**Project Title**

**Synthetic Video Creation for Fall Detection in Elderly Care**

**Module Code and Title**

7COM1086: Artificial Intelligence and Robotics Masters Project

**Your Name and Student ID**

Name: Sathishkumar Palanikumar  
Student ID: 22081990

**Aim of the Project**

The aim of this project is to generate synthetic videos of human falls in indoor environments using AI-based tools. These videos will be used to train machine learning models for fall detection, with a focus on elderly care. The goal is to overcome the challenges posed by the limited availability of real-world fall data by providing diverse, customizable, and realistic synthetic datasets.

**Research Question/Hypothesis**

**Research Question**  
Can synthetic video generation provide realistic and varied datasets of human falls to improve the accuracy, generalization, and robustness of fall detection systems in elderly care?

**Hypothesis:**  
By leveraging AI techniques such as physics-based simulations and multi-camera setups for synthetic video generation, it is possible to produce realistic fall scenarios that significantly improve machine learning models for fall detection in elderly care.

**Objectives**

1. **To create synthetic video data** of human falls in indoor environments, simulating various scenarios including forward, backward, and side falls, focused on elderly people.
2. **To use biomechanics and inverse kinematics** for accurate fall simulation, incorporating real-world complexities such as varying camera angles, occlusion, and illumination.
3. **To evaluate the effectiveness of synthetic videos** in enhancing the performance of fall detection models when compared to real-world datasets, focusing on generalization and robustness.
4. **To integrate deep learning models** such as LSTM, CNN, and Transformer architectures to assess their ability to handle synthetic fall data for detection and classification.
5. **To optimize the system** for efficient generation and application of synthetic data, ensuring scalability and practical deployment in real-time fall detection systems.

**Description**

Synthetic data is increasingly recognized as a cost-effective and ethical solution for creating large-scale datasets for machine learning, especially in healthcare applications like fall detection. In this project, we will use AI tools like Unreal Engine or Blender to simulate realistic fall events in different indoor environments. By integrating biomechanical models and physics engines, we will replicate realistic human movement during falls. This synthetic data will be used to train fall detection models, with a focus on improving generalization across unseen environments, occlusion scenarios, and varying conditions such as camera angles and lighting.

**Research Methodology**

1. **Literature Review**:  
   The review will cover fall detection using synthetic data, human pose estimation techniques, and the use of synthetic IMU and RGB data for training models. Special attention will be given to the use of deep learning in fall detection and the impact of camera occlusion and varying environments on model performance.
2. **Model Implementation**:  
   Using simulation tools like Unreal Engine, synthetic videos of falls will be generated with different types of falls and body interactions with the environment. These simulations will incorporate varying camera angles, lighting, and occlusions to enhance the dataset’s robustness.
3. **AI Integration**:  
   The synthetic videos will be used to train deep learning models such as LSTMs, CNNs, and Transformer networks. These models will be evaluated based on their accuracy in fall detection, using metrics like precision, recall, and F1-score. Additionally, the synthetic data’s impact on improving generalization to real-world data will be tested.
4. **Data Analysis**:  
   The performance of models trained on synthetic video data will be compared against models trained on real-world datasets, such as the AI Hub dataset, to measure improvements in accuracy and generalization. Techniques like data augmentation and feature extraction will be explored to enhance the dataset’s quality.
5. **Evaluation and Testing**:  
   The project will evaluate the ability of the synthetic videos to improve the performance of fall detection models across unseen environments. The robustness of models will be tested against challenging scenarios involving occlusion, varying lighting, and different camera setups.
6. **Ethical Considerations**:  
   Privacy concerns associated with real-world data collection are mitigated by using synthetic data, which de-identifies personal information. The ethical aspects of using synthetic data for healthcare applications, particularly in the elderly population, will be discussed.

**Citations**

1. **Makris, D.**, et al. (2022). *Synthetic IMU Data for Fall Detection: A Study on the Use of 3D Biomechanical Simulation*
   * This paper introduces synthetic IMU data generated through biomechanical simulations for fall detection, highlighting the advantages of synthetic data in reducing the need for real-world data collection.
2. **Mastorakis, G.** (2022). *Human Fall Detection Using Myoskeletal Simulation*
   * Focuses on simulation-based fall modeling and addresses issues such as scene occlusions, proving the robustness of simulation approaches for fall detection in elderly care.
3. **Varol, G.**, et al. (2022). *Enhancing Fall Detection with Transformer Networks and Synthetic Data*
   * This research highlights the use of synthetic data to augment real-world datasets, improving the performance of Transformer models in fall detection.
4. **Ren, S.**, et al. (2023). *Privacy-Preserving Fall Detection Using Synthetic Video Data*
   * This study explores how synthetic video data, generated in controlled environments, enhances privacy in fall detection systems by eliminating the need for real-world data collection.
5. **Wu, P.**, et al. (2023). *Generating Multivariate Synthetic Fall Data for Deep Learning*
   * This paper evaluates the effectiveness of synthetic data generation techniques, demonstrating improved fall detection accuracy with deep learning models trained on both real and synthetic datasets.

**Conclusion**

This project will generate synthetic video data to train fall detection systems aimed at elderly care. By incorporating deep learning models and biomechanics-based simulations, the project will address the limitations of real-world datasets and improve the generalization of machine learning models for fall detection. Through synthetic video creation, we hope to provide a scalable, ethical, and effective solution for improving the accuracy and robustness of fall detection systems in healthcare settings.