Sample Problem Statement

Camera-Based Collision Detection and Distance Measurement Systema

1. Introduction

A problem statement clearly defines an existing issue that requires a solution and explains why the issue is important. It highlights the gap between the current situation and the desired outcome. In modern surveillance and safety systems, detecting collisions between moving bodies is critical for accident prevention, monitoring, and response systems.

With the rapid development of computer vision and artificial intelligence, cameras can now be used as powerful tools for real-time object detection and tracking. However, many existing systems rely on physical sensors or manual observation, which may be expensive, inefficient, or unreliable. This project aims to address this issue by proposing a camera-based collision detection system that automatically detects collision between bodies and measures the distance between them using Python.

2. Background of the Problem

In recent years, the use of cameras for monitoring environments such as roads, laboratories, campuses, and industrial areas has increased significantly. These cameras generate large volumes of visual data that are often underutilized for safety analysis.

Traditional collision detection systems depend on sensors like proximity sensors, infrared sensors, or pressure sensors. While effective, these systems require additional hardware installation and maintenance. They are also limited in flexibility and scalability.

Computer vision-based systems offer a cost-effective alternative by using only camera input and software algorithms. However, many existing approaches focus only on object detection and do not accurately determine when two bodies collide or how far apart they are. Moreover, real-time detection and distance measurement remain challenging due to lighting conditions, background noise, and object movement.

Hence, there is a growing need for a simple, reliable, and real-time camera-based collision detection system that can identify collisions and calculate distances between detected bodies using software techniques.

3. Statement of the Problem

Despite advancements in computer vision and image processing, there is still a lack of simple and efficient systems that can detect collisions between two or more bodies using

only a camera feed. Most existing systems either depend on specialized sensors or provide only basic motion detection without analyzing collision events.

Furthermore, distance estimation between moving bodies is often inaccurate or ignored, making it difficult to assess how close objects are before or during a collision. This limitation reduces the usefulness of such systems in safety-critical applications.

Therefore, the problem addressed in this project is:

To develop a Python-based camera system that can detect collision between multiple bodies, count the number of collided bodies, and calculate the distance between them in real time using computer vision techniques.

This system should work efficiently using a standard camera and should provide visual alerts when a collision is detected.

4. Objectives of the Study

The main objectives of this study are:

- To design and implement a camera-based collision detection system using Python.
- To detect and track multiple bodies from live camera input.
- To identify collision events using bounding box intersection techniques.
- To calculate the distance between detected bodies using Euclidean distance.
- To display collision alerts and distance information in real time.
- To evaluate the accuracy and performance of the system under different conditions.

5. Significance of the Study

This study is significant because it provides a low-cost and software-based solution for collision detection without the need for expensive sensors. The proposed system can be used in several practical applications such as:

- Accident detection systems
- Surveillance and security monitoring
- Robotics and automation
- Smart traffic and safety systems
- Educational computer vision projects

The system promotes the use of artificial intelligence and computer vision for safety enhancement and can be extended to future applications such as automated accident alerts and smart city systems.

6. Scope of the Problem

The scope of this project is limited to detecting collisions between visible bodies using a camera and Python-based computer vision algorithms. The system focuses on:

- Real-time object detection and tracking
- Collision detection using bounding box overlap
- Distance calculation using pixel-based measurements
- Displaying alerts and measurements on screen

The project does not include advanced features such as facial recognition, identity tracking, or integration with external emergency services. Environmental limitations such as lighting variations and camera angle may affect performance. Future improvements can include machine learning-based detection and real-world distance calibration.