GUARDIAN ECHO

by

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Under the Guidance of

Dr. Mohana Priya T

A Project report submitted in partial fulfillment of
the requirements for the award of degree of
Bachelor of Computer Applications of
CHRIST (Deemed to be University)

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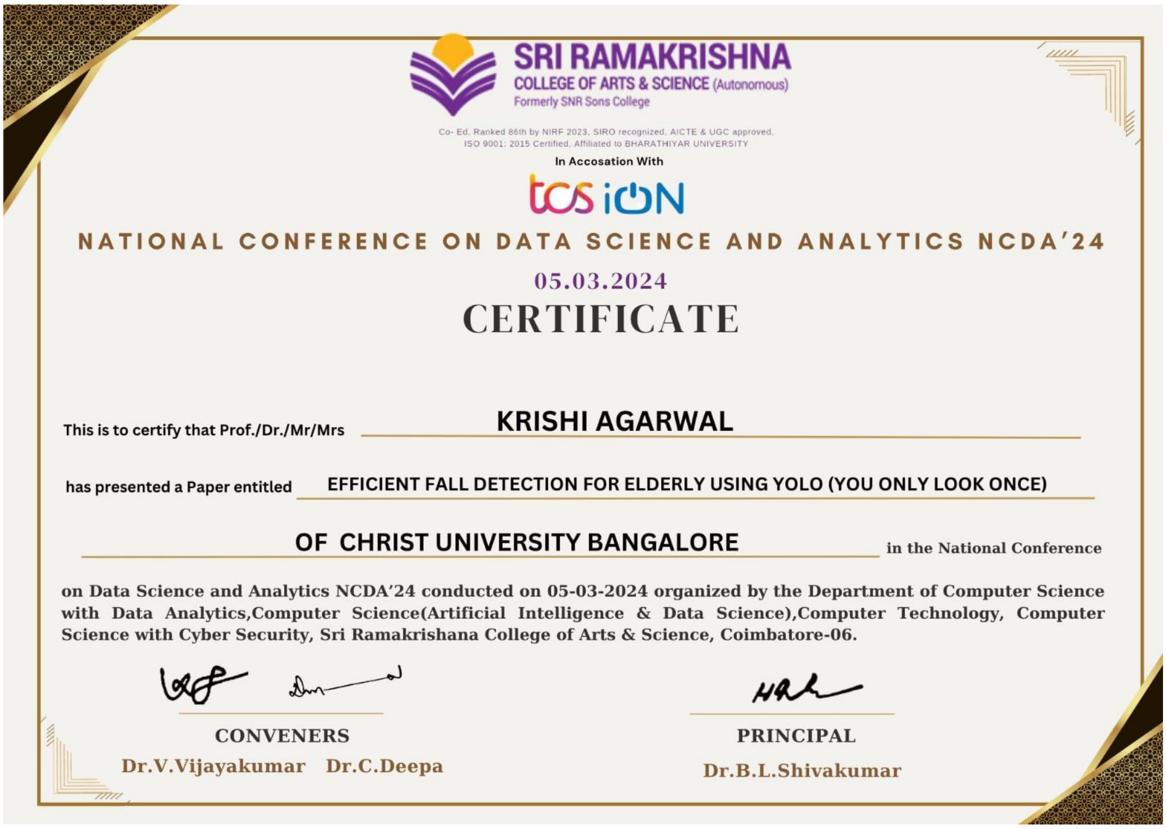

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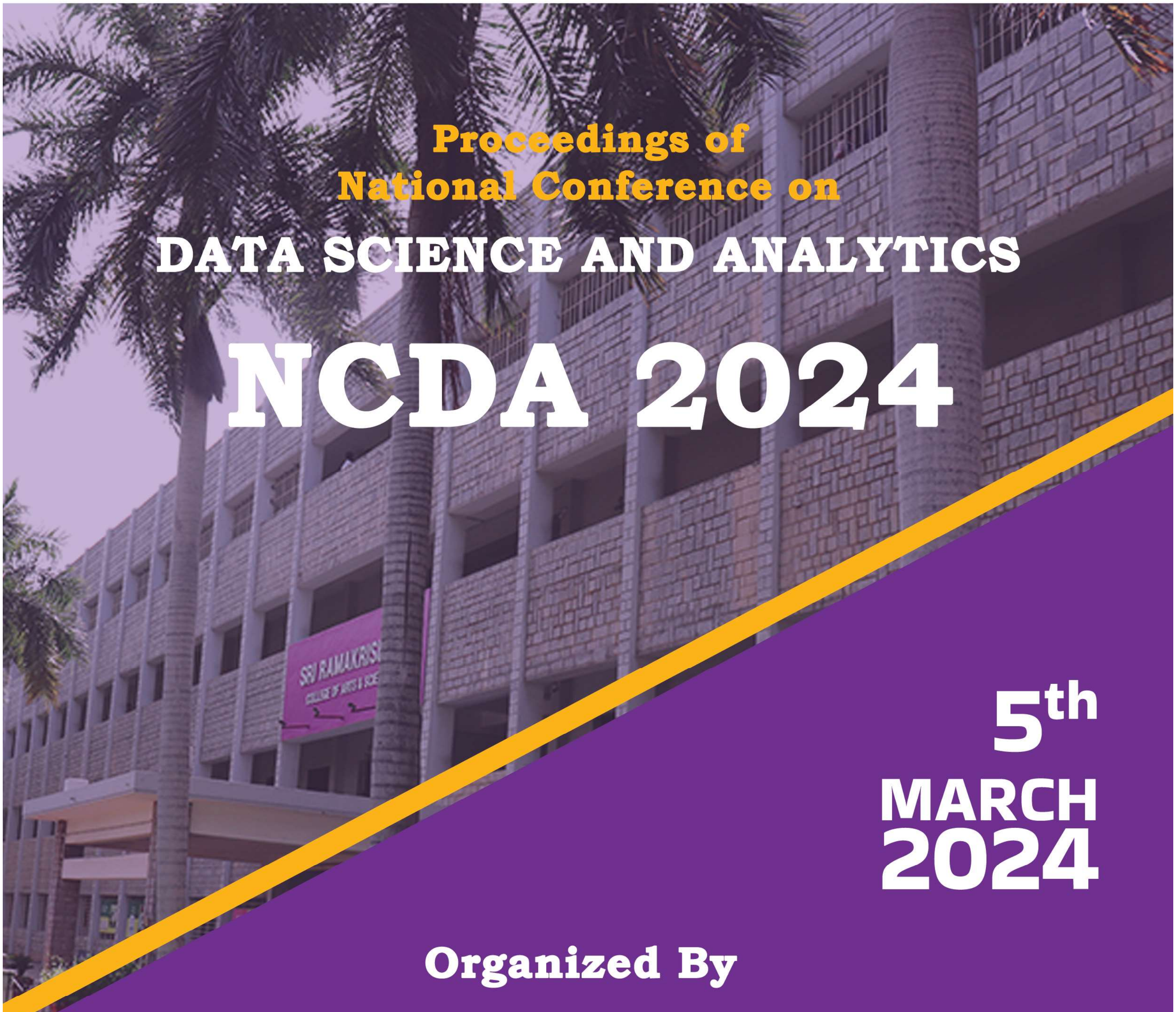

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Efficient Fall Detection for Elderly using Yolo (You Only Look Once)

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Abstract---Background: In an era of technological advancements, safeguarding living and care spaces becomes increasingly crucial. Guardian Echo emerges as a comprehensive fall detection system, aiming to revolutionize safety perception in homes, elderly care facilities, and hospitals. **Objective**: To create a proactive system that swiftly responds to incidents through real-time fall detection. Leveraging Python's YOLO libraries, Guardian Echo offers immediate alerts for swift action. **Methods:** Guardian Echo employs a real-time, four-step process. First, video streams from cameras are acquired for ongoing analysis. Next, static elements like furniture are identified and excluded using YOLO, optimizing the system for efficient person detection. In the core step, each frame undergoes analysis to identify individuals. Their coordinates are then compared to predefined parameters and the locations of known static objects to accurately detect falls. Finally, upon verifying a fall event, immediate alerts are sent to designated caregivers, enabling swift intervention and prompt assistance. This comprehensive approach ensures continuous monitoring, accurate fall detection, and timely response for enhanced safety in care facilities. **Findings:** This application offers real-time fall detection with sub-second notification, facilitating prompt intervention and potentially mitigating the risk of severe health complications arising from delayed awareness. Its technical prowess lies in its ability to accurately discriminate falls from other activities, ensuring timely alerts reach designated caregivers, empowering them to provide immediate assistance, and potentially preventing the detrimental sequelae associated with delayed care. **Application and Improvement**: Future improvements could include expanding the scope beyond falls to enhance its comprehensive safety net.

Keywords---Yolo, Alert System, Accurate Fall Detection, Machine Learning, Image Processing.

1. INTRODUCTION

Guardian Echo is an ambitious project that aims to revolutionize the way we perceive safety in our homes, old age homes, hospitals, and other care facilities. It is designed to be a comprehensive video surveillance system that can accurately detect falls, thereby ensuring the well-being of the occupants. The primary objective of Guardian Echo is to create a proactive system that can prevent incidents or respond to them more quickly. This is achieved by leveraging cutting-edge technologies such as Python's YOLO (You Only Look Once) for object detection and ratio measurement of height and width for fall detection. These technologies enable our system to detect incidents in real time and generate immediate alerts, thereby enabling swift action. The domain of safety and security is vast and complex, encompassing various aspects from physical safety to data security. Guardian Echo focuses on the aspect of physical safety, specifically targeting vulnerable groups such as the elderly and those in care facilities. By focusing on this niche, Guardian Echo aims to address a critical gap in the current safety and security solutions. The project is set in the backdrop of an increasingly aging global population and the growing need for efficient care systems. Falls and other accidents are common among the elderly and can lead to severe injuries or even fatalities. Similarly, cries for help often go unnoticed in large care facilities due to the lack of efficient monitoring systems. Guardian Echo aims to address these issues by providing a reliable and efficient surveillance system.

2. LITERATURE SURVEY

The paper “Latest Research Trends in Fall Detection and Prevention Using Machine Learning” gives a detailed look at how technology, specifically using machine learning, can help in detecting and preventing falls, especially in older adults. It talks about different ways sensors can be used, how well they work, and what we still need to figure out. The good thing about these systems is they can be really accurate in spotting falls and can even alert someone right away. But there are still some challenges like making sure the systems use energy efficiently, having enough data to train them well, and testing them in real-life situations. Overall, the study shows that we need to keep improving these technologies to make sure they work well for older people and those who take care of them. [1] This paper "Fall Detection Using Multi-View-Based Manifold Learning Algorithm." proposes a novel system for identifying falls and slips in real-time surveillance videos. It leverages the power of manifold learning by segmenting pedestrian silhouettes, constructing walking models, and comparing them using Hausdorff distances. This approach promises accurate detection of abnormal activities. While boasting advantages like multi-view analysis and precise segmentation, the system faces challenges in its computational demands, sensitivity to environmental factors, limited detection scope, and reliance on diverse training data.[2]

“Research of multi-object detection and tracking using machine learning based on knowledge for video surveillance system” talks about knowledge-based deep learning approach to boost object detection and tracking in video surveillance. It merges optical flow, which predicts object motion, with CNNs, powerful object recognizers, aiming for robust tracking even in tricky environments. Advantages include improved accuracy, handling multiple objects effectively, and correcting errors. However, trade-offs exist: processing large numbers of objects might slow down real-time performance, and minor execution delays compared to standard algorithms are possible. Finally, the system's effectiveness depends on carefully chosen parameters and kernels, needing adjustment based on specific data.[3]

The paper "Real-time Object Detection Using Deep Learning" by Vaishnavi et al. introduces an end-to-end solution for object detection, focusing on the single shot detector (SSD) technique. The SSD method is highlighted for its speed and accuracy in object detection, especially with low-resolution images. The paper discusses the challenges of object detection, the evolution of image recognition technology, and the methodology used, including the SSD algorithm and the data set description. The authors compare the SSD method with other algorithms such as You Only Look Once (YOLO) and Faster R-CNN, emphasizing the advantages of SSD in terms of quick and accurate object detection, particularly with low-resolution images. The paper also presents the steps involved in the proposed system and provides visual results demonstrating the accurate detection of various objects, such as dogs, boats, and chairs. The SSD method is praised for its ability to detect multiple objects and its high detection accuracy, achieved by employing a large number of boxes or filters with different sizes and aspect ratios. The paper, however, does not explicitly list the disadvantages of the SSD, YOLO, and Faster R-CNN methods, but it provides insights into their performance and limitations based on the discussed methodology and results.[4]

In the research paper "From fall detection to fall prevention - A generic classification of fall related systems," the authors present a comprehensive overview of existing fall-related systems, categorizing them into wearable, non-wearable, and fusion-based systems. They emphasize the importance of technological interventions in mitigating the consequences of falls and propose a three-category classification based on sensor deployment. The paper reviews state-of-the-art fall detection and prevention systems, highlighting various sensor technologies and data processing techniques used in these systems. Overall, the paper provides valuable insights for researchers and

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developers working on fall prevention technologies.[5]

The research paper "Trends in Fall Detection and Prevention Using Machine Learning" delves deeply into the advancements in fall detection and prevention techniques, specifically focusing on the integration of machine learning (ML) algorithms. It discusses the limitations of traditional statistical methods and highlights the increasing preference for ML due to its superior accuracy in classifying fall events. The paper examines wearable and non-wearable systems, popular ML algorithms, and recent cutting-edge studies in the field. It also proposes future research directions like enhancing energy efficiency, sensor fusion, context awareness, and optimizing wearable design to improve the efficacy of ML-based fall detection systems, providing valuable insights for researchers and practitioners.[6]

The study focuses on utilizing deep learning techniques and analyzing activity characteristics to detect human falls on furniture. By employing scene analysis and tracking changes in key features, such as human shape aspect ratio and motion speed, the research aims to enhance the accuracy of fall detection in complex indoor environments. The results demonstrate the effectiveness of the proposed method in accurately distinguishing falls on furniture from other activities like sitting or lying down. This innovative approach shows promise for improving safety measures and providing timely medical assistance in indoor spaces.[7]

This research “Elderly fall detection system based on multiple shape features and motion analysis” paper introduces an intelligent video-based fall detection system that combines shape analysis and motion analysis techniques. The system extracts silhouettes using background subtraction, then measures various features including vertical velocity of the head, Procrustes distance, ferret diameter, and more. These features are used to detect falls with high accuracy, tested on the L2ei dataset achieving up to 99.61% accuracy. Different classifiers such as RBF-SVM, KNN, and BPNN were employed, demonstrating robustness with maximum global error of 1.5%. The system's effectiveness lies in its ability to accurately detect falls using multiple features and classifiers.[8]

Research on fall detection devices has highlighted the importance of placement and type of wearable devices for accurate detection. Studies have indicated that devices worn around the neck, such as pendant necklaces, are more precise in detecting falls compared to wrist-worn devices like watches. While false positives can occur, with accuracy rates ranging from 80% to 93%, there is a consensus among researchers that fall detection systems are highly reliable but not infallible. Further real-world research is recommended to enhance the overall accuracy and effectiveness of fall detection technology, emphasizing the need for continuous improvement in this critical area of healthcare technology. [9]

The research paper delves into the realm of real-time object detection using deep learning, with a specific emphasis on the Single Shot Detector (SSD) method. By leveraging deep learning techniques, the study aims to enhance the precision and speed of object recognition processes. Through the development of an end-to-end solution for object detection, the research addresses the shortcomings of traditional computer vision approaches. The findings highlight the potential for significant advancements in the field of computer science and technology, particularly in the creation of highly efficient and accurate real-time object detection systems.[10]

3. METHODOLOGIES

1.**Real-time Data Acquisition**: This initial phase involves acquiring real-time data on which analysis will be carried out for fall detection.

2.**Data Preprocessing for Object Detection**: In this stage, static elements such as beds, sofas, and wardrobes are identified utilizing the You Only Look Once (YOLO) algorithm, contributing to the preparatory steps for object detection.

3.**Object Coordinate Storage**: The coordinates of static objects detected in the previous step are systematically stored for reference and utilization in subsequent process stages.

4. **Real-Time Processing**: Each video stream frame is treated as an independent image, and individuals within the frames are identified using the YOLO algorithm. The resulting coordinates of persons are extracted and processed in real-time.

5.**Fall Detection Algorithm**: For each set of coordinates obtained from the YOLO algorithm, the height and width of the detected are computed. Fall events are determined based on the ratio of these dimensions and other relevant factors, establishing a robust fall detection mechanism.

6.**Alert Notification System**: Upon the successful identification of a fall event and subsequent validation of its accuracy by considering the coordinates of objects such as beds, alerts are promptly transmitted to designated individuals or caregivers. This ensures timely response and intervention in the event of a fall.

The fall detection system begins with real-time **data acquisition**, which involves capturing live CCTV footage for analysis. This footage is streamed over a secure network line to ensure accessibility only by authorized personnel. Once acquired, the data undergoes **preprocessing for Object Detection**, wherein coordinates of necessary objects, such as furniture like beds, sofas, and wardrobes, are identified using algorithms like YOLO. These coordinates are then **systematically stored** for reference in subsequent stages of the process. Following preprocessing, real-time processing takes place, where each frame of the video stream is analyzed independently. Utilizing the YOLO algorithm, individuals within the frames are identified, and their coordinates are extracted and processed in real-time. Subsequently, the fall detection algorithm evaluates the extracted coordinates to determine if a fall event has occurred. This assessment involves computing the height and width of the detected individuals and comparing them against predefined criteria for fall detection, ensuring a robust mechanism for identifying falls. **Upon detecting a fall event and validating its accuracy** by considering the coordinates of surrounding objects, such as beds, the system promptly triggers an alert notification. These **alerts are transmitted** to designated individuals or caregivers, facilitating timely response and intervention in the event of a fall. This integrated approach to real-time data acquisition, preprocessing, object detection, and fall detection ensures the system's effectiveness in enhancing safety and providing prompt assistance to individuals at risk of falling.

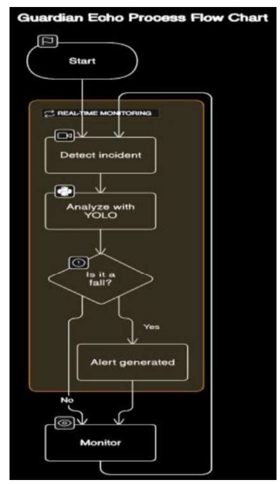

Figure 1. Process Flow Diagram

Pseudo Code [for fall detection]:

Step1: Detect all the coordinates of objects using YOLO.

Step 2: Calculate the height and width of the object based on coordinates.

Step 3: Store the coordinates of bed and sofa.

Step 4: Analyse the current frame of the live footage.

Step 5: Find the coordinates of the human and the height and width of the same.

Step 6: Check for fall, depending on height and width: *[(x/k)>y] where k is a constant, x is the compilation of the size of the x axis of the border box based on the coordinates of the boundary, and y is based on the y axis.*

Step 7: If a fall is detected, go to step 8 else, go to step 11

Step 8: Check if the person is on a bed or sofa based on masking coordinates*.

Step 9: If a person is not on the bed or sofa, go to step 10 else, go to step 11

Step 10: send an alert.

Step 11: Repeat Step 4.

*Masking coordinates: refers to creating a mask [an area of special treatment] on the frame where fall detection will not be treated as an actual fall.

Experiment:

Using pycharm virtual environment and the following libraries **cvzone, ultralytics, hydra-core, matplotlib, numpy, opencv-python, Pillow, PyYAML, requests, scipy, torch, torchvision, tqdm, filterpy, scikit-image** and **lap** and YOLO V8 with AMD Ryzen 5 4600H with Radeon Graphics 3.00 GHz 16 GB RAM and 64 bit operating system the experiment was carried out and accurate results of fall detection was found:

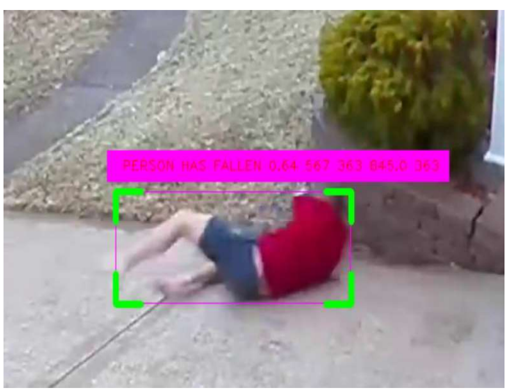

Figure 2. Fall Detection Along with Confidence and Coordinates

Figure 3. Person Sleeping on Bed Is Not Treated as Fall

Results and discussion:

The Guardian Echo system, utilizing YOLO v8 and running on an AMD Ryzen 5 4600H configuration, demonstrated promising results in the conducted experiment.

Positive Outcomes:

- **Accurate Fall Detection:** The system successfully identified and alerted for actual fall events, as shown in Figure 2, with accurate bounding boxes and confidence levels. This highlights its potential for timely intervention and preventing fall-related complications.
- **Noise Reduction:** Figure 3 showcases the system's ability to differentiate falls from similar activities like lying down, avoiding unnecessary alerts and reducing caregiver workload. This demonstrates its ability to focus on critical events while filtering out non-essential information.
- **Real-time Performance:** The experiment achieved real-time processing, crucial for immediate response in fall scenarios. This suggests the system's potential for practical implementation in care settings.

Areas for Improvement:

- **Limited Dataset:** While achieving positive results, the experiment utilized a limited dataset for testing. Expanding the dataset size and diversity (e.g., different environments, lighting conditions, clothing variations) could enhance the system's robustness and generalizability.

● **False Positives/Negatives:** Further fine-tuning the fall detection algorithm and incorporating additional environmental context could potentially reduce false positive and negative detections, leading to more reliable alerts.

● **Scalability and Integration:** Exploring cloud-based deployment and integration with existing care facility infrastructure could enable wider adoption and seamless operation.

Overall, the experiment demonstrates the potential of Guardian Echo as a valuable tool for fall detection in care settings. However, further development and evaluation with larger datasets and real-world deployment are necessary to refine its accuracy, scalability, and integration potential.

Future Work:

● Expand the dataset to include diverse scenarios and environmental conditions.

● Refine the fall detection algorithm to minimize false positives and negatives.

● Explore cloud-based deployment and integration with existing care facility infrastructure.

● Conduct user studies with caregivers and residents to assess usability and acceptance.

By addressing these points, Guardian Echo can evolve into a comprehensive and reliable fall detection system, significantly improving safety and well-being in care facilities.

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