level of user involvement with the research objectives. The level of involvement naturally influences the tasks users are expected to undertake, which should be proportionate to the study's aims. For instance, while it may not be feasible for users to participate in data collection or analysis in basic science research, involving them in revising information sheets or assisting with dissemination could be appropriate. Moreover, it's important to avoid assigning an inappropriately high level of involvement to service users, such as demanding physically demanding data collection in palliative care research. The level and nature of user involvement should be carefully considered and clearly stated.

The recruitment process for service users should be mindful of where and how they are approached. Recruiting users through inappropriate channels may lead to undue influence on the research process, its direction, and outcomes. Researchers sometimes have a tendency to select compliant users who are unlikely to challenge their perspectives. Therefore, it is essential for researchers to provide details about the processes used to identify, approach, and involve users.

Efforts should be made to involve a diverse range of service users where appropriate. For example, in the Macmillan Listening Study, it was recognized that there was a lack of representation from diverse ethnic minorities and individuals receiving palliative care services during the initial project meeting. To address this, users from diverse ethnic backgrounds were specifically approached through community organizations, and users receiving palliative care services were contacted through participating hospices to ensure a broader representation.

Research activities often require technical skills and expertise gained through experience. Therefore, it is not surprising that training plays a crucial role in successful user involvement. The nature of training provided to service users should be carefully developed and clearly explained. It is important to document whether the training is accredited, how it is integrated into the study's operations, and whether it is flexible and responsive to users' evolving needs and concerns as they gain experience. Similarly, the quality of training provided to professional researchers regarding user involvement should be explicitly addressed, especially when the research team's expertise in user involvement is uncertain. User involvement training for professional researchers impacts the quality of research. Clear rationale for user involvement is essential, as poor practices from the research team can lead to suboptimal involvement, thereby affecting research quality.

Ethical considerations are just as important for service users involved in research as they are for participants. However, it is surprising that these concerns are often overlooked. Our experience in cancer research has highlighted ethical issues related to user involvement. Many of these issues align with those faced by participants, such as ensuring that service users are fully informed and have the right to withdraw from the study at any time. Other issues, such as the availability of peer supervision or counselling, when necessary, are not specific to user involvement but should be standard practices in research.

C. Investigation of current project and related work:

It is possible to observe that ALMOND uses only a small portion of samples provided by NTU, whose cardinality dominates the other datasets. We explore deeper this issue with some preliminary experiments, our intent was investigating if the inclusion of a larger number of samples could create a better dataset. Performed experiments were structured comparing ALMOND, presented in Section 3, and its version with two edits, the former including 200 samples more from NTU, the latter including 400 NTU samples. Extra samples have been added only for classes where NTU provided it. In all the cases the dataset has been balanced by actions, except for the two reject classes, duplicating samples of each action to reach the samples number of group's most populated action. As experiments results, we observed that an increment of samples from NTU did not lead the true positive accuracy difference for each datasets that form ALMOND, missing datasets mean there were no changes in terms of accuracy, the positive values mean the percentage of increment in action recognition, otherwise negative values mean worse performance. We can notice that an increment of NTU samples corresponds to worse generalization capacity for the model, giving only a relevant increase of accuracy on samples provided by NTU. With the inclusion of 400 NTU samples the behavior is the same as with 200, but even more pronounced. Generally, increasing the number of samples from a single dataset does not lead to a merged dataset with more useful information, rather shows a loss of heterogeneity. Facing the results of preliminary experiments, we use ALMOND as described in Section 3 without the inclusion of additional samples from NTU

To localize the subject inside the scene we used a Faster R-CNN network pre-trained on the COCO dataset . We noticed an increment of missing detections when subjects are lying down, or assume a horizontal position. Exploring more in detail the COCO dataset, we noticed a lack of samples of lying down subjects compared to people in other common positions. This led us to go deeper into the issue, by investigating if a fine-tuning, on the same dataset extended with digitally rotated by ±90◦ images, can lead to better subject detection. Table 6 reports the comparison between pre-trained Faster R-CNN and the fine-tuned one. Results show that the detection performance are comparable for unrotated images, where a few lying down people is present, while the fine-tuned model provides better results with rotated images. Taking into account the results, the fine-tuned model correctly detect more lying people and provides more stable detection in those cases, in other cases performance are comparable to pre-trained version.

Since the guardian can watch the subject’s videos, an important matter that must be kept in consideration for this kind of applications is the privacy of the subject. The proposed system was designed to be used in a private setting, keeping in mind that there are different laws for different countries which impose different rules. Assuming the guardian can see the monitored subject, the problem of guest privacy can be instead addressed with the use of people identification approaches, anonymizing all the individuals in the scene that are not the monitored subject. An investigation into the most suitable and performant methods will be carried out in future works.

3.REQUIREMENT ANALYSIS

A. Requirement specifications:

- Functional Requirement:

● The image used will be uploaded into the website from where result will be displayed with the machine accuracy.

● The software will be able to produce multiple frames and display the image in the RGB color space

● The software will be able to detect the contours of the detected positions.

● The software, which act as an intermediate in passing these, processed image in order to control the image sent.

- Non-Functional Requirement:

● Usability: The user is facilitated with the control section for the entire process in which they can arrange the position of hand at the center of ROI under consideration, the variation of palm position and respective command generation etc. can be effectively facilitated by mean of user interface. The implementation and calibration of camera and its resolution can also be done as per quality and preciseness requirement. The frame size, flow rate and its command variation with respect to threshold developed and color component of hand color, can be easily calibrated by means of certain defined thresholds.

● Security and support: Application will be permissible to be used only in secure network so there is less feasibility of insecurity over the functionality of the application. On the other hand, the system functions in a real time application scenario, therefore the camera, color and platform compatibility is must in this case. IN case of command transfer using certain connected devices or wireless communication, the proper port assignment would also be a predominant factor to be consider

• Maintainability: The installation and operation manual of the project will be provided to the user.

• Extensibility: The project work is also open for any future modification and hence the work could be defined as the one of the extensible works.

• External Interface Requirement: An interface description for short is a specification used for describing a software component's interface. IDLs are commonly used in remote procedure call software. In these issues, the machines on moreover last part of the "link" might be utilizing.

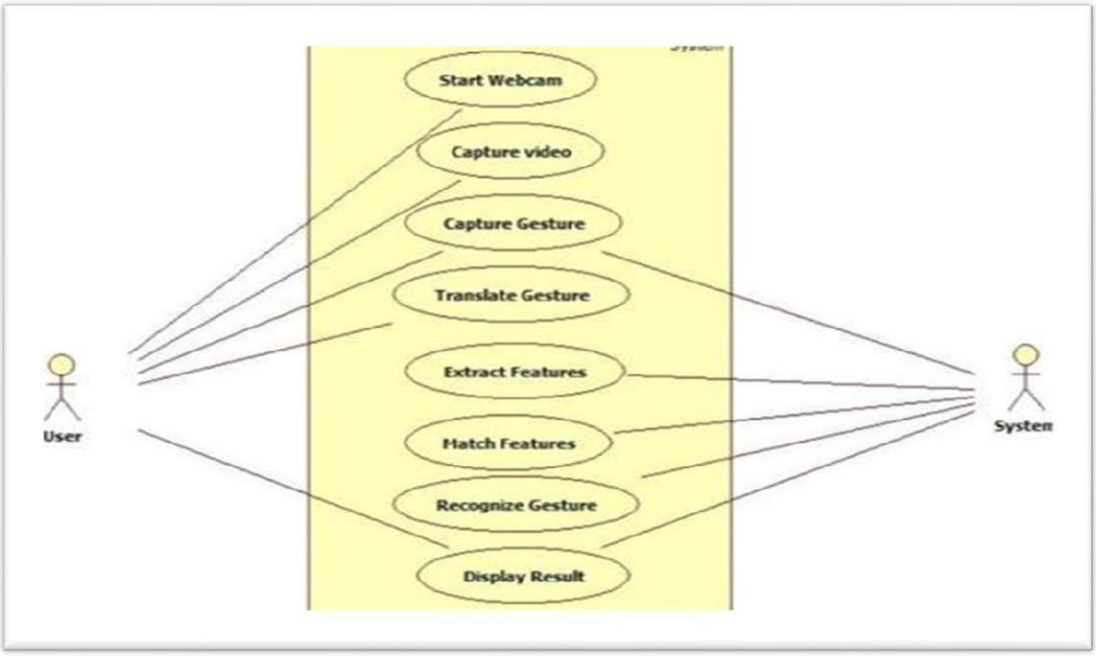
➢ These descriptions are classified into following types:

● User Interface: The external or operating user is an individual who is interested to introduce a novel Algorithm for shape-based hand gesture recognition in real time application scenario. The user interface would be like axis presenting real time movement of human hand and its relative position with respect to defined centroid or morphological thresholds.

● Restoration with Text Removal Software Interface: The Operating Systems can be any version of Windows, Linux, UNIX or Mac.

● Hardware Interface: In the execution of this project, the hardware interface used is a normal32/64-bit operating system supported along with better integration with network interface card for better communication with other workstations. For better and precise outcome, a high-definition camera with calibrated functioning.

B. Use case diagram:

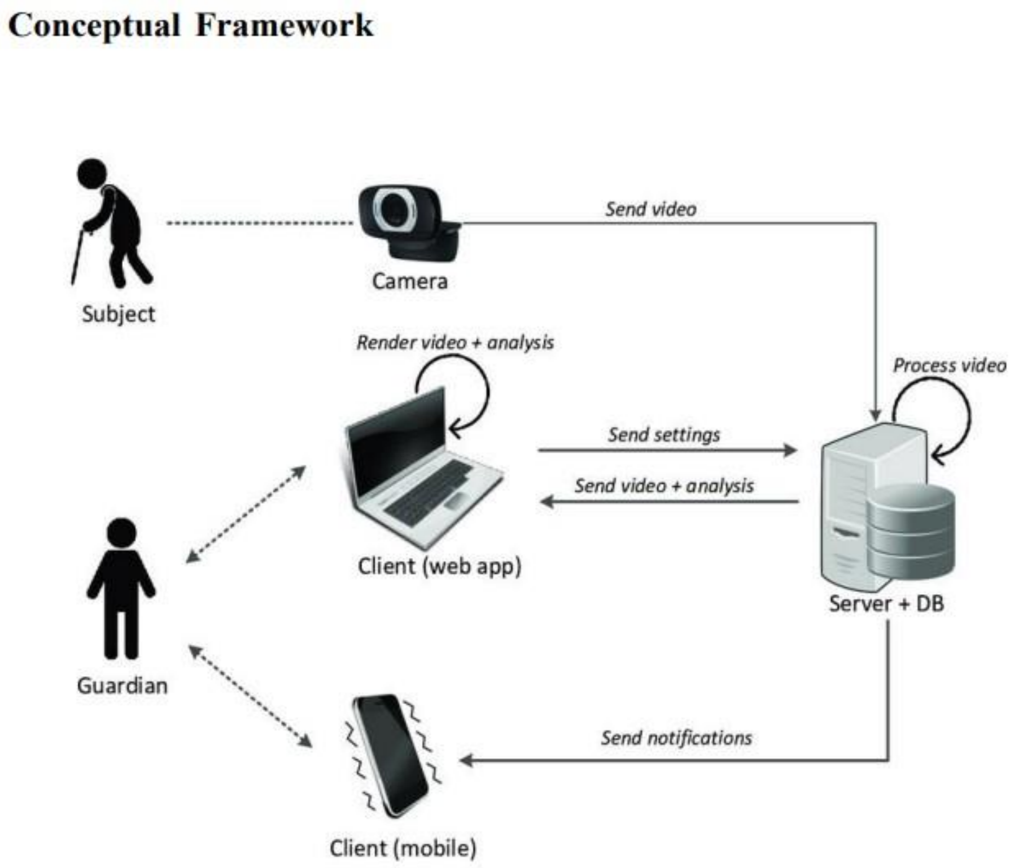


C. Project costing:

Sr.no	Equipment	Cost
1	Global systems for mobile communications	1000
2	Data Acquisition	Varying
3	Ssoftware	4000
4	Antenna, capacitors, etc.	2000

4. SYSTEM DESIGN

A. Architectural Design:



A vision-based system for monitoring elderly people at home can be a valuable tool to help ensure their safety and well-being. Such a system could use cameras and other visual sensors to monitor the activities and movements of the elderly person and provide alerts or notifications if anything unusual or potentially dangerous is detected.

Here are some of the key components and considerations for designing a vision-based system for monitoring elderly people at home:

1. Camera Placement: The cameras should be placed strategically to cover all the areas where the elderly person spends time, such as the living room, bedroom, and kitchen. The cameras should be positioned in a way that doesn't

invade the person's privacy but still provides clear visibility of their movements and activities.

2. Object Detection: The system should be able to detect objects such as a person falling, a stove left on, or a door left open. This can be achieved using machine learning algorithms trained on large datasets of images and videos.

3. Activity Recognition: The system should be able to recognize activities such as walking, sitting, or lying down, and determine whether the person is moving normally or if there is something abnormal or unusual in their behavior.

4. Alert System: The system should have an alert system that sends notifications to caregivers or family members if any abnormal activity or behavior is detected. This can be done via email, text message, or phone call.

5. Privacy and Security: The system should be designed with privacy and security in mind. It should be HIPAA compliant and adhere to all relevant privacy laws and regulations. It should also have robust security features to protect the data from unauthorized access or hacking.

6. User Interface: The system should have a user-friendly interface that allows caregivers and family members to easily monitor the activities of the elderly person and receive alerts and notifications.

Overall, a vision-based system for monitoring elderly people at home can be a valuable tool to help ensure their safety and well-being. By using cameras and other visual sensors, such a system can provide real-time monitoring and alert caregivers and family members if any abnormal activity or behavior is detected.

B. Algorithmic description of each module

Here's an algorithmic description of each module for a vision-based system for monitoring elderly people at home:

1. Data Collection:

- Collect data from various sensors such as cameras, motion sensors, and other visual sensors.

- Store the data in a centralized database.

2. Object Detection:

- Use computer vision algorithms to detect objects such as a person falling, a stove left on, or a door left open.

- Train machine learning models on large datasets of images and videos to improve object detection accuracy.

- Trigger an alert or notification if any abnormal object is detected.

3. Activity Recognition:

- Use computer vision algorithms to recognize activities such as walking, sitting, or lying down.

- Train machine learning models on large datasets of images and videos to improve activity recognition accuracy.

- Determine whether the person is moving normally or if there is something abnormal or unusual in their behavior.

- Trigger an alert or notification if any abnormal activity is detected.

4. Alert System:

- Send notifications to caregivers or family members if any abnormal activity or behaviour is detected.

- Customize which alerts are received and how they are received, such as via email, text message, or phone call.

- Ensure the alert system is reliable and secure to protect privacy.

5. Real-time Monitoring:

- Provide real-time monitoring of the elderly person through live video feeds and location tracking.

- Allow caregivers and family members to view live video feeds and see the person's current location and activity level.

6. Historical Data:

- Provide historical data, such as activity logs and video recordings, for caregivers and family members to review past activity and behavior.

- Store historical data in a centralized database for easy retrieval and analysis.

7. User Interface:

- Develop a user-friendly interface that allows caregivers and family members to easily monitor the activities of the elderly person and receive alerts and notifications.

- Ensure the interface is accessible to all users, including those with visual or hearing impairments.

- Gather feedback from users to improve the user interface.

Overall, a vision-based system for monitoring elderly people at home uses a combination of computer vision algorithms and machine learning models to detect objects and activities, trigger alerts and notifications, and provide real-time monitoring and historical data. The system's user interface should be designed to be user-friendly and accessible to all users.

C. System Modelling

a. Sequence Diagram:

Here's a sequence diagram for a vision-based system for monitoring elderly people at home:

1. User initiates the monitoring process by opening the User Interface module.

2. User Interface module sends a request for real-time monitoring to the Real-time Monitoring module.

3. Real-time Monitoring module starts streaming live video feeds and location tracking data to the User Interface module.

4. User Interface module displays the live video feeds and location tracking data to the user.

5. Real-time Monitoring module sends the live video feeds and location tracking data to the Historical Data module for storage.

6. Object Detection module and Activity Recognition module analyse the live video feeds to detect objects and activities.

7. Object Detection module and Activity Recognition module send any detected objects or activities to the Alert System module.

8. Alert System module checks if any detected object or activity requires an alert or notification to be sent to caregivers or family members.

9. If an alert or notification is required, Alert System module sends the alert or notification to the User Interface module.

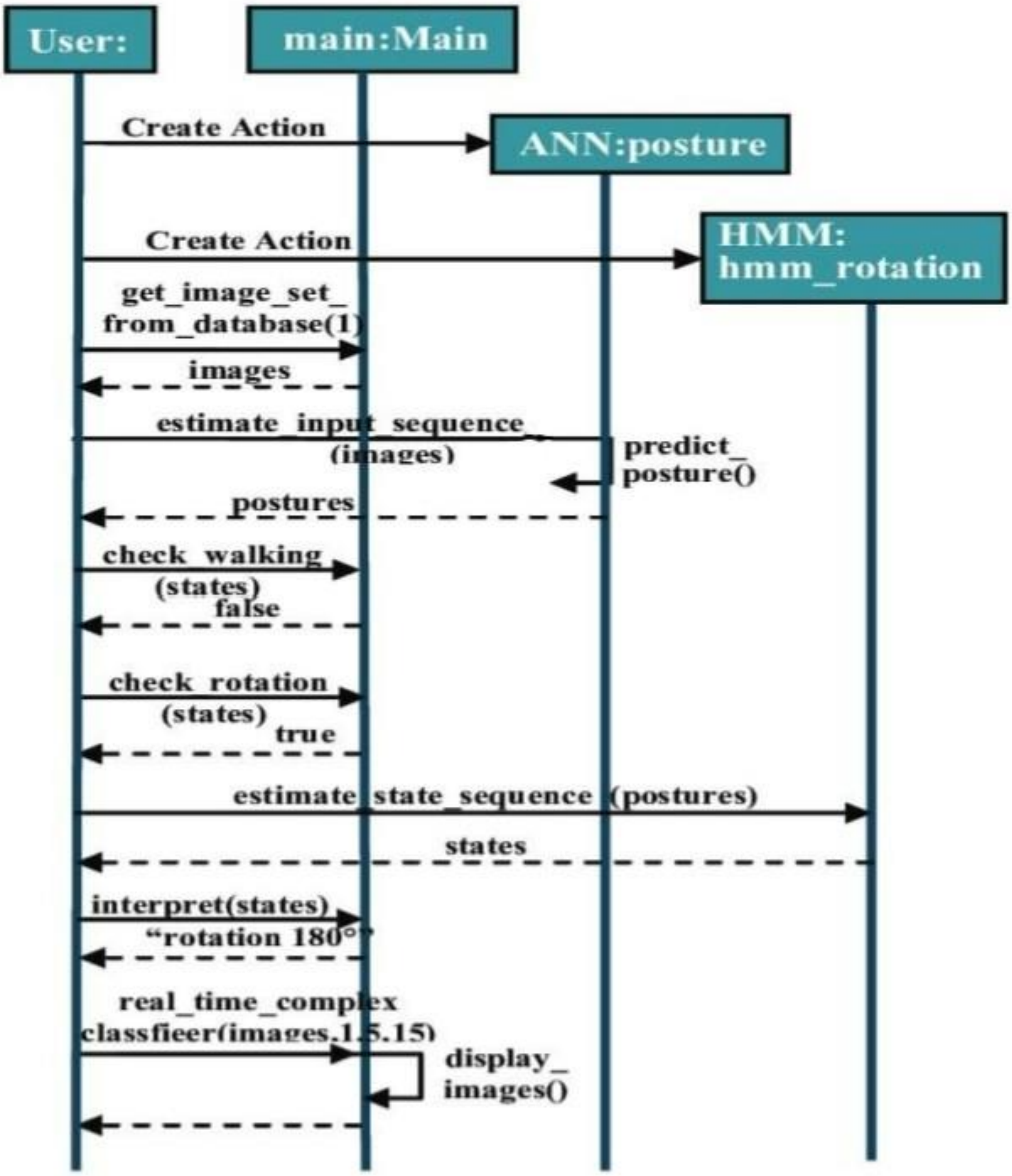
10. User Interface module displays the alert or notification to the user.

11. User can customize which alerts and notifications they receive by sending input to the Alert System module through the User Interface module.

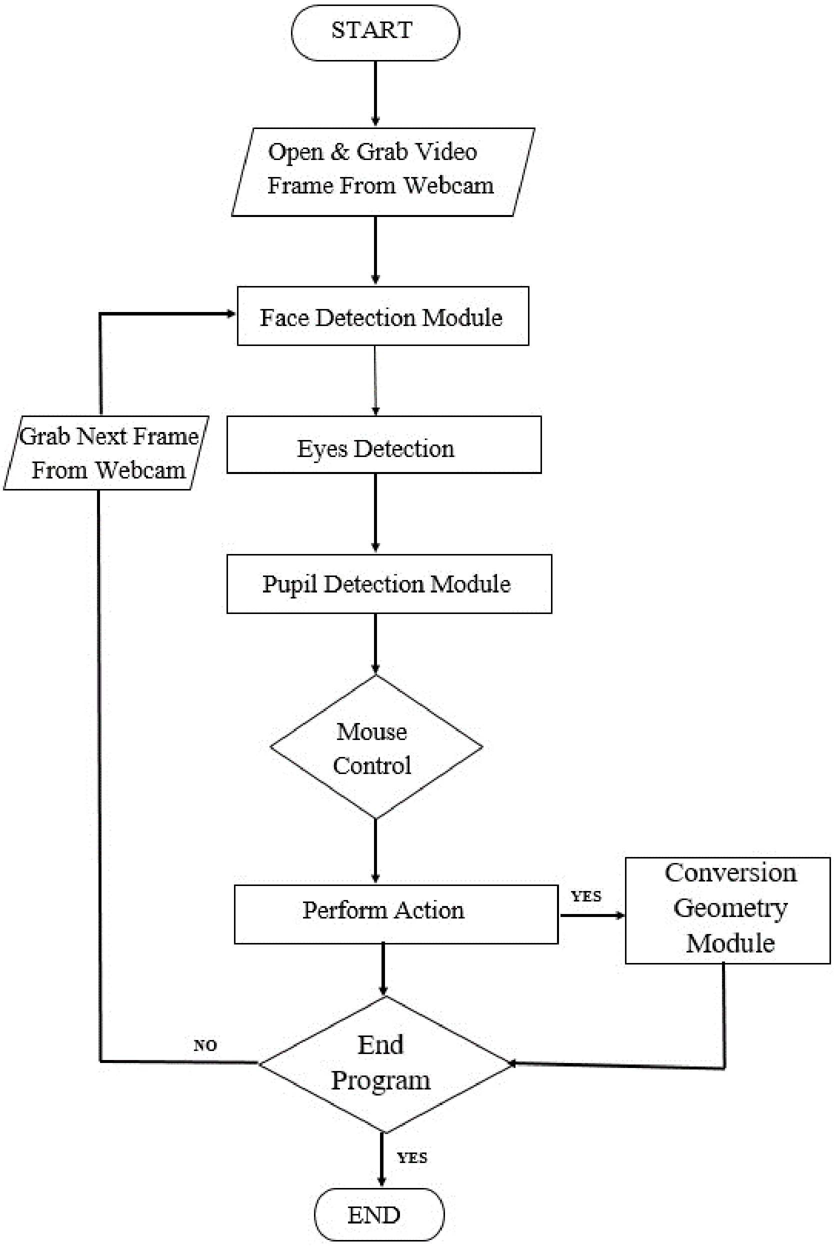
12. Historical Data module stores all detected objects and activities, as well as alerts and notifications that have been sent.

13. User can access historical data through the User Interface module to review past activity and behaviour.

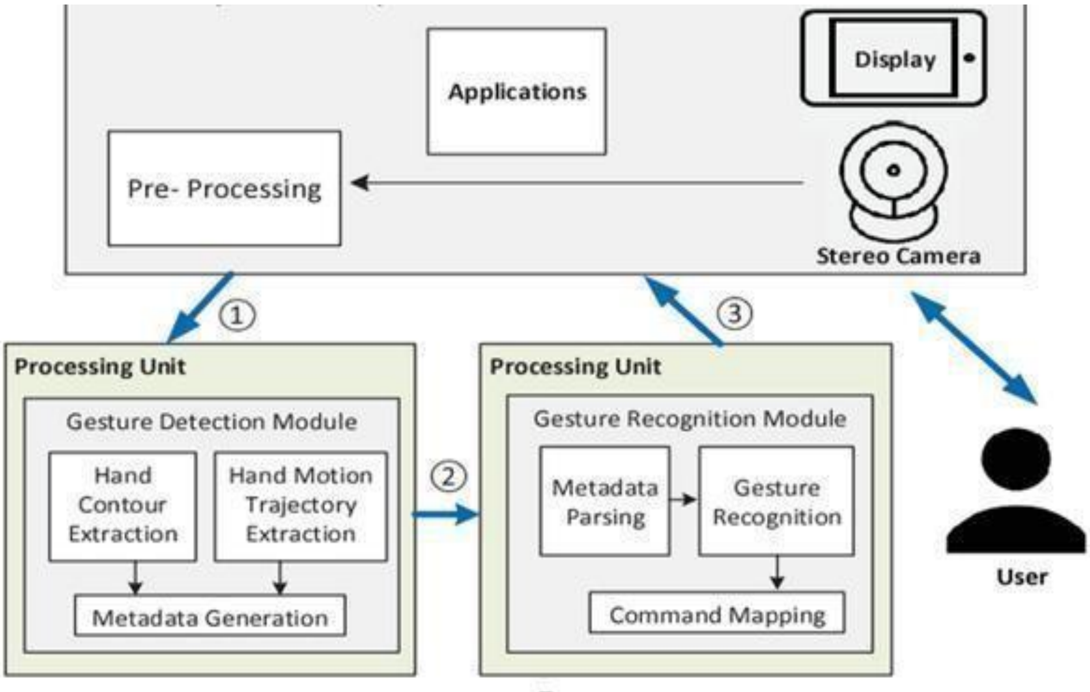
Overall, this sequence diagram illustrates how a vision-based system for monitoring elderly people at home works to provide real-time monitoring, detect and alert on abnormal objects and activities, store historical data, and provide a user-friendly interface for caregivers and family members.


User:
main:Main
Create Action
ANN:posture
Create Action
HMM:
hmm_rotation
get_image_set_
from_database(1)
images
estimate_input_sequence_
(images)
predict_
posture()
postures
check_walking
(states)
false
check_rotation
(states)
true
estimate_state_sequence_(postures)
states
interpret(states)
“rotation 180°”
real_time_complex
classfieer(images,1,5,15)
display_
images()

b. Activity Diagram:



c. Component Diagram:



Here's a deployment diagram for a vision-based system for monitoring elderly people at home:

1. Cameras and Sensors:

- Deploy cameras and sensors throughout the home to capture visual data.

2. Edge Devices:

- Install edge devices, such as Raspberry Pi or NVIDIA Jetson, near the cameras and sensors to process the visual data.

3. Cloud Services:

- Connect the edge devices to cloud services, such as Amazon Web Services or Microsoft Azure, to store and process the visual data.

4. Object Detection and Activity Recognition Algorithms:

- Deploy object detection and activity recognition algorithms on the cloud services to analyse the visual data and detect objects and activities.

5. Alert System:

- Deploy the alert system on the cloud services to trigger alerts and notifications if any abnormal objects or activities are detected.

6. User Interface:

- Deploy the user interface on the cloud services to display real-time monitoring data and historical data, and to receive user input for customized alerts and notifications.

7. Database:

- Set up a centralized database on the cloud services to store all visual data, detected objects and activities, alerts and notifications, and historical data.

Overall, this deployment diagram illustrates how a vision-based system for monitoring elderly people at home can be deployed on a combination of edge devices and cloud services to enable real-time monitoring, object detection and activity recognition, alerting, and data storage and analysis.

d. Data flow Diagram:

In this diagram:

The "Sensor" component represents the devices or systems that collect data for monitoring.

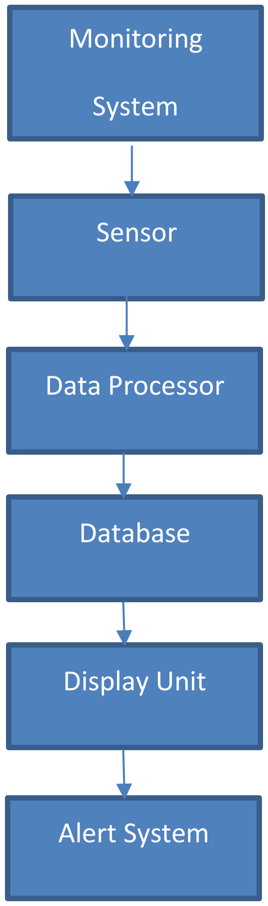
The "Data Processor" processes the data received from the sensor(s) and performs any necessary calculations or analyses.

The "Database" stores the collected and processed data for future reference or analysis.

The "Display Unit" presents the monitored data in a user-friendly format for visualization or analysis.

The "Alert System" generates alerts or notifications based on predefined criteria or thresholds to notify users of any abnormal or critical situations.

Arrows between the components represent the flow of data. For example, data flows from the sensor to the data processor for processing, and from the data processor to the database for storage. Similarly, data flows from the database to the display unit for visualization and from the data processor to the alert system for triggering alerts.


Monitoring System
Sensor
Data Processor
Database
Display Unit
Alert System

5. Implementation:

A. Environmental setting for running the project

1. Create environment with python version 3.9.
2. Open cv: library is used for image processing and need to integrate with python.
3. Activate the environment and install necessary packages.
4. Import packages NumPy, skypi, cypi, cykit.
5. Install tensor flow.

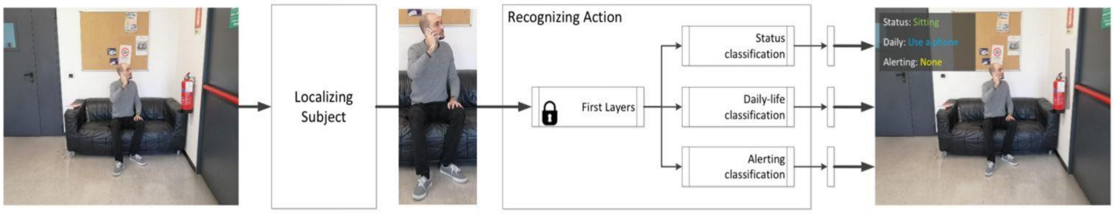
B. Detailed description of class and its methods:

1. Frame extraction:
   - Images frames are taken at equal intervals from the live streamed video.
   - These frames are given to the CNN classifier as input.
   - Open CV library is used for frame extraction.
2. Dataset acquisition:
   - Gathering the ALMOND dataset and using this pretrained dataset as the basis for action detection.
   - The frames are made compatible to the algorithm.
3. Human action recognition algorithm:
   - Human action recognition- detection of human actions from the frame.
   - Classification- classification of the actions detected according to the risk involved.
4. Training the model:
   - Training the neural network.
5. Action recognition:
   - Identifying the human actions from the frame.

- Classifying them according to the class mentioned with the risks involved.

6. Sending alerts:
    - Send alert to the guardian in case of dangerous situations like heart attack, headache.

C. Implementation Details:



1. Hardware Setup:
    - Install cameras strategically throughout the home to capture visual data from important areas.
    - Deploy sensors, such as motion sensors and fall detection sensors, to gather additional contextual information.

2. Software Development:
    - Develop the monitoring system software using suitable programming languages and frameworks.
    - Implement image processing algorithms to analyze the captured visual data, including object detection and motion tracking.
    - Create data analysis algorithms to identify patterns, anomalies, and potential risks based on collected data.
    - Incorporate fall detection algorithms to identify and analyze falls using camera data and fall detection sensors.
    - Design a user interface for caregivers to interact with the system, view live camera feeds, and receive notifications.

3. Database Management:

- Design a database schema to store relevant information, such as data about elderly individuals, caregivers, and monitoring activities.
- Create appropriate database tables and establish relationships between them using SQL.
- Develop SQL queries and stored procedures to handle data insertion, retrieval, and updates.
- Implement data security measures and regular backups to ensure data integrity and protect sensitive information.

1. Integration and Communication:

- Establish communication channels between cameras, sensors, and the central monitoring system for real-time data transmission.
- Implement APIs or communication protocols to enable seamless integration and data exchange between system components.
- Configure the system to receive alerts and notifications from sensors or external systems during emergencies.

2. Testing and Validation:

- Conduct thorough testing to validate the system's functionality, accuracy, and reliability.
- Test image processing algorithms with various scenarios to ensure accurate detection and tracking of activities.
- Evaluate the fall detection capabilities through real-world tests, minimizing false positives.
- Verify the system's responsiveness and reliability in delivering timely notifications and alerts to caregivers.

3. Deployment and Deployment Considerations:

- Install and configure the monitoring system in the homes of elderly individuals.
- Ensure stable network connectivity for seamless data transmission.
- Provide training to caregivers on system usage, accessing the user interface, and interpreting monitoring data.

- Offer ongoing technical support and maintenance to address any issues or concerns.

4. Privacy and Security:

- Implement robust security measures to protect the privacy of elderly individuals, including data encryption and access controls.
- Comply with relevant data protection regulations to ensure lawful handling and storage of personal data.

6. Integration and Testing:

A. Description of the integration modules

- Camera Module:

The camera module encompasses the installation of cameras throughout the home to capture visual data.

It enables real-time streaming and recording of video feeds from different areas.

These video feeds serve as input for other modules, such as image processing and activity recognition.

- Image Processing Module:

The image processing module analyzes the video feeds from the cameras to extract meaningful information.

It employs computer vision techniques to detect objects, track motion, and recognize activities performed by the elderly individuals.

This module plays a vital role in identifying potential risks, such as falls or unusual behavior, through visual analysis.

- Fall Detection Module:

The fall detection module utilizes both camera data and fall detection sensors to identify instances of falls.

It applies algorithms to detect motion patterns associated with falls and triggers alerts when a fall is detected.

This module significantly contributes to ensuring prompt assistance for elderly individuals in the event of falls or accidents.

- Data Analysis Module:

The data analysis module processes the collected visual data and sensor data to derive meaningful insights.

It identifies patterns, trends, and anomalies in the activities of the elderly individuals.

This module plays a crucial role in assessing overall well-being, identifying potential health issues, and generating informative reports for caregivers.

- Notification Module:

The notification module is responsible for sending real-time alerts and notifications to caregivers or designated contacts.

It triggers notifications based on predefined events or detected anomalies, such as falls or prolonged inactivity.

This module ensures that caregivers can promptly respond to critical situations and provide necessary assistance.

- User Interface Module:

The user interface module provides caregivers with a user-friendly interface to interact with the system.

It enables caregivers to view live camera feeds, access historical data, configure system settings, and receive alerts.

This module empowers caregivers to remotely monitor the well-being of elderly individuals and make informed decisions.

- Database Module:

The database module manages the storage and retrieval of relevant data, including information about elderly individuals, caregivers, and monitoring activities.

It stores historical data, activity logs, and other system-related information for analysis and reporting purposes.

This module ensures data integrity, facilitates efficient data retrieval, and supports the scalability of the system.

B. Testing:

- Camera Module:

Test the camera installation and positioning to ensure proper coverage and clear video feeds.

Verify the camera's functionality, including image quality, resolution, and frame rate.

Perform tests to check the camera's ability to capture visual data in different lighting conditions and angles.

- Image Processing Module:

Test the accuracy and efficiency of object detection algorithms by presenting various objects in the camera's field of view.

Evaluate the motion tracking capabilities by simulating different movement scenarios and verifying the accuracy of the tracking results.

Validate the activity recognition algorithms by performing predefined activities and ensuring accurate detection and classification.

- Fall Detection Module:

Conduct tests to evaluate the fall detection algorithms using simulated fall scenarios and assess the system's ability to detect falls accurately.

Test the responsiveness of the module by simulating different types of falls, including various angles, speeds, and impact surfaces.

Validate the module's ability to distinguish between falls and other activities that may mimic falling motions, such as sitting abruptly.

- Data Analysis Module:

Test the data analysis algorithms by providing sample datasets with known patterns and anomalies, and verify the accuracy of the detected insights.

Validate the module's ability to generate meaningful reports and visualizations based on the analyzed data.

Perform performance testing to ensure the module can handle large datasets and process data within acceptable time frames.

- Notification Module:

  Test the module's ability to send notifications to caregivers in real-time by triggering predefined events and verifying that notifications are received promptly.

  Validate the module's delivery mechanism, including email, SMS, or app notifications, to ensure reliable and timely delivery.

  Conduct end-to-end testing to verify that notifications are correctly triggered based on specific events, such as falls or extended inactivity.

- User Interface Module:

  Perform usability testing to ensure the user interface is intuitive and easy to navigate for caregivers.

  Test the functionality of viewing live camera feeds, accessing historical data, and configuring system settings through the user interface.

  Validate the responsiveness and compatibility of the user interface across different devices, such as desktops, tablets, and smartphones.

- Database Module:

  Test the database connectivity and ensure the successful storage and retrieval of data.

  Perform data integrity checks to verify the accuracy and consistency of the stored information.

  Validate the performance of SQL queries and stored procedures for efficient data manipulation and retrieval.

7. Performance Analysis:

Over the past few years, there has been considerable attention given to the utilization of deep learning in computer vision, specifically concerning the recognition of human actions. Several methods based on deep learning have been suggested to tackle this issue, with a primary emphasis on RGB inputs and the utilization of diverse deep learning techniques. In this segment, we emphasize noteworthy research in action recognition and provide an overview of the effectiveness of these approaches on commonly employed datasets.

Method	Year	HMDB-51 [23]	UCF-101 [24]	Kinetics [25]	Charades [26]	NTU [27]
Two streams (RGB+OF) [20]	2014	59.4%	88.0%			
C3D+Linear SVM [21]	2015		85.2%			
LSTM30+OF+RGB [28]	2015		88.6%			
S:VGG-16, T:VGG-16 [29]	2016	65.4%	92.5%			
TSN (3 modalities) [30]	2016	69.4%	94.2%			
ST-LSTM+Trust Gate [31]	2016					69.2%
LTC [32]	2017	67.2%	92.7%			
I3D [33]	2017	80.9%	98.0%	74.2%		
T3D(+TSN) [34]	2017	63.5%	93.2%	71.5%		
P3D ResNet [35]	2017		88.6%			
L^{2}STM [36]	2017	66.2%	93.6%			
STA-LSTM [37]	2018					73.4%
DTMV+RGB-CNN [38]	2018	55.3%	87.5%			
R(2+1)D-Two [39]	2018	78.7%	97.3%	75.4%		
NL I3D [40]	2018			77.7%	39.5%	
VideoLSTM [41]	2018	56.4%	88.9%			
DeepHAR (RGB only) [42]	2018					84.6%
R(2+1)D-152 [43]	2019			81.3%		
PA3D+I3D [44]	2019	82.1%			41.0%	

The existing body of literature primarily focuses on three key deep learning strategies employed for action recognition. Firstly, there are methodologies that integrate diverse information extracted from video streams, commonly referred to as two-stream networks. These networks aim to amalgamate spatial and temporal information to enhance recognition accuracy. Secondly, 3D convolutional networks have been developed to capture spatio-temporal structures within videos. By extending traditional 2D convolutional networks to process three-dimensional data, these models excel at extracting meaningful representations from video sequences. Lastly, long short-term memory (LSTM) networks have been utilized to incorporate temporal analysis of video content. LSTMs, as recurrent neural networks, effectively model sequential data, enabling the recognition of actions over time.

The performance of these methodologies has been extensively evaluated on popular datasets employed in the field of action recognition. Researchers have documented their findings on these standardized benchmark datasets, offering insights into the effectiveness of their techniques. These datasets serve as a standardized evaluation platform for comparing different action recognition methodologies and assessing their performance against state-of-the-art approaches.

Overall, deep learning has emerged as a promising and robust paradigm to address the challenges of action recognition in computer vision. Through the utilization of techniques such as two-stream networks, 3D convolutional networks, and LSTM networks, researchers have made notable advancements in this field, achieving impressive outcomes on well-established datasets.

Two-stream networks used in action recognition typically combine spatial RGB information with temporal information, often represented as motion vectors or optical flows. These two types of information are integrated by training two separate networks, and their outputs are fused in subsequent layers. The spatial network is trained on individual RGB frames, while the temporal network is trained on a sequence of optical flow frames. Both networks perform classification, and their results are fused using a Support Vector Machine (SVM).

To enhance the efficiency of two-stream networks and enable real-time applications, researchers have explored replacing computed optical flows with readily available motion vectors extracted from video streams. This modification reduces the computational workload while maintaining reasonable performance.

In some approaches, instead of employing late fusion, the two streams are fused at intermediate layers through convolutional and pooling operations. This fusion strategy has been demonstrated in the Temporal Segment Network (TSN), where long-range temporal structure modeling and warped flows are utilized to enhance the performance of the original two-stream network.

The concept of fusing multiple sources of information extends beyond spatial and temporal streams. In certain cases, multitask deep architectures have been utilized to simultaneously perform 2D and 3D pose estimation alongside action recognition. The model first predicts the location of body joints through pose estimation and then employs this information to predict the action performed in the video. This joint pose/action learning and recognition approach has proven to be more robust than treating the information separately.

By leveraging these techniques and incorporating the fusion of different information sources, researchers have achieved improved performance and robustness in action recognition tasks, thereby advancing the capabilities of two-stream networks in the field.

Temporal information can be effectively incorporated into network architectures through the use of stack frames and 3D convolutions. The C3D+Linear SVM approach introduced the idea of using small 3x3x3 convolution kernels in all layers, leading to improved recognition performance. This architecture, known as 3D ConvNet, produces robust features (C3D) that can be efficiently utilized in a simple linear classifier for action recognition.

Carreira et al. extended the two-stream network architecture based on inception-V1 by incorporating 3D convolutions, resulting in a two-stream inflated 3D ConvNet (I3D). They also introduced a temporal layer in a DenseNet architecture that models variable temporal convolution kernel depths using 3D filters and 3D pooling kernels.

Another approach to learning video representations is through neural networks with long-term temporal convolutions (LTC). High-quality optical flows were found to be particularly relevant for robust action recognition, and different low-level frame representations were explored.

Non-local operations were introduced by Wang et al. as a family of building blocks for capturing long-range dependencies in action recognition videos. These operations were incorporated into the Inflated 3D ConvNet, resulting in improvements on the Kinetics dataset.

Tran et al. demonstrated the advantages of 3D CNNs over 2D CNNs within the framework of residual learning. They factorized 3D convolutional filters into separate spatial and temporal components, resulting in the R(2+1)D convolutional block (2+1-dimensional ResNet), which achieved comparable or superior results to state-of-the-art methods.

Training networks for action recognition typically require a large amount of annotated data. Some studies have explored how to improve action recognition classification using large-scale weakly supervised pre-training, such as the R(2+1)D-d model. Despite the presence of data noise, these models have shown significant improvements in performance.

Many 3DCNN models are based on RGB and optical flow streams and lack information about human pose. Yan et al. proposed the Pose-Action 3D Machine (PA3D), a novel model that encodes multiple pose modalities within a unified 3D framework. PA3D utilizes a temporal pose convolution to aggregate spatial poses over frames.

To address the computational cost and memory demand of deep 3DCNN models, Qiu et al. introduced a family of Pseudo-3D (P3D) blocks, which replace 2D Residual Units in Res Net. These blocks achieve spatio-temporal encoding for videos.

Approaches based on Long-Short-Term Memory (LSTM) networks process videos as ordered sequences of frames. The LSTM cells retain information about previous frames in internal memory states. Various studies have proposed LSTM-based models, such as recurrent neural networks connected to ConvNet models for generating variable length video descriptions of actions and spatio-temporal LSTM for 3D human action recognition.

To overcome the assumption of stationary motions in videos across spatial locations, Lattice-LSTM extends LSTM by learning independent hidden state transitions of memory cells for individual spatial locations.

Several attention-based models have been developed, incorporating spatial and temporal attention modules. These models assign different levels of importance to different joints in a 3D skeleton using a spatial attention module and allocate varying levels of attention to each frame within a sequence using a temporal attention module. Attention-LSTMs (ALSTMs) consider spatial locality through attention, and Video LSTM enhances ALSTM by introducing Convolutional ALSTM modules to exploit spatial correlations and a Motion-based Attention module to guide the network towards relevant spatio-temporal locations.

8. Future Scope:

The future scope of Human activity recognition is a vast demonstration of categories on which its application can be achieved: -

CCTV cameras fixed on the pillars of a bank can be a human tracking device which tracks the movements of each person in the bank and captures their actions and if something goes way past the limits it can send data to the manager.

Traffic lights can be encapsulated with cameras to track car movements and speed limit accuracies.

Working on true surveillance video tracks, sport videos, movies, and online video data, will help to discover the real requirements for action recognition, and it will help researchers to shift focus to other important issues involved in action recognition.

Camera footages are used to keep eye on people in old age home.

- Enhanced Activity Recognition:

  Further refine and expand the activity recognition capabilities to recognize a broader range of activities and behaviors.

  Incorporate machine learning and deep learning techniques to improve the accuracy and robustness of activity detection.

  Develop algorithms to identify subtle changes in activities that may indicate changes in health conditions or well-being.

- Advanced Fall Detection:

  Explore the use of advanced sensor technologies, such as depth sensors or wearable devices, to enhance fall detection accuracy.

  Integrate machine learning algorithms to improve the system's ability to differentiate between falls and normal movements.

Implement real-time video analysis techniques to detect falls even in challenging scenarios, such as low-light environments or occlusions.

- Health Monitoring:

Integrate additional health monitoring features, such as heart rate monitoring, breathing pattern analysis, or sleep monitoring.

Develop algorithms to detect and alert caregivers about potential health emergencies, such as irregular heartbeats or abnormal breathing patterns.

Integrate with wearable devices or medical sensors to collect real-time health data and provide more comprehensive health monitoring.

- Behavior Analysis and Anomaly Detection:

Implement behavior analysis algorithms to identify deviations from normal routines or patterns, which may indicate potential health or safety risks.

Develop anomaly detection techniques to detect unusual behaviors or events that require immediate attention or intervention.

Utilize machine learning algorithms to continuously learn and adapt to the specific behaviors and preferences of individual users.

- Integration with Smart Home Technology:

Integrate the monitoring system with smart home devices and systems to enhance the overall functionality and convenience.

Enable remote control of lights, thermostats, or other appliances to support the comfort and safety of elderly individuals.

Utilize voice-activated assistants or voice recognition technologies to provide hands-free control and interaction with the system.

- Data Analytics and Predictive Insights:

Develop advanced data analytics techniques to derive more valuable insights from the collected data.

Apply predictive analytics algorithms to anticipate potential health issues or safety risks based on historical data and patterns.

Provide caregivers with personalized recommendations and proactive suggestions for improving the well-being and safety of the elderly individuals.

- Integration with Telemedicine and Healthcare Services:

Establish integration with telemedicine platforms to enable virtual consultations and remote healthcare monitoring.

Facilitate seamless data sharing between the monitoring system and healthcare providers, enabling better coordination of care.

Integrate with emergency response systems to ensure quick response and appropriate assistance during emergencies.

9. Applications:

- It helps doctor to prioritize patient and provide urgent care.
- If the case of emergency occurred then alert send to guardian then he can react accordingly.
- Automatic recognition of abnormal activities to notify guardian.
- By recognizing the action of elderly people, we can give them proper medicines with the help of doctors.
- we can do primary medication immediately in home.

10. Installation guide and user manual:

- **Download python**:

1. Visit python.org using web browser.
2. Download python 3.9.
3. Run the python.exe file that you just downloaded.
4. Choose the "add to path" option without fail.

- **OpenCV installation:**

1. Check if the path is correct and python is downloaded in the same directory.
2. For installation, python.exe -m pip install opencv-python

- **TensorFlow installation:**

1. python -m pip install "tensorflow<2.11"
2. for verifying the install,
   python -c "import tensorflow as tf";
   print(tf.config.list_physical_devices('GPU'))"

- **Connect the GSM:**

1. Pin in the GSM into COM3 port of the computer.
2. Make sure to enter COM3 as input to the code.

- **Web cam installation**:

1. The guardian should install camera in such a way that the elderly person can be detected very easily.
2. The live camera footage is to be given as input to the program.

- **Compile the code:**

1. Compile the code using idle.

11. Results:

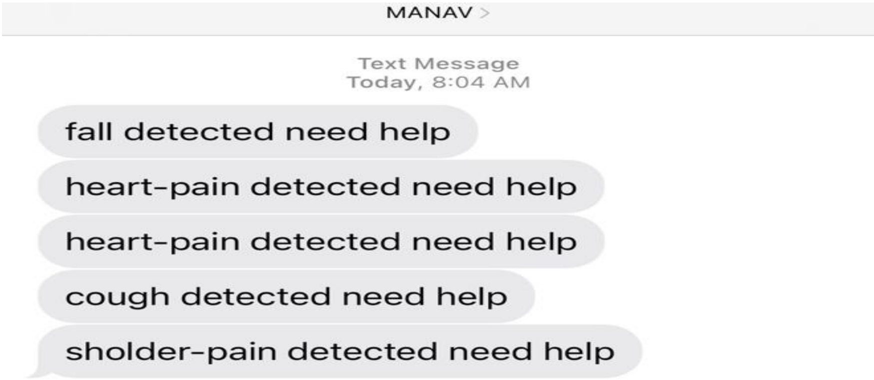


Fig (11.1). Alerts send to the guardian after gestures where detected

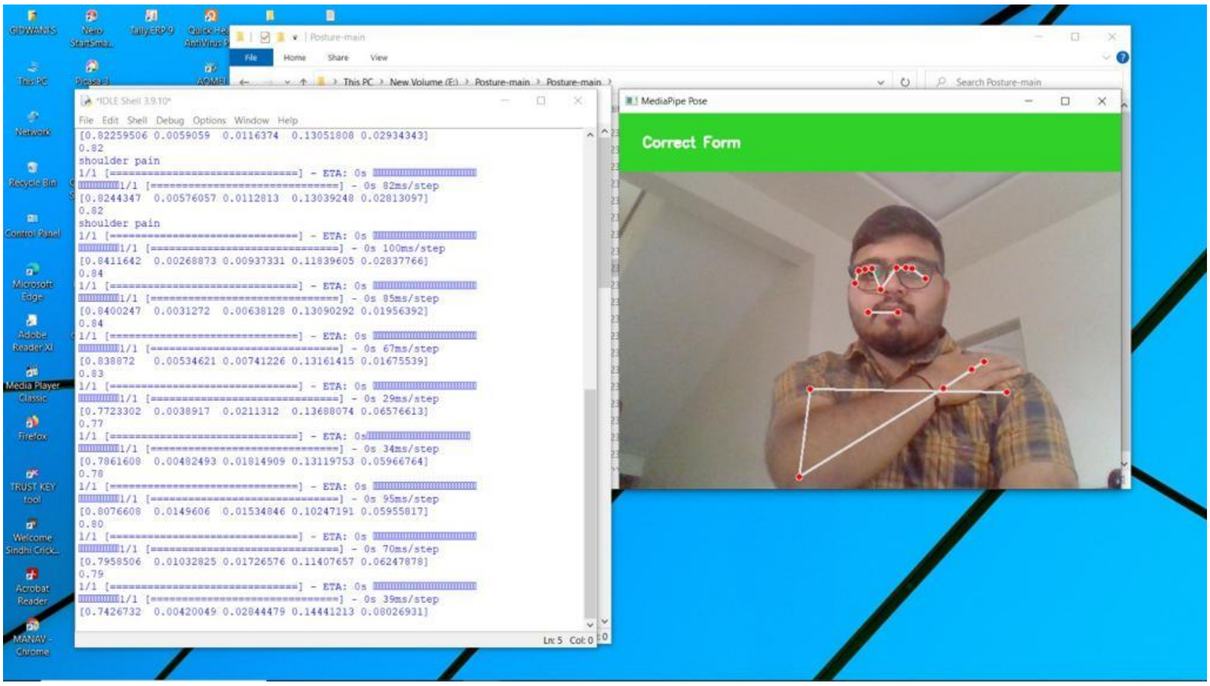


Fig (11.2). web cam scanning for elderly person with shoulder pain.

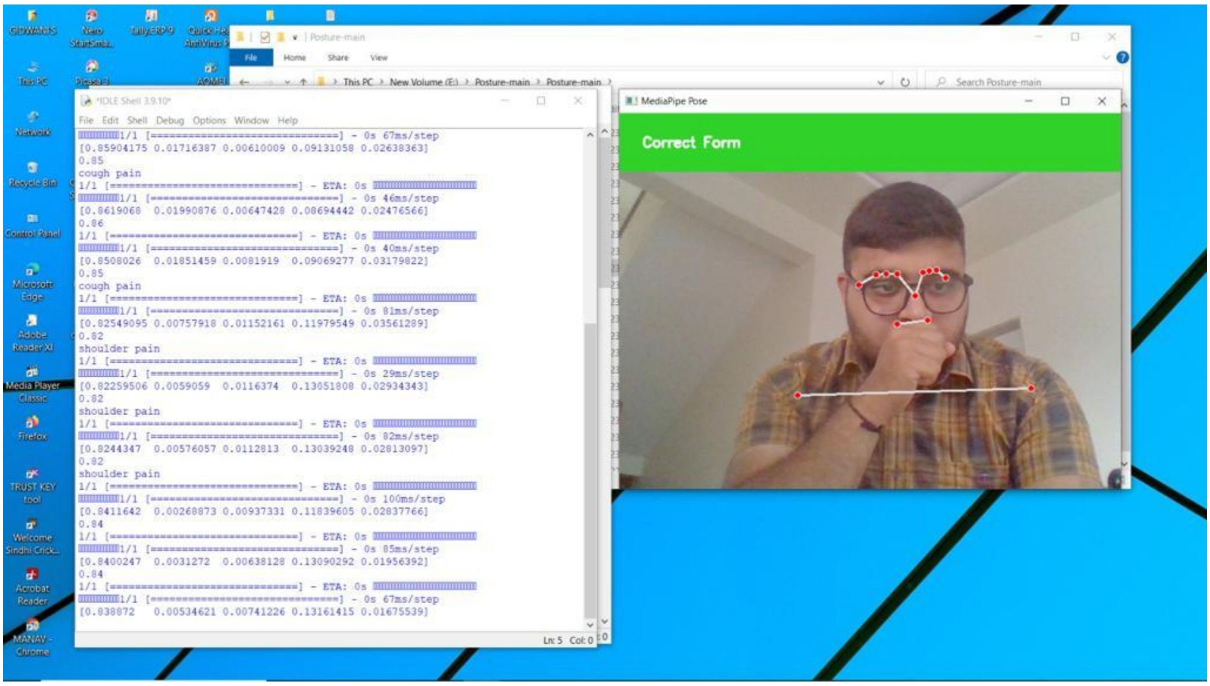


Fig (11.3). web cam scanning for elderly person coughing.

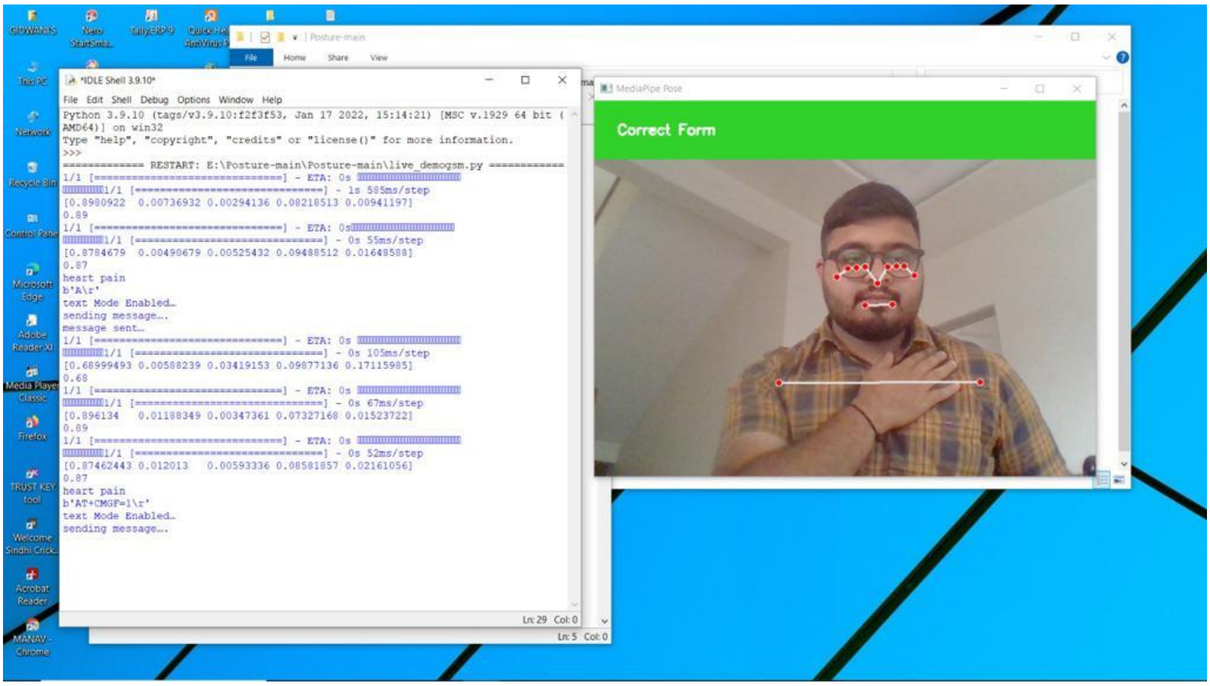


Fig (11.4). web cam scanning the action of heart ache

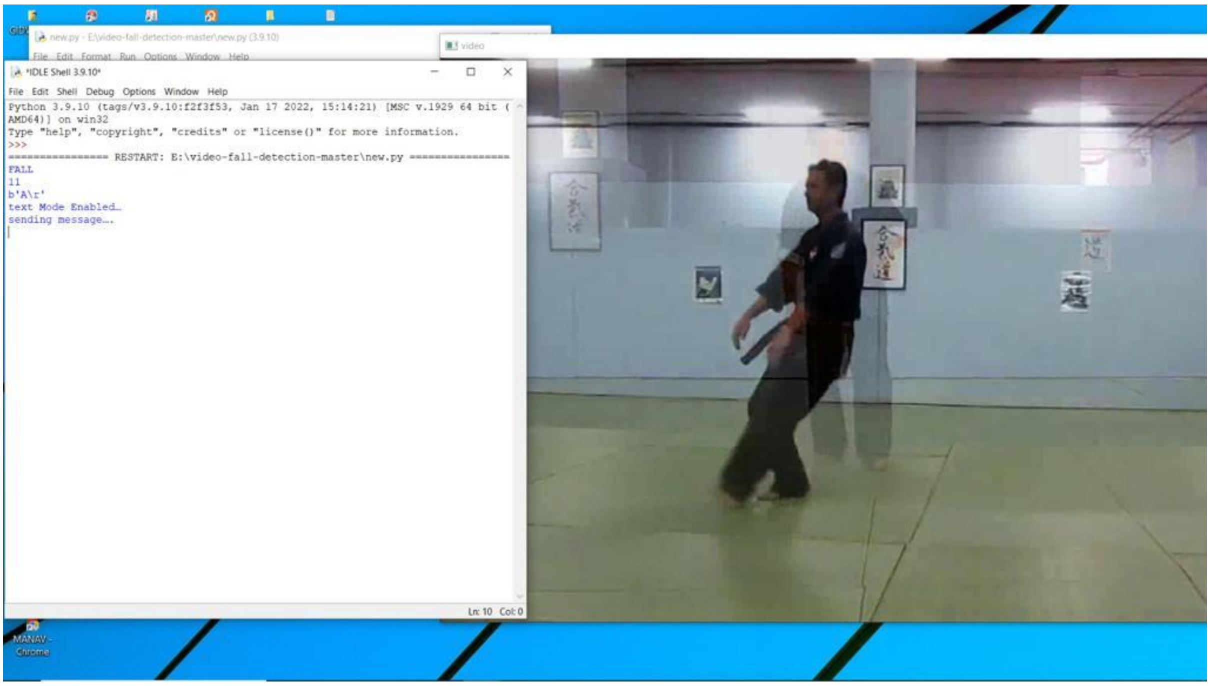


Fig (11.5). the video uploaded to the system detects fall and sends alerts.

12. Plagiarism Report:

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13. ETHICS:

- Surf the internet for personal and non-class related purposes during classes.
- Make a copy of software for personal or commercial use
- Make a copy of software for a friend.
- Loan CDs of software for a friend.
- Download Pirated software from the Internet.
- Distribute Pirated software from the Internet.
- Buy software with a single user license and then install it on multiple computers.
- Share a Pirated copy of software.
- Install a Pirated copy of software.

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3. Punam Thakare / International Journal on Computer Science and Engineering (IJCSE) Assistant Professor: MCA Dept, ICEM, Parandwadi Pune, India.

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