

## **Week 2 Report:**

# **Design Document**

### **1. Introduction:**

In continuation of the project initiated in Week 1, this report focuses on the design aspects of the Video Analysis Application for sports strategy planning, particularly tailored for football coaching. Building upon the project's goals and scope, this document elaborates on the architectural design, technology considerations, and the overall plan for the development of the application.

### **2. Design Objectives:**

- Develop a comprehensive design document outlining the architectural components and functionalities of the Video Analysis Application.
- Design an intuitive user interface that facilitates easy navigation and visualization of analysis results.
- Define the technology stack required for the implementation of each module, ensuring compatibility, efficiency, and scalability.
- Establish a clear plan for prototype development, with a focus on extracting video segments without emotion analysis as an initial step.

### **3. System Architecture:**

The system architecture for the Video Analysis Application maintains continuity with the high-level architecture outlined in the Week 1 report. However, this section provides additional elaboration on the interaction between modules and the flow of data within the system. Detailed notes regarding each module's responsibilities, input-output relationships, and integration points are provided to ensure smooth and seamless operation of the application.

#### **High-Level Architecture:**

The system architecture is organized into several interconnected modules, each playing a distinct role in the video analysis process. These modules collaborate to process input data, perform analysis tasks, and produce meaningful output. Here is a detailed breakdown of each module:

##### **1. Input Module:**

- Responsible for handling video input from football matches.
- Capable of processing video streams or loading video files.
- Output: Raw video frames extracted from the input source.

##### **2. Object Detection Module:**

- Utilizes a pre-trained object detection model to identify key elements within the video frames, such as players and goals.
- Extracts bounding boxes and object labels to represent detected objects.
- Output: Detected objects along with their respective locations within the video frames.

### **3. Emotion Analysis Module:**

- Implements facial emotion recognition algorithms to analyze emotional expressions exhibited by players and the crowd.
- Focuses on regions of interest (ROIs) detected by the Object Detection Module to extract facial features for analysis.
- Output: Emotions associated with players and the crowd during specific moments within the video.

### **4. Event Detection Module:**

- Employs algorithms designed to detect specific events occurring during football matches, such as goals, celebrations, and setbacks.
- Analyzes the combination of detected objects (e.g., players) and emotions to identify significant events.
- Output: Identified events along with their corresponding timestamps within the video timeline.

### **5. Temporal Analysis Module:**

- Integrates results from Object Detection, Emotion Analysis, and Event Detection modules to analyze temporal relationships between events, objects, and emotions.
- Focuses on identifying patterns and sequences of events over time to provide contextual understanding.
- Output: Temporal context and patterns derived from the analysis of video data.

### **6. Scenario Analysis Module (Machine Learning Model):**

- Applies machine learning models to recognize specific patterns associated with different scenarios within football matches.
- Utilizes features extracted from the Temporal Analysis Module to train the model on labelled datasets.
- Output: Predicted scenarios and associated confidence scores based on temporal patterns observed in the video data.

### **7. Output Module:**

- Generates segmented video clips highlighting significant moments, such as 'Goal moments,' 'Happy moments,' and 'Loss moments,' based on the identified scenarios.
- Provides a user-friendly interface for visualization and navigation of analysis results.
- Output: Segmented and annotated video clips for further review and analysis by users.

### **Detailed Module Interactions:**

#### **1. Video Input → Object Detection:**

- Raw video frames are passed to the Object Detection Module for analysis.
- The Object Detection Module identifies players and goals within the video frames using a pre-trained object detection model.

#### **2. Object Detection → Emotion Analysis:**

- Regions of interest (ROIs) containing detected faces are extracted from the video frames.
- These ROIs are forwarded to the Emotion Analysis Module for facial emotion recognition.
- The Emotion Analysis Module analyzes facial expressions in the context of detected objects, such as players and spectators.

#### **3. Object Detection, Emotion Analysis → Event Detection:**

- Detected objects (players, goals) and associated emotions are combined in the Event Detection Module.
- The Event Detection Module processes this combined data to identify specific events, such as goals, celebrations, and setbacks, within the video footage.

#### **4. Object Detection, Emotion Analysis, Event Detection → Temporal Analysis:**

- Results from the previous modules, including detected objects, emotions, and identified events, are integrated in the Temporal Analysis Module.
- The Temporal Analysis Module analyzes the temporal relationships between events, objects, and emotions, providing insights into the context and timing of occurrences.

#### **5. Temporal Analysis → Scenario Analysis (Machine Learning Model):**

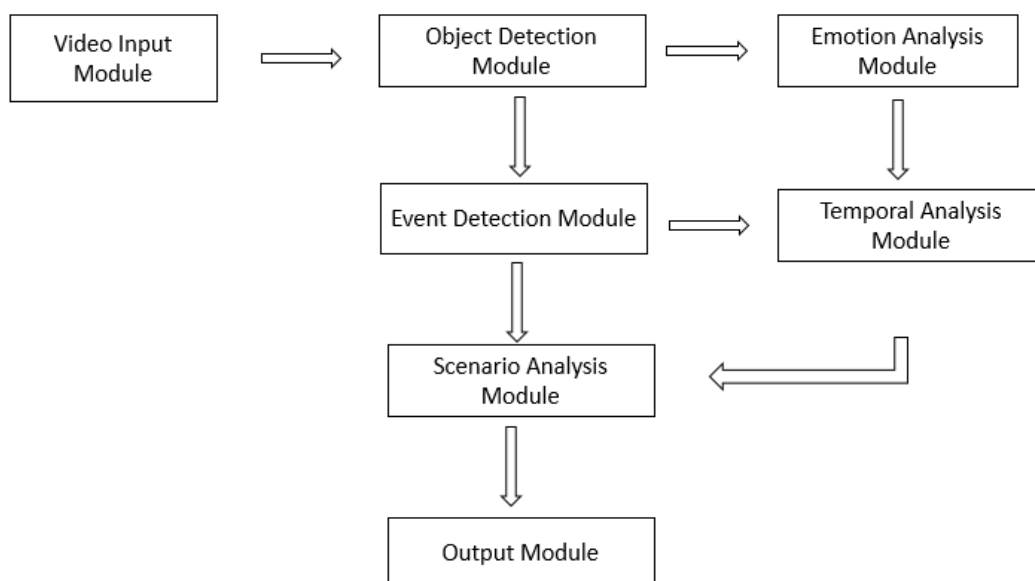
- Temporal patterns derived from the Temporal Analysis Module serve as features for the Scenario Analysis Module.
- The Scenario Analysis Module employs machine learning models trained to recognize patterns associated with different scenarios.

- Leveraging the temporal context, the Scenario Analysis Module predicts scenarios such as 'Goal moments,' 'Happy moments,' and 'Loss moments' based on the analyzed data.

#### 6. Scenario Analysis → Output Module:

- Identified scenarios generated by the Scenario Analysis Module are forwarded to the Output Module.
- The Output Module utilizes the identified scenarios to generate segmented videos, highlighting significant moments within the footage.
- Segmented videos provide a visual representation of 'Goal moments,' 'Happy moments,' and 'Loss moments,' aiding in strategic analysis and decision-making.

#### Data Flow:



#### 4. User Interface Design:

The user interface (UI) design of the Video Analysis Application prioritizes simplicity, clarity, and ease of navigation to ensure a seamless user experience. While wireframes and mockups have not been developed, the UI design focuses on clear labelling, intuitive form elements, and straightforward interactions to facilitate efficient video analysis tasks.

#### Key UI Elements:

1. **Header:** The application's title prominently displayed at the top of the interface provides users with a clear understanding of the application's purpose.
2. **Video Selection:** A file input field allows users to select the video file they wish to analyze. This feature provides flexibility and convenience for users to upload their video files easily.
3. **Scenario Selection:** A dropdown menu enables users to select the scenario they want to analyze, such as 'Goal moments,' 'Happy moments,' or 'Loss moments.' This selection determines the focus of the analysis.
4. **Segment Duration:** An input field allows users to specify the duration of each video segment in seconds. Users can customize the analysis based on their preferences and requirements by adjusting the segment duration.
5. **Emotion Analysis Toggle:** A checkbox enables users to toggle emotion analysis on or off. When enabled, the application analyzes facial expressions to capture emotions expressed by players and the crowd during the selected scenarios.
6. **Analysis Button:** A prominent button triggers the video analysis process. Upon clicking this button, the application initiates the analysis based on the user's selections and preferences.
7. **Output Section:** A designated area displays the analysis results, including information about the selected video, chosen scenario, segment duration, and the status of emotion analysis. Additionally, the output section presents the segmented video clips highlighting significant moments based on the identified scenarios.

## 5. Prototype Development Plan:

An implementation plan has been devised to guide the development process of the Video Analysis Application prototype. The plan outlines specific tasks and milestones to be achieved during each week of development, ensuring a systematic approach to building the prototype.

### Week 1:

- Set up project environment to establish the development environment and tools required for the project.

### Week 2:

- Develop video upload functionality to allow users to upload video files for analysis.
- Begin implementing segment extraction functionality to extract specific segments from uploaded videos based on user-defined start and end times.

### Week 3:

- Complete segment extraction functionality to ensure accurate and efficient extraction of video segments.

- Work on user dashboard to provide users with a central interface for accessing and managing uploaded videos and analysis results.

**Week 4:**

- Finalize user dashboard to incorporate all planned features and functionalities.
- Conduct testing and bug fixing to identify and resolve any issues or inconsistencies in the prototype.

**Conclusion:**

The design document for the Video Analysis Application represents a comprehensive blueprint for the development of a sophisticated tool tailored to meet the needs of football coaches and analysts. By incorporating detailed requirements, system architecture, user interface design, and prototype development plans, this document provides a clear roadmap for building a robust and user-friendly application.