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Clueless: A Campus Tour Guide for CHRIST (Deemed to be University)

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Abstract : In this era of digital transformation, technology has been the driving factor behind unprecedented innovation. The technology known as Augmented Reality (AR), which overlays digital data on the physical world, is a noteworthy advancement that improves our awareness of and engagement with our environment.

Traditional navigation methods, while their usefulness, frequently cause a disconnect between the user and their environment since users must divide their attention between the device and their surroundings. Furthermore, these tools, like GPS, lack indoor and altitude-based navigation features and have accuracy limitations of up to 20 meters.

This research uses CHRIST (Deemed to be University) as a case study to investigate how augmented reality might improve navigation under challenging situations. The University's numerous staircases and towers make it difficult for guests and new students to find their way around, for example, because of the intricate arrangement of the stairways, lifts, and areas of interest. Potential linguistic problems further complicate the situation. This project uses creative AR technology to address these issues and improve the navigation experience.

***IndexTerms* – AR Navigation, Mapbox, Indoor Navigation.**

I. Introduction

This paper will discuss the need for better navigation tools like AR-based maps for students to navigate within and around their campus and execute a discrete literature review of papers with similar technology, objectives, or use cases. It also discusses the methodology and modules used to enable easy navigation on our campus.

It identifies a need for a system to improve navigation at our university for various reasons. The primary reason is to facilitate the students or parents who are new to the campus to navigate the campus independently without worrying about the language barrier and make them comfortable and safe. Another reason is to use a technology like AR so that users can find buildings and rooms on the same and different floors with just their mobile device. It uses QR codes placed at convenient places on the campus to reset the user's position concerning the building architecture to minimize the need for the internet. The users could move inside the building to different rooms by entering the destination room number, and a waypoint is generated to reach that destination using the closest path.

II. Literature Review

AR superimposes digital information onto the user's view of the real world. The composite view helps enhance the user's perception of reality [1]. AR apparatus could be used for navigation but could result in inconvenience and distraction for users. The augmented reality (AR) research community has been working on various ideas and concepts to improve the depiction of virtual objects in a natural scene. However, current AR applications require complex equipment, which makes them difficult to use. They require AR equipment to integrate seamlessly into the user's natural environment. Considering the visualization and interaction possibilities of AR on the one hand and social issues on the other, an innovative visualization paradigm is created for navigation systems, where users intuitively perceive navigation information through the windshield of a car and maintain their unrestricted freedom of movement as the AR apparatus integrates into the users' environment. User interaction can occur unaffectedly because users are not locked up in a cage and chained to wearable equipment [2].

While one could use traditional geo-visualization methods, such as paper and digital maps, they need more intuitiveness and have limited interaction modes. Hence, AR is a more suitable approach to visualizing geographic data, introducing a robust, markerless, and near-real-time mobile outdoor AR method. Leveraging SSD, a vision-based deep learning object detection method, the system addresses traditional AR drawbacks by reducing computational load through a lightweight SSD modification. To minimize detection errors by establishing spatial relationships using GPS, IMU, and magnetometer data [3]. The proposed method is tested on the Wuhan University campus, demonstrating high success rates, accuracy, stability, and flexibility. It combines geovisualization with mobile outdoor visual-IMU-magnetometer AR, showcasing the potential of deep-learning-based approaches for geographic object detection. The paper enhances user experiences in uncontrolled outdoor environments for various geospatial information applications. Another research introduces an innovative marker-free AR-based indoor navigation system specifically designed for smart glasses. [4] The proposed system leverages RGB-D cameras to observe the surroundings, employing Simultaneous Localization and Mapping (SLAM) technology to construct a point cloud map.

AR-based navigation finds its applications in the entertainment industry. One good example of such an application is a popular augmented reality (AR) smartphone app, Pokemon Go. It blended augmented reality, edge computing, ubiquitous smartphone usage, and location-based multiplayer features and witnessed widespread adoption. It integrated sensor-based services to enhance user experience while causing high power consumption in mobile devices[5].

Challenges in indoor navigation and localization, such as limitations of GPS-based technology in indoor environments [6], and some approaches to overcome them are reviewed in some papers, such as a system that employs a see-through heads-up display presenting a world-registered wireframe model of the building labeled with directional information with a wrist-worn pad serves as a three-dimensional world-in-miniature (WIM) map and an input device. Tracking involves a combination of wall-mounted ARToolkit markers observed by a head-mounted camera and an inertial tracker. To cover large areas with a limited marker set, a structured marker reuse scheme based on graph coloring is developed [7]. Another paper discusses using AR in museums to enhance visitor experiences and improve navigation within indoor environments. It discusses two localization methods, dead reckoning and Pedestrian Dead Reckoning (PDR), which are implemented, with PDR demonstrating higher accuracy but requiring specific constraints during user movement. It explores computer-vision-based techniques like artwork tracking and sensor-based methods such as dead reckoning for indoor localization.

Additionally, it investigates the usability of AR technology in indoor navigation, implementing three distinct methods for presenting navigation information. These methods involve displaying arrows at fixed distances, at the next turn, and multiple arrows leading up to the next turn [8]. At the same time, other papers discuss the system that employs simple markers placed on building ceilings. A smartphone's camera detects these markers, and associated audio and visual information guides users along the shortest path between arbitrary nodes [9]. Another system developed at Sunway University detects the user's location through sensors like the magnetic field, Wi-Fi signals, and inertial sensors, employing an Ant Colony Optimization (ACO) algorithm for route calculation. AR provides an immersive virtual navigation experience, replacing traditional maps [10]. Another paper [11] presents a comprehensive solution involving mapping, tracking, and visualization for large indoor environments. The tracking system combines visual feature tracking algorithms, including recognizable visual descriptors and a visual simultaneous localization and mapping (SLAM) algorithm. Without visual cues, an inertial sensor is a short-range fallback solution [11].

III. EXISTING SYSTEMS

This paper identifies two systems that could help navigate the campus. The Campus Tour Guide system provides information about essential rooms in a college block but does not guide users on how to reach them, and it does not utilize AR technology.

On the other hand, FESTU.Navigator is an Android-based AR application that uses text recognition to determine the user's location based on the classroom number. However, it fails in scenarios where the room or block does not have detectable text.

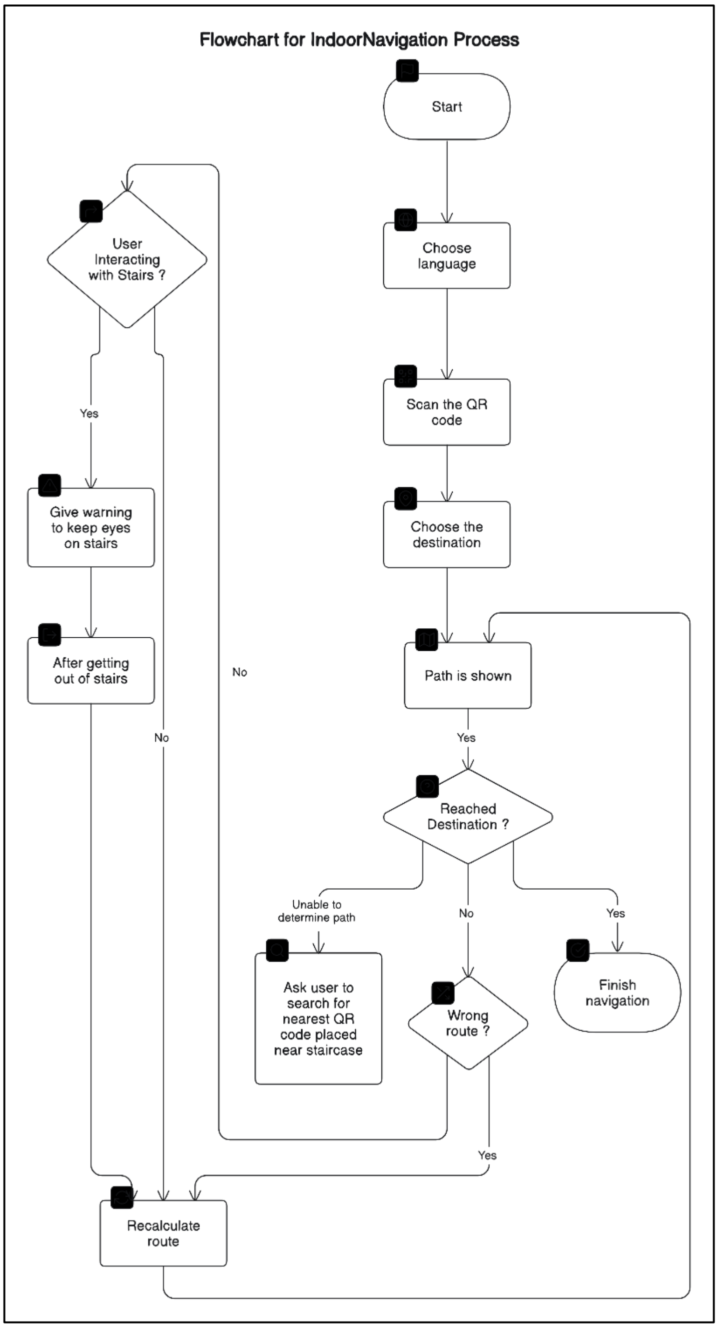
IV. PROPOSED SYSTEM

The proposed solution introduces an AR interface designed to enhance navigation within CHRIST (Deemed to be University). By overlaying directional cues and waypoints onto the real-world environment, users can intuitively and safely find their way around the campus. Users can view their current location and set a destination, with the app providing a path based on a graph of interconnected nodes. This innovative app benefits newcomers, existing faculty, and students, allowing them to navigate the CHRIST (Deemed to be University) campus seamlessly using their phone camera, AR overlays, and GPS.

Figure 1 shows a bird's eye view of the process while using the app. The user needs to scan a QR code placed on each floor at walls that are near/ opposite the staircase so that they are easily accessible for the users. These QR codes contain text codes corresponding to the floor number and building. This code helps the application understand the current floor the user is in, giving better precision comparable to GPS. A dialog box is displayed for users to enter their destination.

The user can select a destination out of the available options. A* Graph traversal and a pathfinding algorithm generate the shortest path from the user's current location to the destination. Waypoints are generated and displayed on the user's screen so that they can navigate to the destination. It can detect if a user goes in the opposite direction or non-walkable areas and recalculate the shortest path. If the user has to climb the stairs, the path will not be displayed to prevent the user from tripping while climbing the stairs. Instead, a warning is displayed.

Fig 1. Application Flow



V. Modules Required

5.1 Mapbox

Mapbox creates location-based and geospatial applications with interactive and customizable maps. It offers customizable maps and APIs (Application Programming Interfaces) that developers can integrate to display interactive and visually appealing maps into their applications and websites.

5.2 AI for Path Finding

The system uses a robust pathfinding algorithm known as the A* algorithm or A star algorithm in AI; it quickly determines the shortest path in a graph while considering both the actual cost incurred and an estimate of the remaining cost.

5.3 XR Module

This module provides foundational functionalities for working with virtual reality (VR) and augmented reality (AR) experiences within the Unity environment. It acts as a bridge between the object in Unity and the XR platform. It is a software layer that facilitates AR development. It helps handle cross-platform compatibility, ensuring seamless adaptation to various AR devices and platforms supported by Unity. It facilitates input tracking. It enables robust tracking of user gestures and movements within the real world, allowing for intuitive interactions with the overlaid AR elements. It also integrates with AR frameworks like ARCore (Android) and ARKit (iOS). It eliminates the need for separate implementations for each platform, streamlining development and ensuring optimal performance on target devices.

5.4 ARCore for Android and ArKit for iOS

ARCore (Android) and ARKit (iOS) are fundamental tools for building AR experiences. They are responsible for understanding the real world by leveraging the device's camera and sensors to help in perceiving the physical environment by detecting surfaces, tracking natural features, and estimating lighting conditions; it also helps in anchoring the virtual objects by precisely placing and locking virtual elements in the real world.

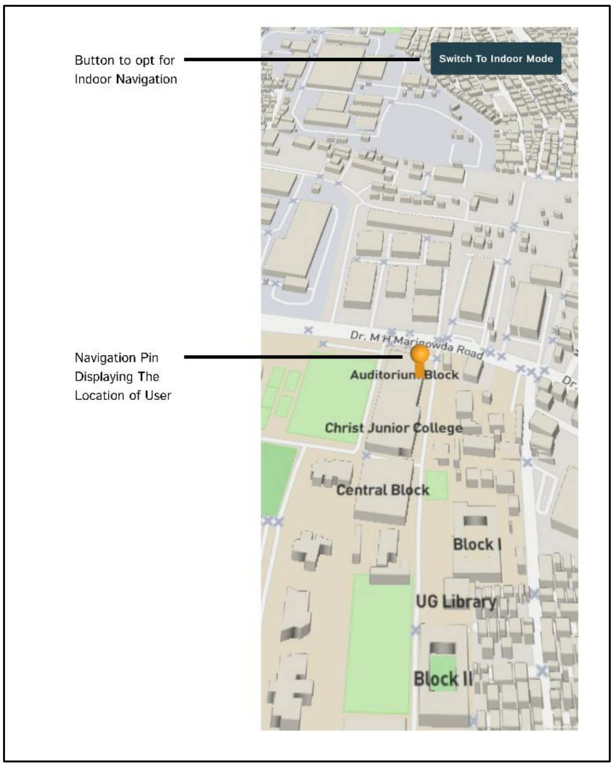
VI. ARCHITECTURE

Integrating *Clueless* application into the daily lives of the students to navigate through the University would empower them and allow them to be independent concerning navigation. The application offers an immersive and interactive experience that aligns with real-world scenarios, creating an environment where users can navigate and engage effortlessly with their surroundings. *Clueless* would make navigation interactive, unlike the traditional methods of using maps and asking others for directions. Break the language barrier as users can interact with the app in the desired languages available on the app.

6.1 Outdoor Navigation

The system facilitates outdoor navigation using GPS. The system uses MapBox to create an outdoor map with labels for each block or tower. Users can navigate to different blocks of the building by switching the GPS on and moving around the campus just like using a regular maps application.

Fig 2. Outdoor Navigation



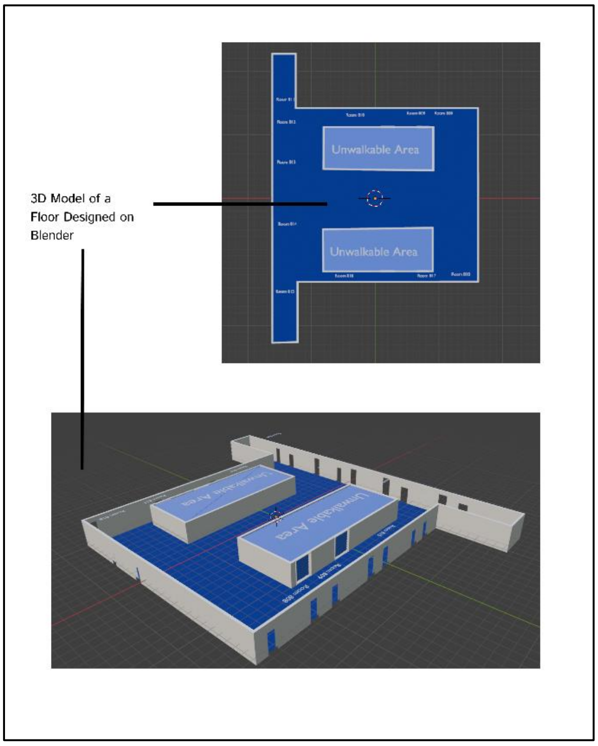
6.2 Indoor Navigation

The system uses AR for indoor navigation. It takes various components to facilitate navigation within the building. The details are as follows:

3D model of the floors

The system needs 3D maps or models of all the floors for each tower or block that contains the doors with room numbers, the un-walkable area within the floor, and the stairs' location. It uses the Magicplane app to scan the floors, convert the scan into an OBJ file, and annotate the room numbers using 3D computer graphics software like Blender.

Fig 3. 3D Model of The Floor in Blender



QR Codes

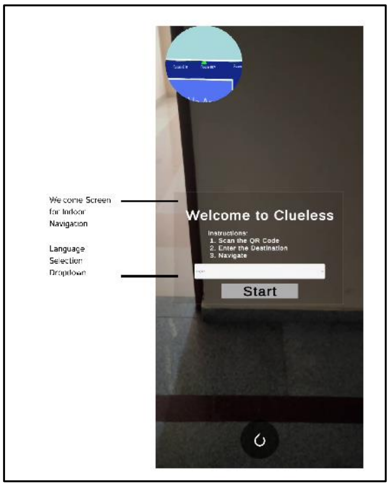
It uses QR codes to calibrate the map based on the floor and the direction of the stairs. The QR code contains text codes corresponding to the floor number and building. This code helps the application understand the user's current floor.

Fig 4. Sample QR code

Indoor Navigation Begins

A welcome panel with instructions to use the application is shown to the user to navigate in the indoor environment. The user can also choose a language of their preference from the drop-down.

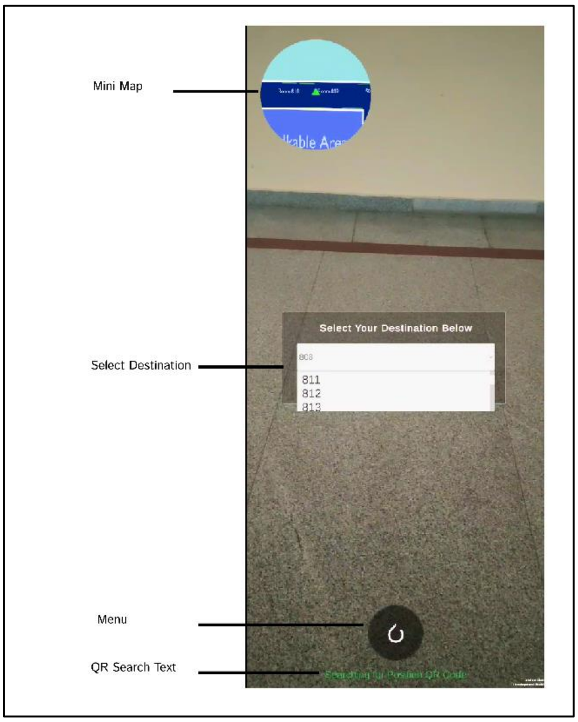
Fig 5. Welcome Screen on Opening Indoor Navigation



Choosing The Destination

The user can choose the destination they would like to reach from the drop-down. Then, the system calculates the shortest path, generating a pathway. Users can follow the pathway to reach the destination.

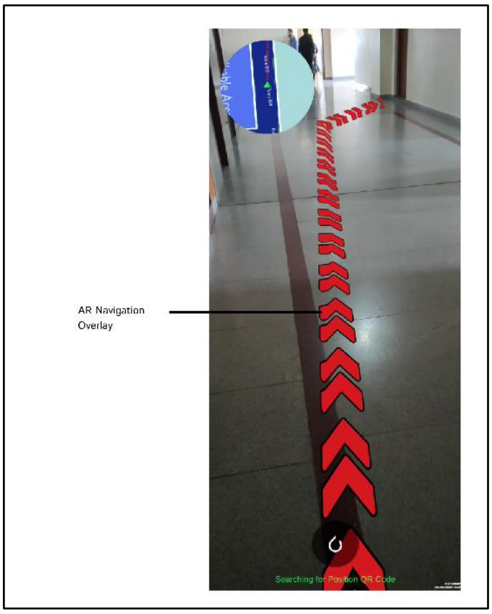
Fig 6. Selecting Destination from The Drop-down



Choosing Navigating to The Destination

Smallest distance to the destination is calculated and an overlay is displayed on user's screen. The user can move towards the destination following the arrows.

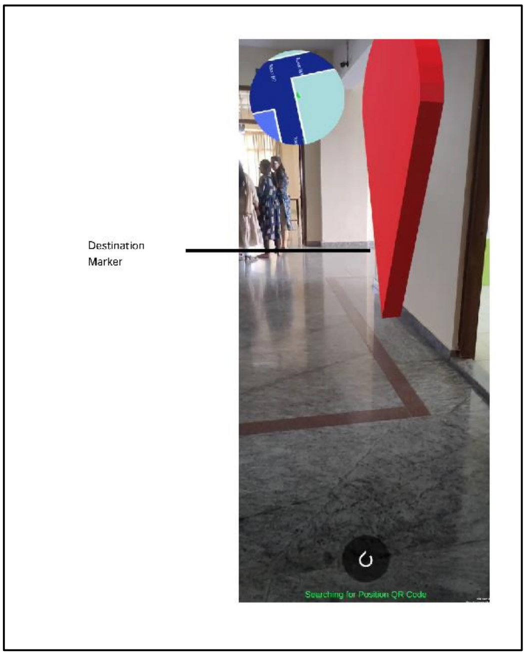
Fig 7. Navigating to Destination



Reaching The Destination

On reaching the destination, a destination marker is shown and navigation is ended. User can then use the menu and navigate to different room.

Fig 8. Destination Reached



VII. Conclusion

The proposed application assists users in finding their way around the campus using their mobile devices, creates a better navigation experience compared to traditional methods, and allows students/ users to navigate around the campus independently.

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