Fall detection system for elderly people

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Executive Summary

This is a fall detection system which is made by python with our current version using Yolov12 as detection algorithm. The alerting system work by connecting our flask server which is hosted by the main device then the client, our mobile app, receive the alert message which cause it to ring notify the care taker in time in order to prevent negligence and further injuries which might occur if they are not spotted on time there are also further notifications which are sent through Discord application. The mobile app is made by Kotlin with webhook made by JavaScript and hosted through Cloudflare. For normal devices which are made by us by converting old laptop and use it in most case its fps is around 10 fps.

Introduction

Falling is one of the major causes of death as well as a sign of many chronic diseases. Nearly 700000 died from fall in 2025 worldwide with 37 million falls each year severe enough to require medical attention, further more than 7.8 million people died yearly from other diseases that can be indicated by fall such as stroke.

With 1.1 billion elderly people globally, elderly are the most vulnerable people to collapse due to many reasons so we decided to solve that problem by making fall detection device which is not only low cost but also can be used with many people in the same time. Despite having existed for a while most fall detection systems in the market are either too expensive (many need monthly subscription) or complicated to use in real world environment with many having bad alerting systems (mostly are not dedicated for fall detection).

Objective

1. Create affordable fall detector which can be used in low end computer or laptops with minimal hardware requirement.
2. Alerting system that capture user attention when alarm is on
3. Low complexity app which can be used by anybody including people with little knowledge in computing and electronic.

State of the arts

There are 3 main types of fall detector devices which are Wearable sensors, Ambient Device and Vision-based device

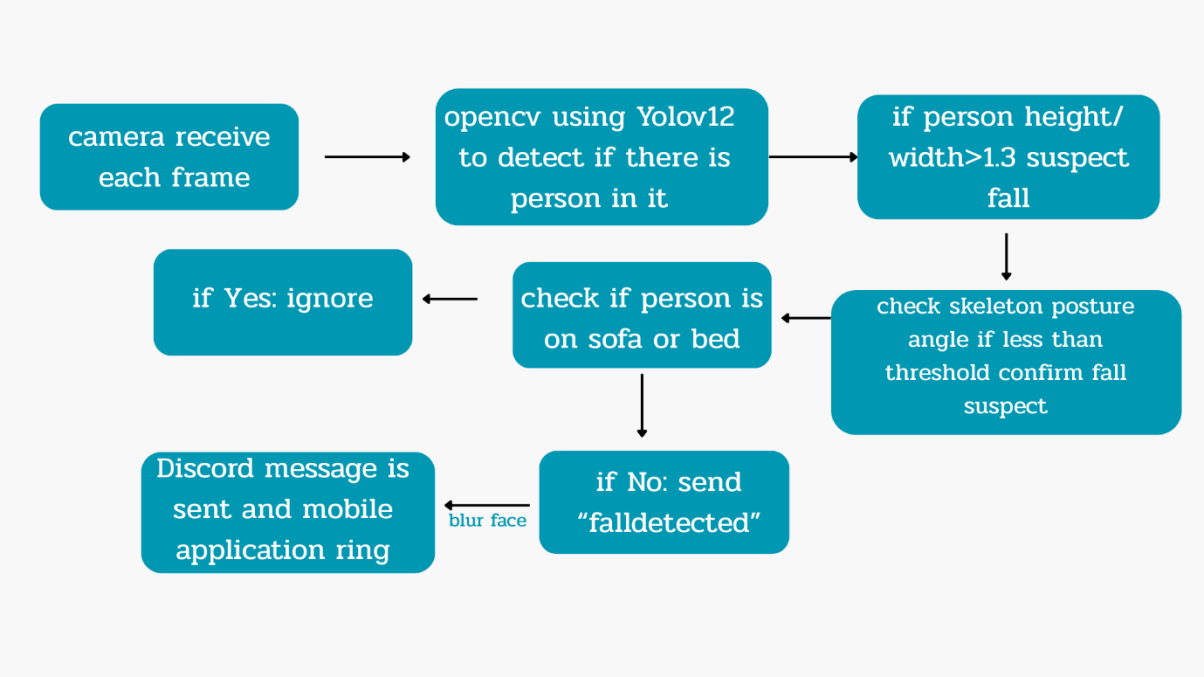
Type	Pros	Cons

Wearable Sensors (accelerometers, gyroscopes, smartwatches)	- Direct measurement of motion and orientation → high sensitivity - Portable and personal → works anywhere - Often low power and cost-effective	- User compliance required (must be worn at all times) - Can generate false positives from sudden but non-harmful movements - Battery life limits continuous monitoring - Not suitable for people who forget to wear devices - higher total cost in large scale facility
Ambient Devices (pressure mats, floor sensors, infrared sensors)	- Non-intrusive → no need for user to wear anything - Can cover specific areas (bed, bathroom) effectively - Low maintenance once installed	- Limited to monitored area → cannot detect falls outside sensor range - Installation cost can be high - Hard to scale for multi-room or multi-person coverage - Sensor malfunction or obstruction can reduce accuracy

Vision-Based Devices (cameras with AI detection)	- Wide coverage → can monitor multiple people in real time - Non-contact and passive → no user compliance needed - Can provide rich contextual data (posture, movement patterns) - Alerts can be integrated with apps and notifications easily	- Privacy concerns → video monitoring may not be acceptable in all environments - Lighting conditions and occlusion can affect accuracy - Computationally intensive → requires powerful processing - Risk of false negatives if camera is blocked or angles are poor

Main Body

1. System Overview / Architecture



2. Methodology

This project was carried out following a systematic procedure to develop a functional fall detection system for elderly people. The methodology consists of system design, implementation, testing, and improvement.

First, a camera was used to capture real-time video of the monitored area. The video frames were processed using the YOLOv12 object detection model to detect human presence. Once a person was detected, the system analyzed the body posture by calculating the height-to-width ratio of the detected bounding box.

Next, logical conditions were applied to determine whether the detected posture indicated a fall. To reduce false alarms, the system checked whether the person was located on objects such as beds, chairs, or sofas. Time-based verification was also implemented to confirm whether the person was able to stand up independently within a given time period.

After a fall was confirmed, the system sent alert notifications through a Flask server to a mobile application and a Discord messaging platform. This allowed caregivers to receive timely alerts regardless of their location.

Finally, the system was tested using multiple participants performing different activities, including actual falls, resting, and normal daily movements. The detection results were recorded and analyzed to evaluate system performance.

3. Detection Algorithm

Each scene is captured via camera that is connected to laptop after that each scene is check if there is a human in it if there is check the body height / width ratio then check if the person is suspect to be fallen or not. If yes check if the person on object (bed, chair or sofa) after that save the alert. In order to minimize the amount of fall alerts we make it check if another fall is detected within 15 second but after 5 second compare to 1st fall to ensure that the fall is real and that the target is unable to get up by themselves.

Why YOLOv12

1. YOLOv12 is high precision image detector module which offer open source due to that it is easier to custom train and rely on the high precision infrastructure offered by YOLO.
2. YOLOv12 is not ultra heavy AI system, due to that we can use it in old or low-cost hardware which can be purchase for less than 100$.

4. Alerting Mechanism

After the detect is confirm the system send alert through its flask server and send alert text and picture through Discord application.

5. System Features & Advantages

- Real-time detection and alerting

- Low cost and scalable to multiple users

- User-friendly interface

Compare to other fall detector in system

	Normal fall detector in market	Our fall detector
price	300-1000$	Less than 100$
Usage lifespan	Some requires monthly subscription	Free
Alerting system	Unreliable mostly message only	- In main chat app - In our own app which can alert in alarm clock like manner which is more noticeable -blur face when send image to chat app
installation	Expensive and complex	Minimal and flexible can upgrade or attach external camera
privacy	No additional privacy protections	Blur face when send alerting image through discord

6. Data collection and testing result

Person/data	Height(cm)	Weight(kg)	Gender(Birth)
Person 1	175	60	Male
Person 2	182	72	Male
Person 3	158	49	Female
Person 4	163	65	Female
Person 5	166	69	Female

Person 6	173	55	Male
Person 7	149	46	Female
Person 8	176	63	Male
Person 9	165	72	Female
Person 10	173	60	Female

Result

Each done 10 rounds in order to get 100%

True positive = actually fall and is reported

- report carried out within 10 seconds = 1 point
- within 15 seconds = 0.5 point.
- 10 point = 100%

True negative 2 = sleep on bed/sofa/chair and walking freely for 15 second

True negative 1 = walking pass and doing daily activity freely for 15 second/round

Reported in accuracy rate

Person\type	True negative 1	True negative 2	True positive
Person 1	100%	90%	90%
Person 2	100%	90%	90%
Person 3	100%	100%	95%
Person 4	100%	100%	100%
Person 5	100%	90%	100%
Person 6	100%	90%	85%
Person 7	100%	100%	100%
Person 8	100%	90%	90%
Person 9	100%	100%	95%
Person 10	100%	90%	90%
Over all	100%	94%	93.5%

7. Obstacle and Improvement

From v.1 version of our application, we develop a sound alerting system which was plan to be used in the v.1 but become unreliable we also switch from Line messaging to discord messaging so our message can reach many people in the same time with only 1 send and this is also more stable or lighter way.

8. Working distance

- roughly 90 cm from the device to 6.9 meters per straight axis(x and y)
- total area: 6 x 6 square meters
- alerting system: entire country
- alert time: within 2 minutes

9. Development timeline

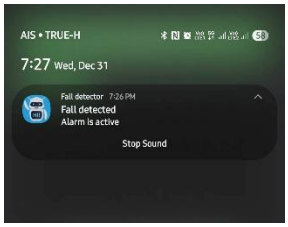
Day(s)	activity
1	Plan
2 - 5	Simple detector and algorithm
6-9	Real server
9-11	Message sending and webhook
11-13	Beta deployment
14-15	Real test + convert into exe
16-19	Change webhook from Line app to Discord and fix android alerting system
20	Writing conclusion

10. UI and user interface design

- Web UI

Fall Detection Live Stream

- Mobile app UI and dialog box



- Discord alert

11. Hardware Specifications

- 3rd Gen Intel Core i5 processors (like i5-3317U)

- integrated Intel HD Graphics 4000 (sometimes with an NVIDIA GT 620M dedicated GPU)

- 4 GB DDR3 RAM

12. Discussion and Ethics

The device captures multiple users in the same time so we need to warn each person before they enter the area where our device is active. The save images of the users should also be keep locally only in specific server and not broadcast to the public.

13. Limitation

1. **Internet Dependency**
The system requires an active internet connection to function properly, as alert notifications are transmitted through the Flask server and external services such as Discord. Without connectivity, real-time alerts cannot be delivered to caregivers.

2. **Limited Operational Coverage Area**
The effective detection range of the system is constrained by the camera's field of view and model performance. The system operates optimally within a distance of approximately **1.2 meters to 6.9 meters** from the device, with a lateral coverage of **6 meters**, resulting in an effective monitoring area of approximately **6 × 6 square meters**.

3. **Power Requirement**
As an electronic system, continuous electrical power is required for operation. In the event of a power outage, the system will be unavailable unless an external power backup is provided.

Conclusion

The development of this fall detector proofs that successful household AI device can be made to be affordable and accessible while retain the simplicity of the user interface and reliability of the device as whole. Due to that, low-income household can now be able to afford to have fall detection system which can be install manually with little effort.

Key Outcomes

Accessibility through Affordability: The entire system cost less than 100$ including add-ons, the project eliminates financial barrier and financial constrain for low-income people.

Reliable Alerting Mechanism: due to dual alerting system, it ensures that a fall does not go unnoticed, while remaining simple enough for be deactivate when false positive occurs.

Intuitive User Experience: the applications in system have user friendly interface and “low complexity” design philosophy which make it easy to be used.

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