Smart Indoor Navigation System using AR

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Presentation Outline

- Motivation
- Project Objectives
- Scope of Project
- Project Applications
- Methodology
- Results
- Result Analysis
- List of Remaining Tasks
- Gantt Chart
- References

Motivation

- To assist users to navigate in complex indoor environment.
- For easy visual guidance for navigation.

Project Objectives

- To implement advanced pathfinding for real-time navigation in complex indoor environments.
- To integrate augmented reality to enhance user interaction and spatial awareness.
- To utilize 3D modeling for dynamic environment awareness.

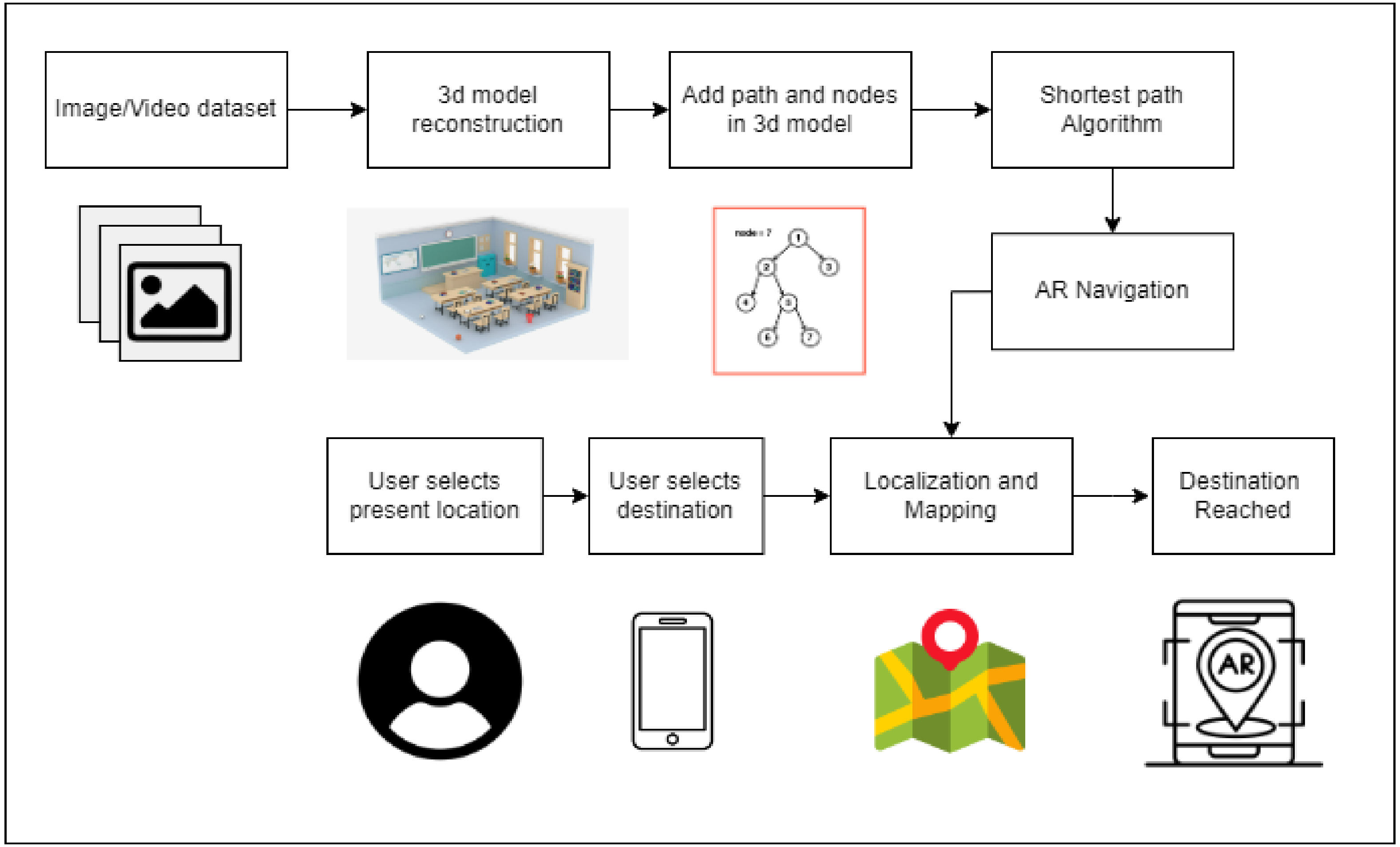
Scope of Project

- A functional AR navigation mobile application compatible with Android
- Develop an intuitive AR navigation system for enhanced user experience in large venues (e.g., airports, shopping malls, hospitals)
- Offering guided tours for tourists
- Enabling virtual tours and navigation in large properties

Project Applications

- Shopping Malls and Retail Centers
- Airports and Transportation Hubs
- Hospitals and Healthcare Facilities
- Corporate Offices and Business Complexes
- Educational Institutions
- Tourism and Cultural Heritage
- Entertainment and Gaming

Methodology - [1]
(System Block Diagram)



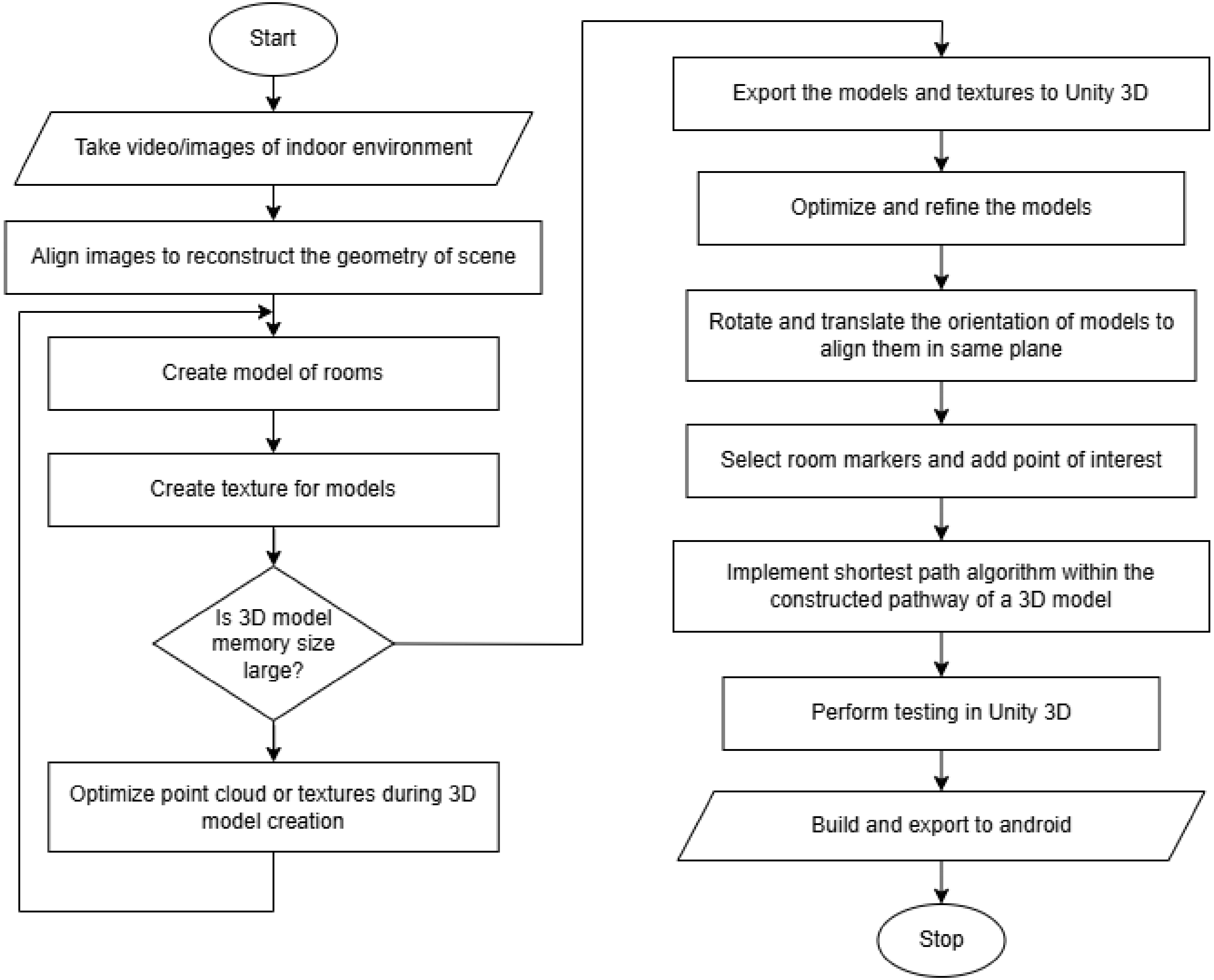
Methodology-[2]
(Working Principle-Creation of Model)

- Take video/image of building
- Create 3D model of building
- Optimize and refine the model
- Setup AR foundation
- Select point of interest and markers
- Implement navigation algorithm
- Test and build system

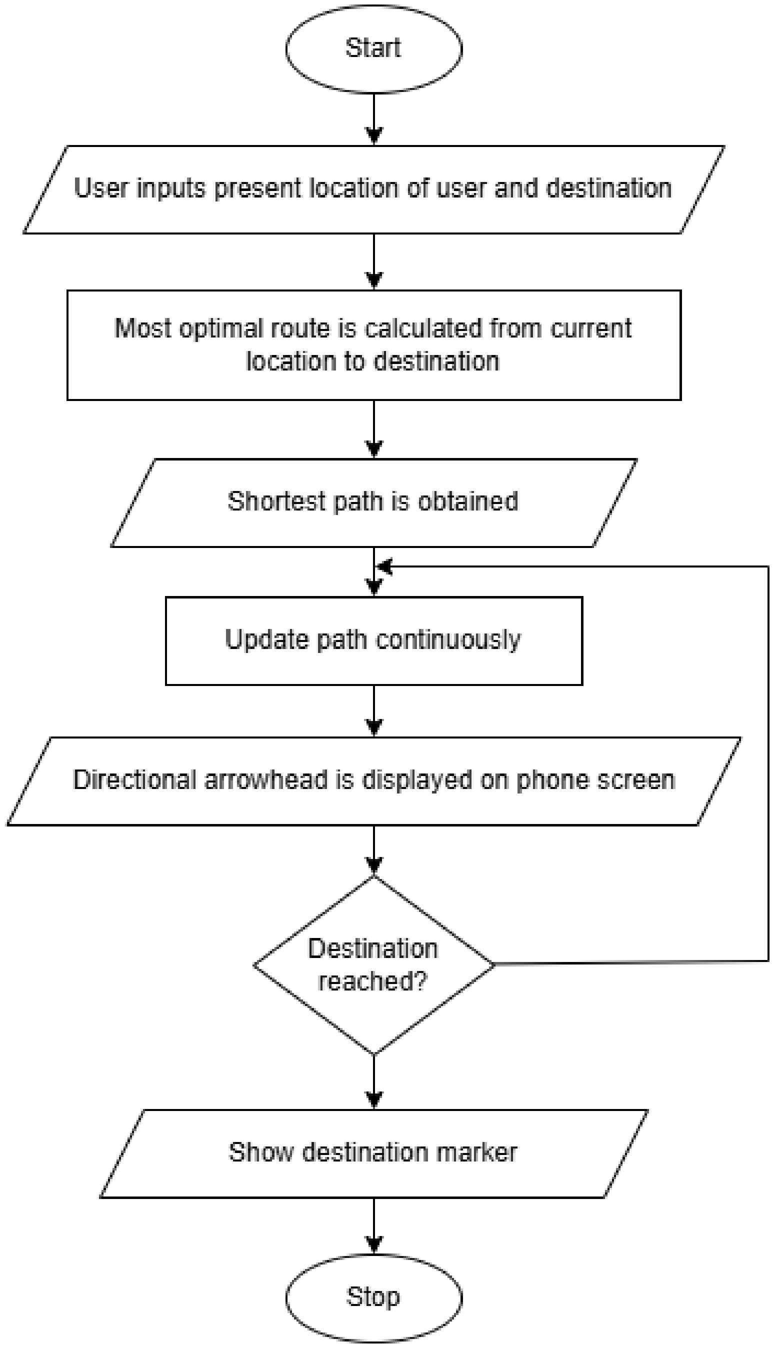
Methodology-[3]
(Working Principle - User Interactions)

- Take destination input from user
- Obtain user’s current position
- Calculate optimal path to destination
- Display AR path to user
- Update path with user movement until destination reached

Methodology - [4] (Flow Chart - A)



Methodology - [5] (Flow Chart - B)



Methodology - [6]
(AR Navigation)

- Combines real-time positioning with virtual data overlay
- Improves navigation experiences
- Able to solve the challenge of comparing the real world against reference like a map

Methodology - [7]
(Pathfinding Algorithm)

- Finds optimal path from a starting point to destination point
- Helps to navigate through complex environments
- Some pathfinding algorithms are:
  - Cycle detection
  - Dijkstra’s algorithm
  - A* algorithm
  - Minimum Spanning Trees algorithm

Methodology - [8]
(A* Shortest Path Algorithm)

- Finds the shortest path from a starting point to specific goal
- Heuristic function guides the pathfinding
- Uses heuristics to optimize the search
- Faster than Dijkstra’s algorithm

Methodology - [9]
(A* Algorithm vs Dijkstra Algorithm)

A* Shortest Path Algorithm	Dijkstra Algorithm
Finds shortest path using heuristics	Finds shortest path without heuristics
Best-first search exploration strategy	Breadth-first search exploration strategy
Efficient for large, complex graph	Efficient for small or less complex graphs
Can be used for both static and dynamic pathfinding	Cannot be used for dynamic pathfinding
Best for scenario where goal is known	Suitable for finding shortest paths from a single source to all node

Methodology - [10] (Positioning Technology)

- Methods and systems used to determine the geographic location of objects, people, or devices
- Essential for navigation, tracking, spatial analysis, and location-based services
- Some techniques: Wi-Fi positioning, BLE positioning, IMU, Visual Recognition

Methodology - [11]
(Positioning Technology - Wi-Fi Positioning)

- Used indoors where GPS is weak/unavailable.
- Utilizes signals from access points (APs).
- Measure signal strength (RSSI) from multiple APs
- Compare with a database of known Wi-Fi fingerprints.
- Triangulate the user's position using geometric principles.

Methodology - [12]
(Positioning Technology – BLE Positioning)

- Uses Bluetooth Low Energy (BLE) beacons.
- Transmit signals with unique identifiers (UUIDs)
- Effective for indoor environments like retail stores, museums, hospitals.

Methodology - [13]
(Positioning Technology - Visual Recognition)

- Analyzes data from cameras/sensors to identify landmarks and spatial features.
- Can implemented using technique as Visual Odometry, Visual SLAM
- Strengths: High accuracy, works in complex environments
- Weaknesses: High computational demands, lighting sensitivity

Methodology - [14]
(Mapping & Localization)

- Mapping:
  - Creating detailed representations of the indoor space
  - Techniques: Manual surveying and automated mapping
  - Manual Mapping: Traditional method of mapping, involves manually collecting spatial data and creating floor plans.
  - Automated Mapping : Uses data from cameras, Builds and continuously updates maps in real-time, accurate representation

Methodology - [15]
(Mapping & Localization)

- Localization:
  - Determining the user’s precise position
  - Combines data from multiple sources such as Visual Odometry(to track movements through camera data), IMUs(orientation and motion data)

Methodology - [16] (Software Requirements)

- Agisoft:
  - Creating a 3D model of the rooms
- Unity 3D:
  - Creating nodes at each room model
- Marker Detection Library:
  - Framework for detecting and recognizing markers, such as QR codes

Results – [1]

Results – [2]

Result Analysis - [1]

- 3D Model Creation of rooms:
  a. Low quality model of rooms are created. Eg: For E-hall, the size of the model is 40 MB
  b. On increasing the quality of the model, the size may scale up to 400 - 600 MB for each room
  c. Size of each model will lead to an increase in the overall size of the application.

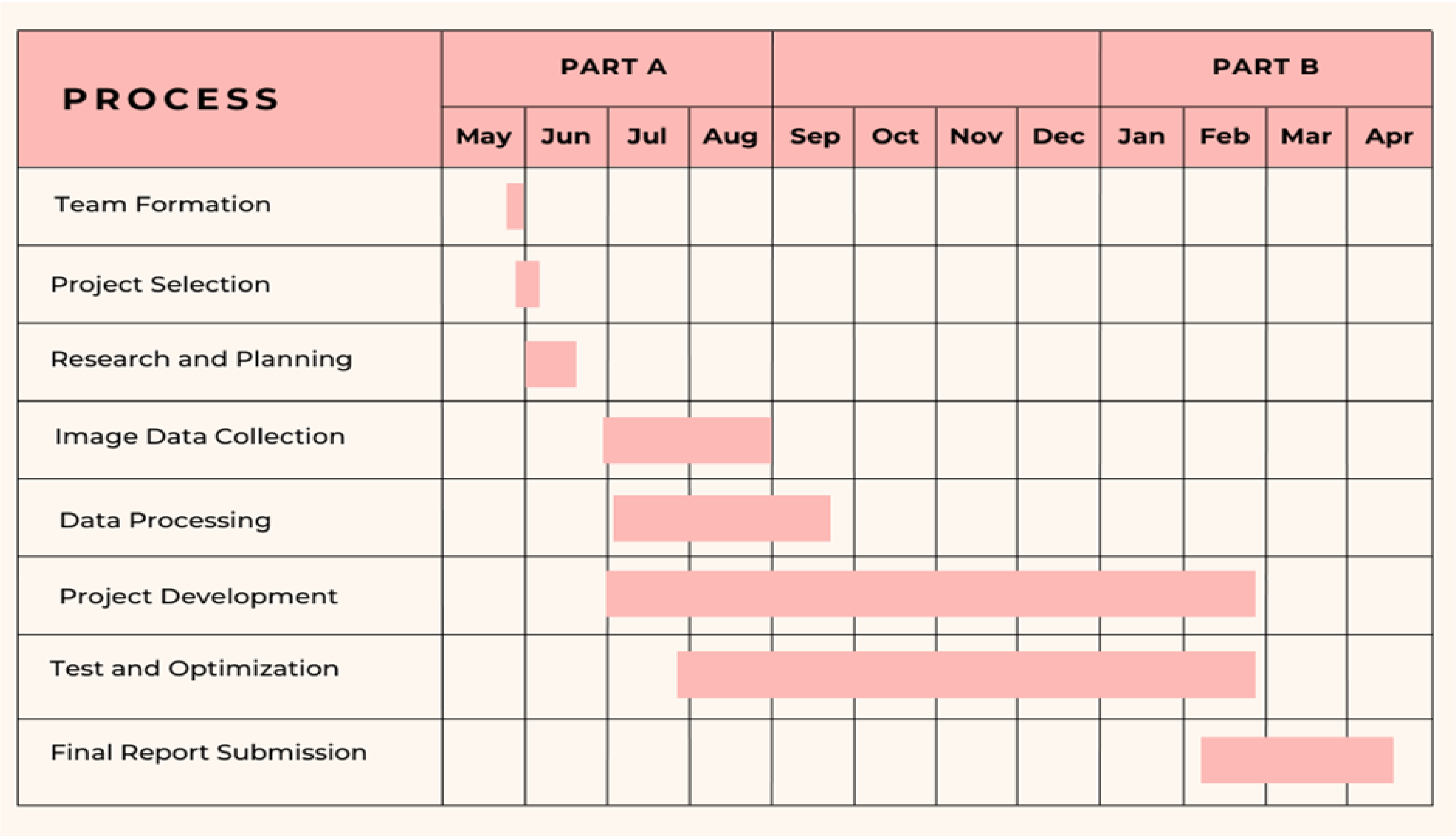
Result Analysis - [1]

- 3D Model of floor in Unity3D :
    a. Orientations of models for different rooms are not consistent.
    b. After rotation and translation, the orientation of models are arranged in same plane for a floor
    c. To do so, we created a plane in Unity3D and placed the model over the surface
    d. Define each room, with unique game object.

List of Remaining Tasks

1. Take videos and create model of remaining classrooms and passage
2. Smooth the 3D model of rooms
3. After creation of multiple floors, connect them with the 3D model of ladder
4. Provide unique game object for each rooms and ladders
5. Create a graph of the rooms for implementation of A* algorithm
6. Build android application

Gantt Chart


PROCESS
PART A
PART B
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
Team Formation
Project Selection
Research and Planning
Image Data Collection
Data Processing
Project Development
Test and Optimization
Final Report Submission

REFERENCES – [1]

[1] "Augmented reality," Wikimedia Foundation, Inc., [Online]. Available: https://en.wikipedia.org/wiki/Augmented_reality. [Accessed 31 May 2024].

[2] G. Bhorkar, "A Survey of Augmented Reality Navigation," 2017.

[3] W. Narzt, G. Pomberger, A. Ferscha, D. Kolb, R. Muller, J. Wieghardt, H. Hortner and C. Lindinger, "Augmented reality navigation systems," *Universal Access in the Information Society,* vol. 4, pp. 177-187, 2006.

REFERENCES – [2]

[4] B. Al Delail, L. Weruaga, J. Zemerly and J. Ng, "Indoor localization and navigation using smartphones augmented reality and inertial tracking," *Proceedings of the IEEE International Conference on Electronics, Circuits, and Systems,* pp. 929-932, 2013.
[5] Google, "Google AR & VR," Google Developers, [Online]. Available: https://developers.google.com/ar (accessed Jul. 18, 2024).

THANK YOU!