**SUMMER INTERNSHIP COURSE**

**2025-26**

**SYNOPSIS FORMAT**

1. **Purpose/Objective**: To enhance the accuracy of participant identification in sporting events by integrating facial recognition alongside traditional bib number detection.
2. **Background/Context**:In competitive events, especially those involving large numbers of participants like marathons or sports races, participant identification has traditionally been handled using bib number detection. While efficient, this method is prone to failures due to occluded, blurred, or incorrectly tagged bibs, leading to mismatches and errors in event records. Before this project, **Timing Technologies** relied solely on bib detection, which lacked a secondary validation system.  
    To address these limitations and reduce manual verification workload, the company initiated a new system integrating **face recognition**. This project aimed to automate the cross-verification process using facial data of registered participants.
3. **Methodology/Approach**:The project began with preparing a dataset of registered participants whose facial data had been stored in .pickle files. These files contained base64-encoded images along with essential metadata such as bib numbers and roll numbers. Using the face\_recognition library’s CNN model, facial encodings were generated from these images and stored in memory for real-time comparison. The real-time input for the system consisted of wrongly tagged frames captured during the event, which were stored in a MongoDB database using GridFS.

For each incoming frame, the system retrieved the image from GridFS and resized it to optimize performance. It then used CNN-based facial detection to identify all visible faces and selected the largest face in the frame for matching. The detected face encoding was compared against the stored encodings using a face distance threshold to determine if a confident match could be made. If a match was successful, the system recorded the result in the bib\_detection\_results MongoDB collection with metadata such as timestamp, confidence score, and match method.

To improve processing speed and handle large volumes of data efficiently, the system utilized Python’s ThreadPoolExecutor to process multiple frames concurrently. This ensured the solution could scale for events involving hundreds or thousands of participants. Additionally, the system captured performance logs, including detection time, comparison time, and total processing time, and stored these logs in an Excel file for future review and performance monitoring.

1. **Findings/Results** : The system successfully verified participant identities even in cases where bib numbers were misread, obscured, or entirely missing. It demonstrated high matching accuracy, with many faces correctly linked to their corresponding registered bibs. MongoDB stored the verified results, and the Excel log provided detailed metrics for each processed frame. The project proved that facial recognition could be effectively used to complement or even replace bib detection in cases where visibility is compromised.
2. **Analysis/Interpretation**: The introduction of face recognition provided a reliable secondary validation method, especially in failure cases of bib detection. Analyzing the logs and match confidence scores revealed that most identification failures were resolved using facial data. The use of a CNN model contributed to better accuracy, and the threaded design allowed the system to maintain acceptable processing speed, even under high load. This showed that integrating multiple detection methods not only improves data reliability but also builds a more robust and automated verification workflow.
3. **Conclusion/Recommendation**:The facial recognition module added a valuable layer of verification to the participant identification process at Timing Technologies. It addressed critical limitations of the earlier bib-only system by ensuring accurate identification even when bibs were unreadable or missing. The use of modern computer vision tools and a multi-threaded pipeline made the solution scalable and efficient. It is recommended that this facial verification module be adopted for all large-scale sports events, and future upgrades such as real-time alerts or edge-device integration could be explored for enhanced responsiveness.

**SYNOPSIS**

**1.** **Basic Information**

| Name of Student | PULIKHANDAM BHAVYA SRI |
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| Roll Number | AP23110010929 |
| Branch | CSE |
| Name of Internship station/ Company | TIMING TECHNOLOGIES INDIA PRIVATE LIMITED |
| Location | HYDERABAD |
| Date of Joining | 20/05/25 |
| Address of the Company | 3rd Floor, West Wing, Block No. 1, My Home Hub, Sy No. 79(P) & 64(P) |
| Project Title | Automated Participant Identification Using Face Recognition, Bib Detection |

| Project Purpose (One sentence only - about 10/12 words, describing the anticipated change. What is the immediate outcome or direct benefit the project will achieve resulting from the activities and outputs). It should not contain project details which can be described elsewhere on the form. |
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| To automate participant identification through facial verification and minimize manual errors. |

| *What is the situation/status in the company before the project was given to you?)* | Indicators of success *(evidence: how we will know the purpose (above) has been achieved?)* | What is the progress till date? |
| --- | --- | --- |
| Bib detection alone was not always reliable | Reduction od mismatched data especially in unclear bibs | Multi threading implemented to increase the speed |
| Manual Verification was time-consuming and error-prone | Face matches conformed through mongodb logs | Processing frmes automatically in mongodb |

**Outputs:** Please list here all of the outputs (specific deliverables) you expect the project activities to deliver.

| Outputs *(The results of project activities.*  *These should be sufficient to achieve the project purpose.)* | 1.A fully functional facial recognition system integrated with MongoDB and existing bib detection pipeline.  2.An automated pipeline to process, verify, and log wrongly tagged participant frames using face recognition.  3.Detailed details in mongo db |
| --- | --- |
| Main Activities *(List the tasks to be done to deliver the outputs.)* | 1.1 Develop facial encoding extraction using registered participant images.  1.2 Load and manage .pickle files with participant metadata and encodings.  1.3 Connect and integrate the system with MongoDB (for reading input and writing results)  2.1 Fetch wrongly tagged frames from MongoDB using specific filtering criteria.  2.2 Detect faces in frames using CNN, match against known encodings, and log results.  2.3 Mark processed frames and insert verified matches into bib\_detection\_results collection.  3.1 Capture processing times for each frame (fetching, detection, comparison, insertion).  3.2 Structure data into logs and compile in a pandas DataFrame.  3.3 Export the performance and match log into an Excel file. |

**Brief Background of the Project**(**500 words max**. Please include the rationale, the context and relevant/expected work to be conducted in this area)

| In large-scale sports events such as marathons, athlete identification plays a critical role in ensuring the accuracy and fairness of event results. Traditionally, participants are identified using bib numbers — a computer vision system reads the printed numbers from images or video frames captured during the event. However, this method, while widely adopted, has several limitations. Bib numbers can often be obscured by clothing, motion blur, poor lighting, or misalignment during physical activity. Such issues can lead to wrong tagging, missed identifications, and ultimately, delays or inaccuracies in result generation. Prior to this project, **Timing Technologies** relied solely on bib detection methods to identify participants. While efficient in ideal scenarios, the system frequently failed when bibs were unreadable or duplicated, creating significant challenges for post-race result verification. In these cases, manual intervention was needed to cross-verify participants — a time-consuming and error-prone process, especially in events with thousands of athletes.  Recognizing the need for a more reliable and automated identification solution, the company initiated the **“Automated Participant Identification Using Face Recognition, Bib Detection”** project. The goal was to integrate **facial recognition technology** as a secondary layer of verification that would work in conjunction with the existing bib detection pipeline. Facial recognition can identify individuals regardless of bib visibility, providing an additional checkpoint to improve accuracy and reduce manual review time.  The work conducted in this area involved building a Python-based facial recognition system using the face\_recognition library with a CNN model. Pre-registered participant images were encoded and stored for quick comparisons. During events, wrongly tagged frames were retrieved from MongoDB’s GridFS, and faces were extracted, matched, and logged automatically. The system was designed to process multiple frames in parallel using threading, and results were stored back in MongoDB, along with detailed logs exported in Excel format for transparency and analysis.  This project addresses a critical gap in the participant identification process and reflects a growing trend in the use of biometric technologies in live sports and event management. By automating the facial verification process, it ensures greater accuracy in real-time identification, reduces human error, and improves the credibility of event outcomes.  Moving forward, the system can be extended to support live camera feeds, facial alerts, and integration with mobile or edge devices for on-ground validation. This project not only improves operational efficiency but also sets a foundation for smarter, technology-driven event timing systems that can scale with participant volumes and evolving requirements. |
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**Signature of Student**:

(I confirm that all relevant project related information has been shared and I agree that I shall work towards the goals set in this form)