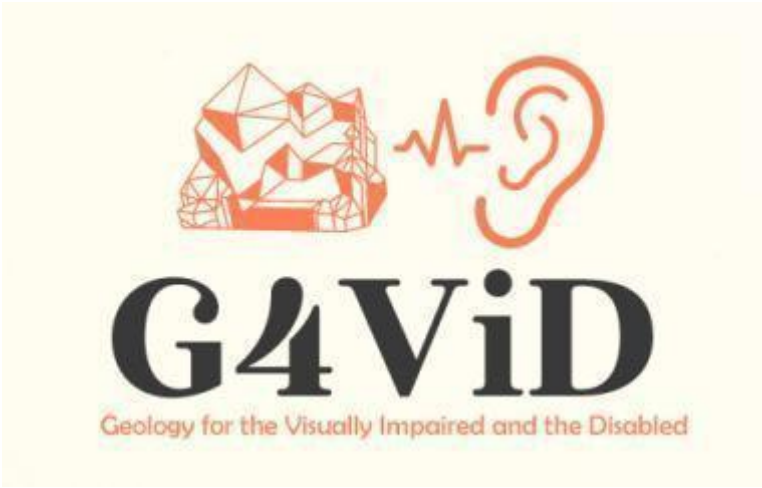

Project No: 2020-1-EL01-KA201-079157

Intellectual Output

O3: Navigation Software

Partner: PANEPISTIMIO PATRON (E10209090, GR)

IKY

Erasmus+

Project information

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1. Introduction

1.1 General

In a world where technology is always changing, innovation is a powerful tool that helps people with disabilities. Technology can make life easier for them and let them interact with the world in their own way. This research is about a special GPS feature that helps visually impaired and disabled people explore geological sites.

Nowadays, apps are essential for connecting people and giving them opportunities, whether they have disabilities or not. Just like apps like "Be My Eyes" and tools for autism training have made life better for people with disabilities, this geology app does the same. Our GPS feature uses geology knowledge and advanced technology to take users on a journey where geological sites are not just places to visit but also experiences they can touch and hear.

Much like the trend of applications simulating various conditions and disabilities to enhance understanding, this geology application endeavors to create a digital bridge between the world of geology and the realm of the differently abled. It aspires to foster a two-way integration—bringing geology enthusiasts closer to the wonders of geosites and simultaneously inviting visually impaired and disabled individuals to be active participants in the realm of geology. This application's distinctive feature, the GPS navigation system, offers a glimpse into a future where exploration knows no boundaries, where geology becomes a sensory journey, and where inclusivity is not just a goal but a vibrant reality. In the pages that follow, we delve into the intricate design, development, and profound impact of this GPS feature, which stands as a testament to the potential of technology to create a more inclusive and connected world for all.

1.2 About this Intellectual Output

The focal point of Intellectual Output 3 is a pioneering endeavor: the creation of a tailored navigation system within the G4ViD Android application. This system has been meticulously engineered to cater to the unique needs of individuals who are visually impaired or blind, extending a helping hand to guide them to geosites within geoparks. But this project goes beyond regular navigation. It aims to help users not only find these amazing natural places but also fully experience them by using their senses. Through this system, users can "feel" and "listen to" the distinctive attributes of geosites, be it the rugged texture of tree trunks, the thunderous rumble of volcanoes, or the soothing rush of waterfalls. In essence, this project is an embodiment of technology's potential to foster accessibility, inclusivity, and a profound connection with the natural world. The formulation of the software specifications was meticulously informed by the invaluable insights of visually impaired users, who actively participated in the development process. These collaborative efforts were initiated through the administration of questionnaires created by a multidisciplinary team, including experts in

Special Education, physiologists, and dedicated scientists. Furthermore, the iterative refinement of the system unfolded through a series of extensive testing sessions, thoughtfully arranged to incorporate the invaluable feedback from visually impaired users. This user-centered approach ensured that the final system was not only expertly designed but also authentically tailored to the needs and preferences of its primary users.

2. Navigation

2.1 General

Navigation is a multifaceted field of study that revolves around the intricate process of monitoring and controlling the movement of individuals, vehicles, and crafts as they traverse from one point to another. It is an essential discipline encompassing four key categories: land navigation, marine navigation, aeronautical navigation, and space navigation. Within these domains, navigators employ specialized knowledge and techniques to perform their tasks effectively, all of which involve the critical aspect of determining positions and directions relative to known locations or patterns. Beyond its technical aspects, navigation can be broadly defined as any skill or study centered on ascertaining one's position and direction.

IO3 dives into the topic of land navigation, with a particular focus on the concept of "wayfinding." Wayfinding, the fundamental process that facilitates the orientation and movement of individuals (including animals) within physical space, is a critical aspect of land navigation. It comprises four distinct stages, each of which plays a pivotal role in successfully reaching a desired destination:

1. Orientation:

   Orientation is the initial step in wayfinding, where individuals endeavor to determine their current location. This determination is often made in relation to nearby objects or reference points and the ultimate destination.

2. Route Decision:

   Once orientation is established, the next stage is route decision. This involves selecting the optimal course or direction to reach the desired destination. The selection process may incorporate various factors such as distance, terrain, and potential obstacles.

3. Route Monitoring:

   Route monitoring serves as a critical checkpoint during the journey. Navigators continually assess and verify that the chosen route aligns with the path leading to the intended destination. Adjustments may be made as needed to stay on course.

4. Destination Recognition:

The final stage of wayfinding occurs when the destination is recognized. This recognition can take many forms, such as visual cues, landmarks, or distinctive features, and it signifies the successful completion of the journey.

2.2 Navigational Challenges in Geoparks

Navigation, as defined by its fundamental wayfinding principles, is a crucial aspect of human mobility and exploration. However, in the unique context of geoparks, the application of navigation can be full of challenges and potential hazards. This chapter dives into the various dangers associated with navigation in geoparks, where factors such as relief, terrain, geosite characteristics, and weather can significantly impact the navigation experience.

- Relief of the Geopark

Geoparks, by their nature, often encompass mountainous regions with geosites situated at different elevations. Accessing these geosites may require individuals to possess amateur hiking skills, and navigating the steep and rugged terrain can prove to be a daunting task.

- Terrain Challenges:

The terrain within geoparks is typically rocky and untamed. Navigators may encounter dirt roads, rocks of varying sizes scattered along the path, or even face the need to navigate through caves to reach certain geosites. These natural obstacles can pose significant challenges to navigation and may require careful planning and adaptability.

- Nature of Geosites:

Geosites within a geopark can vary greatly, from individual rocks or trees to expansive mountain ranges, volcanoes, or waterfalls. Navigating to viewpoints of these features often involves traversing areas near cliffs or other hazardous terrain, adding an element of danger to the navigation process.

- Weather-Related Hazards:

Weather conditions, such as heavy rainstorms or snowstorms, can dramatically alter the landscape within a geopark. Pathways may become eroded or completely obliterated, forcing individuals to forge new routes independently to reach their intended geosites. These weather-related challenges can disrupt navigation plans and escalate the risks associated with exploration.

It is worth noting that these inherent dangers in geopark navigation can be magnified for individuals with disabilities, visual impairments, or those who are blind. The need for inclusive

navigational solutions that consider the unique needs of all visitors is paramount. Additionally, the effectiveness of navigation tools, including GPS-based systems, relies on a clear signal path from the device to the sky. Geoparks, with their varying relief and rugged landscapes, can introduce issues such as reduced GPS accuracy and, in some cases, complete unavailability of GPS signals. These technical challenges further underscore the complexities of navigation within geoparks.

2.3 Custom Navigation

Building upon the awareness of the potential dangers associated with navigation in geoparks, this chapter explores the development and implementation of a custom navigation solution tailored to address the unique challenges posed by these environments. Recognizing the limitations of conventional navigation software, such as "Google Maps Navigation" this chapter underscores the critical need for a safer and more context-aware alternative.

The Inadequacy of Conventional Navigation Software: Conventional navigation software, exemplified by widely-used applications like "Google Maps Navigation" offers comprehensive route planning and monitoring features. However, these features, while valuable in many contexts, may become problematic and even pose risks to users when applied in the challenging terrain and conditions of geoparks.

Custom Navigation as the Solution: In light of these challenges, a decisive shift towards a custom navigation solution was deemed necessary to prioritize user safety and navigation reliability. To achieve this, the design and implementation of the custom navigation feature were guided by a distinct approach that adheres to the fundamental principles of wayfinding, with a particular emphasis on orientation and destination recognition:

1. Orientation-Centric Design:

The custom navigation solution places a strong emphasis on the orientation phase of wayfinding. By focusing on helping users determine their location in relation to prominent nearby objects and the desired geosites within the geopark, the system aims to provide users with a clear understanding of their immediate surroundings.

2. Destination Recognition:

Another critical aspect of the custom navigation design revolves around facilitating destination recognition. Users are guided towards recognizing key landmarks and features that signify their proximity to the geosites they intend to visit. This recognition serves as a crucial milestone in the navigation process.

By deliberately omitting certain aspects of conventional navigation, such as detailed route decision and route monitoring, which can prove risky in geopark environments, the custom navigation solution minimizes the potential for hazardous outcomes. Instead, it empowers users to make informed choices while navigating based on their understanding of the terrain and their proximity to geosites.

3. Design, Challenges and Implementation

3.1 Design and challenges

The design and implementation of the custom GPS feature within the application presented a series of intricate challenges, each requiring thoughtful consideration and resolution. This section delves into the various design considerations and challenges encountered during the development of this innovative GPS feature, emphasizing the user interaction, technical implementation, and unique design choices made.

User Interaction Challenges:

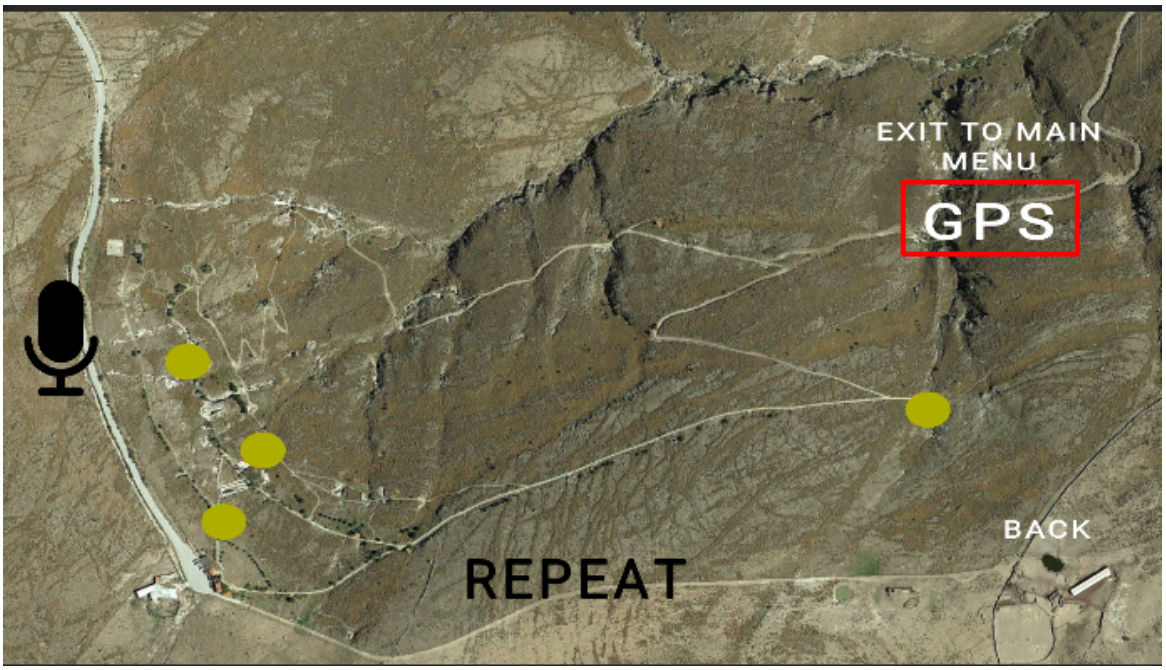
User interaction stood as the foremost challenge in the development of the GPS feature. Initially, the idea was to operate the GPS feature seamlessly in the background, automatically triggering the geosite screen when the user entered its vicinity. However, after conducting extensive testing and gathering user feedback, it became apparent that this approach was not universally suitable. Users often wished to explore different screens and functionalities within the application while remaining near a geosite, which this automated approach did not accommodate.

As a result, the decision was made to make the GPS feature optional for the user. This shift in approach allowed users to retain control over when and how they interacted with the geosites within the application, enhancing their overall experience.

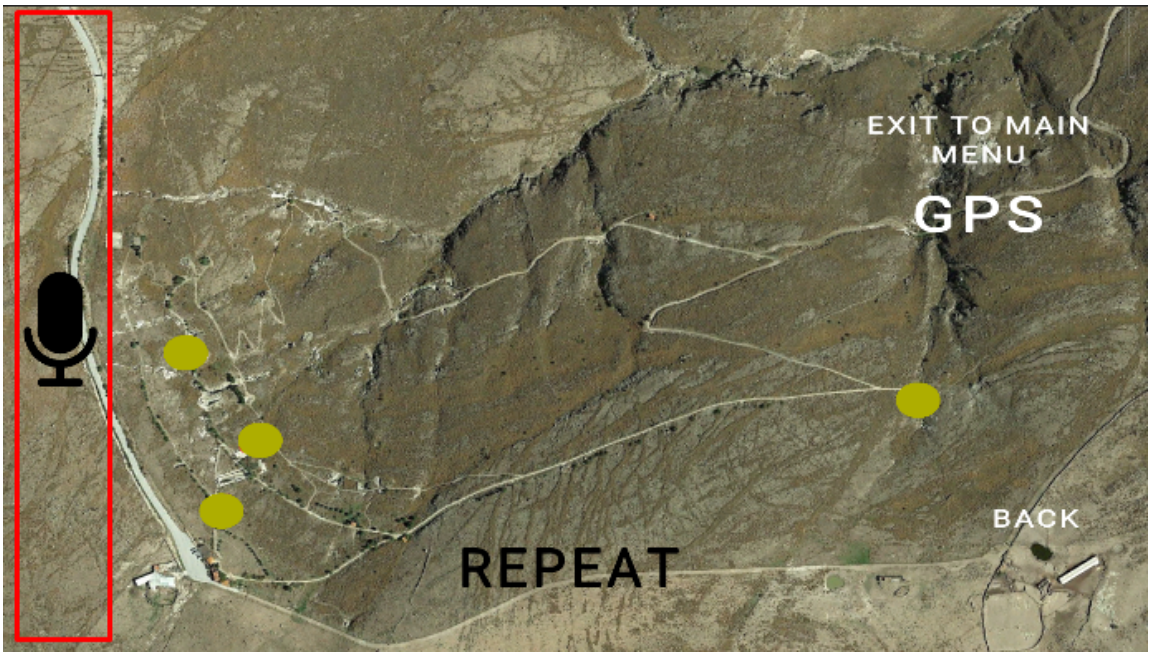
Design Template and Trigger Points:

Consistency in design was a central principle across all aspects of the application, including the GPS feature. The mechanism relied on specific trigger points to activate:

Touch Screen Button: Users could access the GPS feature via a designated button within the Geopark Map Menu.



Voice Command: Another method of activating the GPS feature was through a phonetic command. Users could simply press the microphone button and say "GPS" to initiate the functionality.



Orientation and Destination Recognition:

In alignment with the decision to exclude route decision and route monitoring features, the GPS feature's design centered around orientation and destination recognition. The application continuously tracked the user's coordinates, mapping their location on the geopark map and cross-referencing it with the predefined coordinates of geosites integrated into the application. When a match is detected, the corresponding geosite information would appear on the user's screen.

Addressing GPS Service Challenges:

The availability and accuracy of the GPS service on the user's device posed challenges largely beyond the control of application developers. While total unavailability was beyond mitigation, the application tackled the issue of low accuracy by incorporating a matching threshold. Through extensive testing in geoparks, a deviation threshold of 0.01% was determined to ensure accurate geosite recognition even in conditions with reduced GPS accuracy.

Technical Implementation:

A crucial technical decision revolved around choosing the underlying GPS service. Given that the application was built within the Unity game engine, it was decided to leverage Unity's embedded location services library. This choice not only saved valuable development resources but also allowed the application to utilize existing infrastructure and seamlessly integrate GPS functionality.

This section illuminates the multifaceted considerations and solutions that shaped the design and functionality of the custom GPS feature. It underscores the importance of user-centric design and the thoughtful integration of GPS technology to enhance the overall user experience within the geopark application.

3.2 Implementation

The successful implementation of the custom GPS feature was characterized by its straightforward approach, focusing on two primary components: orientation and destination recognition. This section provides an in-depth overview of the implementation process, highlighting the key technical aspects and methods employed.

Orientation Implementation:

In the context of the GPS feature, orientation primarily pertained to determining the precise coordinates of the user within the geopark. This information was critical for the application to

facilitate the orientation phase of wayfinding effectively. The implementation relied on the Unity game engine's location services library, which provided access to the user's latitude and longitude coordinates.

The application stored these coordinates as key-value pairs, with latitude as the key and longitude as the value. This data structure ensured that the user's current position was readily accessible for subsequent processing.

Destination Recognition:

Destination recognition was a fundamental aspect of the custom GPS feature, enabling the application to identify and present information about nearby geosites. To achieve this, the application stored a database of coordinates for all the geosites featured within a given geopark. These coordinates were organized as key-value pairs, associating latitude with longitude for each geosite.

The recognition process unfolded as follows:

Coordinate Matching: The application employed a foreach loop to iterate through the stored coordinates of geosites, parsing them multiple times to seek a match with the user's current coordinates.

Retries: If an initial match was not found, the application allowed for up to three retries, accommodating potential discrepancies due to GPS accuracy or momentary location variations.

Proximity-Based Recognition: In the absence of an immediate match, users were prompted to move closer to the geosite and attempt recognition again. This approach ensured that users had a chance to reposition themselves for a more accurate recognition attempt.

Recognition Success: Once a match was successfully made between the user's coordinates and those of a geosite, the application transitioned to the next step, which involved opening the geosite scene. This marked the completion of the destination recognition process.

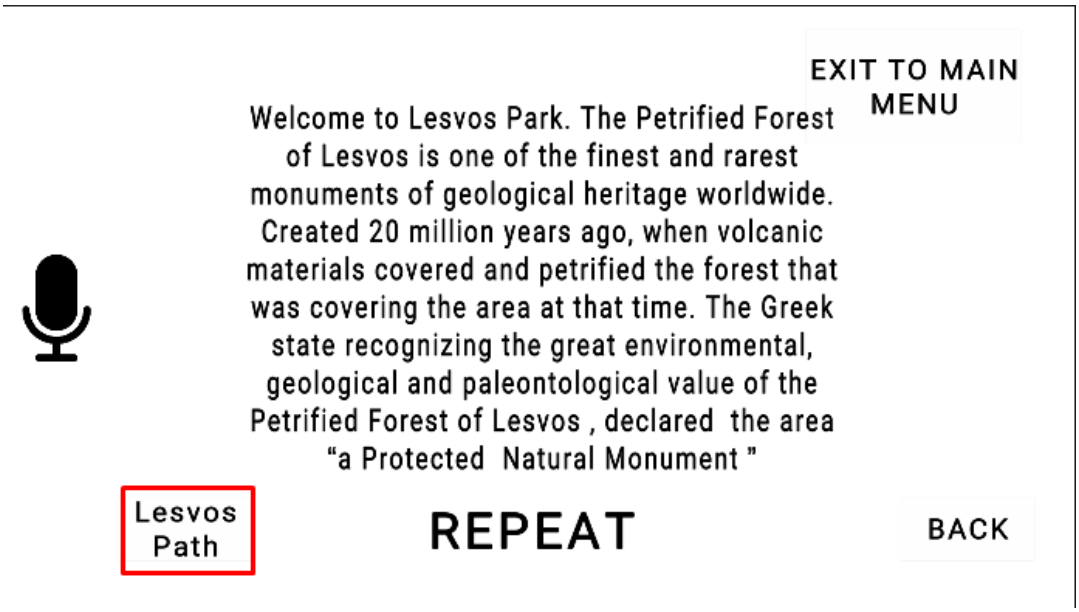
In summary, the implementation of the GPS feature capitalized on the Unity game engine's location services library, effectively translating orientation and destination recognition into practical functionalities. The iterative recognition process, along with user-friendly retries and proximity-based recognition, enhanced the overall user experience and contributed to the feature's success.

4. GPS Feature – Hands on

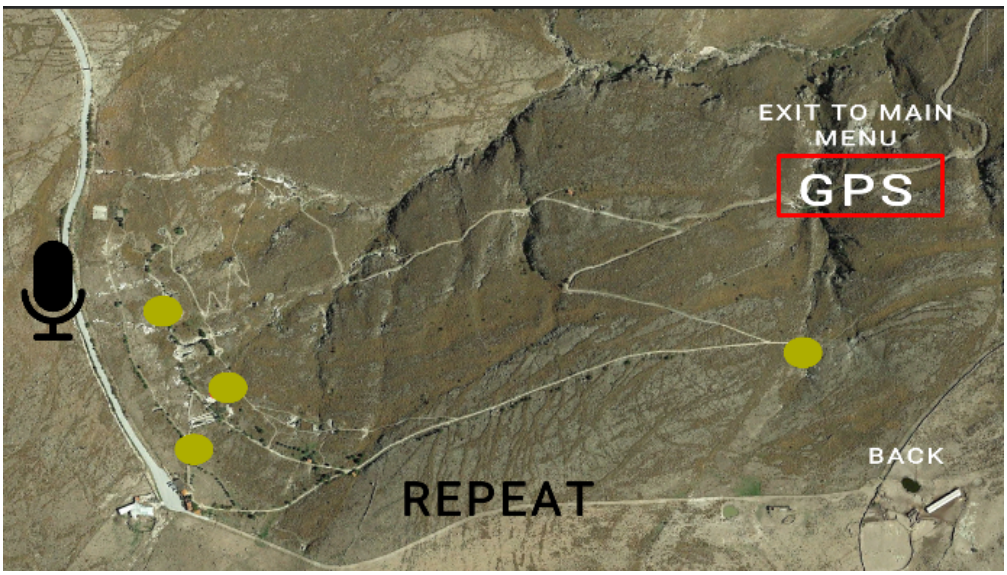
The user initiates the GPS feature by tapping the "Select Park Button" located within the Main Menu of the application. Alternatively, they can activate this feature by simply pressing the microphone button and issuing the voice command "Select Park." This intuitive interaction process offers users flexibility in accessing the GPS functionality, aligning with our commitment to user-centered design.

Following the initial menu selection, users proceed to the Park Selection Menu, where they can effortlessly choose their desired geopark for navigation. This selection can be made either by tapping the corresponding button associated with the chosen geopark or by employing voice command functionality. For instance, the user can simply say "Lesvos" to enter Lesvos Park, demonstrating the seamless integration of both touch-based and voice-activated navigation options within the application's user interface.

At this point, users have the opportunity to engage with a concise summary of the selected Geopark, providing them with valuable insights. To proceed further, they can seamlessly enter the Map Menu by either tapping on the "Lesvos" Button corresponding to their chosen geopark or by issuing a voice command. For example, they can say "Path" to activate this transition, underscoring the application's commitment to providing intuitive and accessible navigation pathways for users.



Upon entering the next screen, users gain access to the navigation feature within the application. Activating this feature is incredibly straightforward, as it merely necessitates the user to either press the dedicated "GPS" button or employ voice command functionality by uttering "GPS." This simplicity in engagement underscores our commitment to ensuring a user-friendly and accessible navigation experience within the application.



Upon initiation of the GPS mechanism, the application commences its operation, retrieving the user's latitude and longitude coordinates. When the user's proximity to one of the four geosites within the park is detected, the corresponding geosite screen seamlessly appears, granting the user access to the primary feature of the application. This intuitive process ensures that users can effortlessly engage with the geosites as they explore the geopark, embodying our commitment to delivering a streamlined and user-centric navigation experience.

In instances where the user's current location falls outside the range of a geosite, the application offers two practical alternatives for progression. Users have the option to manually select their desired geosite by issuing a voice command, such as "First Geosite," providing a direct and user-initiated approach. Alternatively, users can opt to move closer to the geosite they wish to explore, subsequently reactivating the GPS mechanism. This adaptive approach empowers users to tailor their navigation experience to their preferences, promoting flexibility and convenience in geopark exploration.