

MAPPING CLAFLIN UNIVERSITY IN 3D USING UNITY ENGINE

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I would like to thank my community for shaping me into who I am today, through every stage of my life thus far and beyond. Thank you, family, for taking care of me from the very beginning and guiding me on the right path. Thank you, friends, for staying by my side through thick and thin, and being the source of my happiest days. Thank you, faculty and staff, for challenging me to improve myself academically and logically.

THESIS STATEMENT

Wayfinding at college universities can be daunting for new and prospective students, faculty, staff, and visitors. Getting lost in an unfamiliar environment can make one's campus experience, and possibly their attitude, deteriorate over time. Good wayfinding designs should be implemented into the environment to assist individuals with navigating to their intended destinations without getting lost. Examples of wayfinding issues that can exist pertain to color, lighting, signs, maps, numbering, and spatial and floor plans (Alansari, 2022, pg. 70-71). Maps have a large impact on the wayfinding effectiveness of individuals, especially maps that are updated regularly and contain key information about their features.

The specific problem that this proposal addresses is the creation of a 3-dimensional map of Claflin University using a software engine called Unity to improve the wayfinding experience of Claflin's campus virtually. Other campuses have created interactive maps of their own, utilizing various software applications to do so. For example, the College of Charleston used ArcGIS 9.2 and data collected from various sources to create a 2-dimensional interactive map (Sataloff, 2012). Their interactive map can be used by their college community online, and it provides location information, accurate crime data, and hyperlinks to their website. Another research utilized a software tool called Figma to create an interactive map for their campus (Sanjivani, 2023). Their interactive map provides sufficient detail for users who desire an atlas-based model that contains information on buildings' floor plans. It has functions such as a search bar, click to view function on the map, highlighting location on clicking, and displaying information about

a selected area. However, it lacks a user-friendly interface and compatibility with other campus systems, such as event calendars and course schedules. Concepts from these two interactive maps, and more, and be applied to the creation of a new interactive map for Claflin University.

KEYWORDS AND ABBREVIATIONS

Keywords: Unity, user interface, artificial intelligence, Claflin University, interactive map, wayfinding

Abbreviations

UI – User Interface

AI – Artificial Intelligence

AR – Artificial Reality

SDK – Software Development Kit

IDE – Integrated Development Environment

GIS – Geographic Information System

HTML – HyperText Markup Language

CSS – Cascading Style Sheets

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INTRODUCTION

Wayfinding through a university's campus is an important skill that new and prospective students, faculty, staff, and visitors must use. Students are expected to visit many locations on campus, and without the assistance of an individual who knows the layout of campus or university maps, wayfinding quickly can be difficult. Faculty and staff must also be able to navigate through their campus, as they must be present at their offices, classrooms, and other designated locations. Visitors need not learn where every important location is, though a wayfinding tool will greatly enhance their ability to navigate to their building of interest. The design of a campus' layout, as well as tools such as maps, assist individuals with wayfinding.

Currently, there are a handful of resources that assist with wayfinding on Claflin University's campus. Google Maps has mapped Claflin's buildings, though its images are outdated, and it is impossible to navigate freely between buildings in street view. The Claflin University website contains pictures of buildings along with descriptions of their operations and department, though there are no maps appended to their respective pages. It contains a virtual tour module at <https://www.claflin.edu/admissions-aid>, though it utilizes stationary 360° images and an embedding of Google Maps. It also contains a page with written directions to navigate to Claflin University from surrounding cities and an image of Claflin's within South Carolina at <https://www.claflin.edu/about/location-directions>, though the image caters to aesthetics more than practicality.

This study will introduce a 3-dimensional interactive map to Claflin University's campus which will improve the wayfinding experience of its users. The Claflin

University website can include the 3D map and keep it up to date for use by the public. The presentation of the campus environment during meetings can utilize the 3D map to simulate camera angles from a walking or drone perspective. New and prospective students, faculty, staff, and visitors can become familiarized with the layout of campus prior to wayfinding.

Background of the Study

Software called ArcGIS 9.2 has been used to map the College of Charleston's campus (Sataloff, 2012). The maps created with ArcGIS 9.2 have become a valuable online resource for locating campus buildings, parking areas, and accurate crime information. The interactive map requires manual updates, though its design can be applied to Claflin University's campus.

Software called Placenote SDK, Unity Game Engine, and XCode IDE has been used to create a mobile application that can create and display paths using augmented reality (AR) (Abhijith, 2020). The application can map paths by dropping nodes spatially, which are saved with their location to the previous nodes. Then, when loading the map selected by the user, the application scans areas that were previously scanned and localizes the path. The concept of the mapping software can be applied to creating paths for users to follow.

A software tool called Figma was utilized to create a prototype interactive map of a campus which included floor plans (Sanjivani, 2023). The prototype contained features such as a search bar, click to view feature on the map, highlighting location on clicking, and information being displayed of the specified area. The prototype was replicated using

HTML, CSS, and the basics of JavaScript, though the finished product contained minor differences from the prototype. The methods used in the study can be replicated and improved for Claflin.

Two interactive maps for the University of Wisconsin-Madison were created which adopted a wayfinding-based and an atlas-based model respectively (Roth, 2009). They were both completed in Flash 8 using ActionScript 2.0, Adobe Illustrator CS2, and Adobe Photoshop CS2. Between the two interactive maps, users can query to search for points of interest, receive navigation to locations using various map browsing methods, list popular campus sites and resources, receive detailed information about features of interest, and navigate to webpages in Lakeshore Nature Preservation website about a specified feature. The thoroughness of the study can be used to optimize the design of a Claflin interactive map.

A pictorial case study was conducted at Texas State University to discover and address wayfinding issues (Alansari, 2022). The color, lighting, signs, maps, numbering, and spatial floor plan were analyzed with relation to the wayfinding effectiveness of the environment, and solutions were produced to counter these issues. Claflin's campus can be checked with the same wayfinding recommendations as the ones in the study.

This study is needed because good wayfinding designs can help the campus community navigate to their destination more efficiently, and a 3-dimensional map of Claflin University can be a powerful asset. As technology continues to evolve, so should Claflin University's campus experience and assets.

Purpose of the Study

The purpose of this study is to develop a Unity based web application that provides a 3D map of Claflin's campus with wayfinding tools and intuitive computer controls. The virtual wayfinding ability of new and prospective students, faculty, staff, and visitors who have access to computers will be enhanced by using the 3D map. When viewing campus from the perspective of a person or a drone is relevant to a presentation, the 3D map can be used to showcase both perspectives and transition between them seamlessly.

Research Question(s)

The research questions guiding this study are:

1. How can the wayfinding experience for Claflin's campus be improved by interactive maps?
2. How can maps be improved to match evolving demands?
3. How can a 3-dimensional recreation of Claflin's campus be used to improve other projects, events, and showcases?

LITERATURE REVIEW

This research addresses the modernization of implementing virtual tours of Claflin University's campus to accommodate for the wayfinding abilities of visitors, prospective students, and current students and staff. This research will result in the improvement of the wayfinding ability for Claflin's campus of individuals who have access to a personal computer (PC). There are a variety of existing procedures that modernize wayfinding, especially via digital software such as Unity. Mapping tools and pictures have been used to create interactive web maps that contain useful information and can be easily updated. Software has been created that can scan surroundings, placing nodes, and saving pathways based on the placed nodes. Other mapping tools can construct maps containing information about the different floors of buildings by floor surveying and hand designing room outlines. Interactive maps have taken two different approaches, a wayfinding-based model, and an atlas-based model. Maps that adopt a wayfinding-based model serve the purpose of guiding its users to their destination without getting lost. Maps that adopt an atlas-based model serve the purpose of informing its users about the purpose and history of features shown on the map. Studies show that the easier it is to perform wayfinding in an environment, the greater an individual's experience will be, and vice versa.

The accuracy of the College of Charleston's map was enhanced by an interactive map that can easily be updated (Sataloff, 2012). This was done by using software called ArcGIS 9.2 and data collected from various sources, such as photos, Garmin Vista GPS, and locations of public safety call boxes. The finalized interactive map can be used by the

college community, and the map contains sufficient information and an intuitive user interface (UI). However, this map is limited to the College of Charleston, and its data needs to be manually updated.

A software application for smartphones was created that focuses on an indoor navigation system which can scan surroundings, creating placing nodes, and saving pathways based on the nodes that it places (Abjihijith, 2020). This was done by utilizing various technologies, such as Placenote SDK, Unity Game Engine, and XCode IDE. This approach makes the finished product usable anywhere, as it utilizes a database in its own cloud that stores the scanned information. However, this approach suggests that only predetermined paths can be followed, which makes wayfinding from two specific points a bit complicated. This software can be modified to include additional features, such as obstacle detection, routing artificial intelligence (AI), and labels that include information.

Another interactive map was created that details individual floors of buildings on campus (Sanjivani, 2023). This was done by tracing classroom outlines using a software tool called Figma, converting the tracing to an SVG file, and replicating the prototype using HTML, CSS, and the basics of JavaScript. This approach provides sufficient detail as an atlas-based model, but it has various issues. Due to challenges, the prototype was unable to be replicated perfectly, so the finished software included deviations from the prototype. The UI is not intuitive, and it is unable to provide routing information to its end users. With modifications to the software, this interactive map can include features that make it more user-friendly and compatible with other campus systems, such as event calendars and course schedules.

Two interactive maps were created to assist students with navigating the University of Wisconsin-Madison campus, adopting a wayfinding-based model and an atlas-based model respectively (Roth, 2009). The map that adopted the wayfinding-based model was created in Flash 8 using ActionScript 2.0 (AS2), Adobe Illustrator CS2, Adobe Photoshop CS2, Zoomify, a MySQL database, and Ruby on Rails. The map that adopted the atlas-based model was created in Flash 8 using ActionScript 2.0, Adobe Illustrator CS2, Adobe Photoshop CS2, ArcGIS 8.0, and various sources for data. Due to the creation of two independent interactive maps, users are capable of either wayfinding or researching the University of Wisconsin-Madison campus efficiently. However, since the two maps are independent from one another, information that could be useful at just a glance may only be included in the other interactive map. The two maps could be merged into one user-friendly interactive map.

A pictorial case study was conducted in the Human Sciences Building at Texas Tech University to discover the wayfinding issues that exist within the building (Alansari, 2022). This was done by recording the wayfinding issues with a camera to document the wayfinding corners and analyzing the color, lighting, signs, maps, numbering, and spatial floor plan. This approach highlights various factors that contribute to the enhancement of wayfinding and developing numerous recommendations to improve the wayfinding of the first floor of the Human Sciences building. However, the scope of this project was limited to one floor of the Human Sciences Building and does not directly affect individuals who are studying the environment virtually. The proposed

designs that are implemented in the environment can also be used to make a virtual environment via software editors such as Unity Engine.

METHODOLOGY

This study was conducted for the purpose of developing a web application that provides a 3D map of Claflin's campus with wayfinding tools and intuitive computer controls. The 3D map of Claflin was created using Unity Engine and coded in C# with Unity libraries. The virtual wayfinding ability of prospective students, faculty, and visitors who have access to computers will be enhanced by using the 3D map. When viewing campus from the perspective of a person or a drone is relevant to a presentation, the 3D map can be used to showcase both perspectives and transition between them seamlessly. The research questions guiding this study are:

1. How can the wayfinding experience for Claflin's campus be improved by interactive maps?
2. How can maps be improved to match evolving demands?
3. How can a 3-dimensional recreation of Claflin's campus be used to improve other projects, events, and showcases?

Population and Sampling Procedure

The target population for this study are new and prospective students, faculty, staff, and visitors. The size of the target population is estimated to be two thousand individuals, mostly new and prospective students. A randomly selected sample of current Claflin University students, faculty, and staff will be chosen to participate in this study if they wish to volunteer. Random sampling allows the population of participants to consist of diverse backgrounds, roles, and skill sets. The desired minimum sample size is ten for each of students, faculty, and staff. All students who work in the Admissions office

should be given invitations, as they are trusted family members of students, faculty, and staff members are also invited to become participants, as they are potential visitors.

Research Design and Development Procedures

The 3D map of Claflin University was made using Unity Engine and C# coding with Unity Libraries. Unity is a “cross-platform game engine that helps to create games in 2D, 3D, and virtual and augmented reality as well as simulations and other experiences” (Abhijith, 2020, pg. 1548). Google Maps was also used to scale the sizes and locations of buildings for a prototype of the software. During the development of the 3D map, a handful of team members tested the software application to find and report any issues they find or make suggestions.

The scene for the 3D map was initially created with a flat plane and a capsule to represent the ground and player. The ground requires no script, but the player model has a PlayerController script attached to it. The PlayerController script contains modified code from an introductory lesson on learn.unity.com, which was originally a simple player movement script that allows for horizontal movement, jumping, and moving the camera. The ability to enter a flying mode, which replaces jumping with levitating up and down, was added to the script. The ability to pause the program and lock the mouse while the program is unpaused was also added to the script.

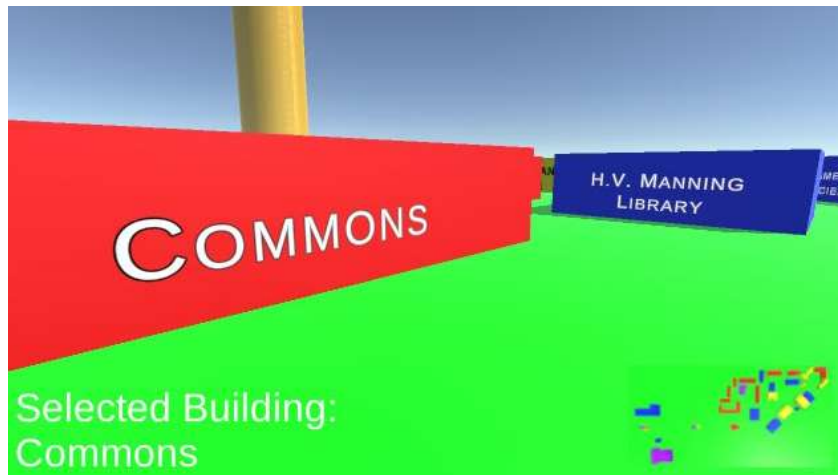


Figure 1. A screenshot of the Claflin 3D map environment

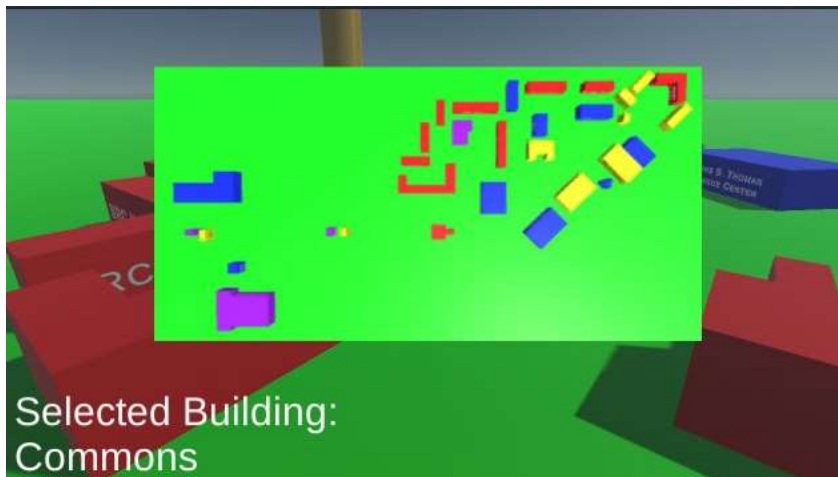


Figure 2. A screenshot of the Claflin 3D map Pause Menu

Once player controls were added, basic cubes and text were added to represent Claflin University's buildings. The size and location of each building was calculated using Google Maps. Each building was given color coating to differentiate between education halls, offices, residence halls, and wellness centers. The ground was changed to green to represent grass, and the player capsule does not need to be set to any color since the software takes a first-person perspective. While the buildings were being added, an issue was fixed to where users could fly through objects.

A beacon was created that highlights a selected building. For users to select a building to be highlighted with the beacon, a new script BeaconController was created. A user interface was also created that will show users which building they have selected. In the BeaconController script, an array is created that stores the info for the currently existing buildings. By receiving user input for up and down while the program is paused, a pointer will cycle between different buildings. Depending on the current building that the pointer is on, the beacon will reposition to the building's location and the user interface will display the building's name. Additionally, an image of an overhead view of the buildings will be present on the user interface. While the program is paused, the background will darken slightly, and a larger map will be presented.

Limitations

The Claflin University campus 3D map must be updated to match the current state of Claflin University's campus, or else its information may be unreliable. Updating the 3D map requires knowledge on how to use Unity and programming in C# with Unity libraries.

Only computers with a keyboard and touchpad or mouse can properly use the 3D map. Touch controls, video game controllers, voice controls, and other user inputs are not supported by the 3D map. Additionally, GPS tracking and routing is not supported, which could be greatly beneficial for mobile controls.

Information on the exact measurements of Claflin's buildings is not publicly available, so every building was created from estimations and measurements. As such, the 3D map's buildings, and their locations relative to one another were not scaled

accurately. This can affect users who may wish to utilize the 3D map to simulate precise movements or scale their own projects accurately.

Ethical Procedures & Considerations

An ethical issue that the 3D map presents is the usage of information from prospective participants. To ensure that ethics are maintained, prospective participants from the Admissions office and the random sampling are to be sent a form via email to gather information from those who are interested. All personal information and form responses will be kept private to ensure their safety. If an individual is not interested, they may decline participation and receive no further queries. For legal purposes, if an individual is interested, they must consent to their names and feedback being analyzed to ensure that all feedback is authentic. After this study is over, all participant names and feedback will be safely discarded to ensure the safety of their information.

Malicious people may look to resources such as interactive maps to plan terrorist attacks, and the 3D map created by this study is a resource that provides sufficient detail to navigate Claflin's campus virtually. Because this is a security issue, access to this 3D map should be limited to prevent the wrong people from using it. Some ways to limit access to the map are requiring users to sign in to Claflin's services, request access from an admin, or use GPS services to verify that their location is close to Claflin University.

RESULTS

The purpose of this study is to develop a Unity based web application that provides a 3D map of Claflin's campus with wayfinding tools and intuitive computer controls. The research questions guiding this study are:

1. How can the wayfinding experience for Claflin's campus be improved by interactive maps?
2. How can maps be improved to match evolving demands?
3. How can a 3-dimensional recreation of Claflin's campus be used to improve other projects, events, and showcases?

Study Results

The Claflin 3D interactive map can replicate the wayfinding experience for Claflin University's campus. Walking, jumping, and flying are movement options that are available for users to navigate through campus. There is also a beacon that can be toggled on and off and highlight buildings and can cycle through an array to select buildings.



Figure 1. A screenshot of the Claflin 3D map environment

The 3D map can be paused, suspending the camera's rotation and position while removing the mouse position restriction. The pause menu also enlarges the minimap, allowing users to view Claflin's campus from an overhead view like Google Maps.

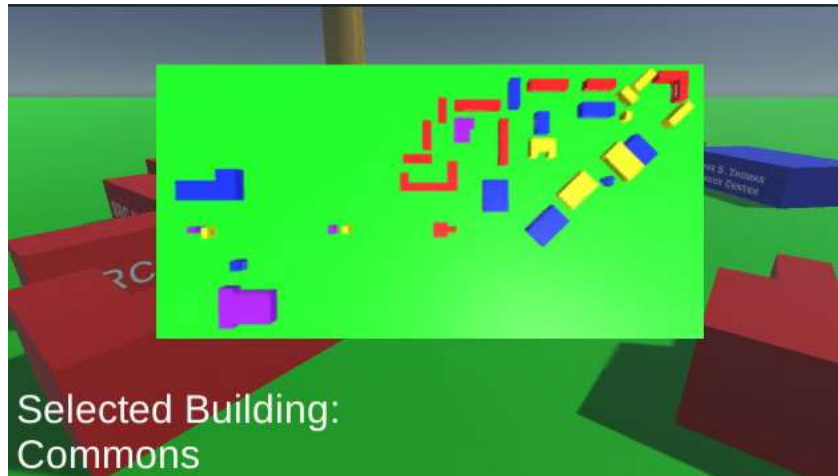


Figure 2. A screenshot of the Claflin 3D map Pause Menu

The finalized controls are the following: The mouse or touchpad enables the user to pan the camera and scan the environment. The WASD or arrow keys enable the user to navigate forward, backward, and strafe left and right. The E key toggles the user's mode, which is either ground mode or flying mode. The B key toggles beacon effects on or off. The P or M key pauses and resumes the program. The user can also click the screen to resume the program while it is paused. While viewing the pause menu, the W and S key enables the beacon to cycle through Claflin's buildings. While in ground mode, the user can press the spacebar to jump. While in flying mode, the user can press the spacebar to fly up or left shift to fly down.

DISCUSSION AND CONCLUSIONS

Wayfinding through a university's campus is an important skill that new and prospective students, faculty, staff, and visitors must use. There are a handful of resources that assist with wayfinding on Claflin University's campus, but they have their own specific areas that can be improved upon. Google Maps has mapped Claflin's buildings, though its images are outdated, and it is impossible to navigate freely between buildings in street view. The Claflin University website contains pictures of buildings along with descriptions of their operations and department, though there are no maps appended to their respective pages. It contains a virtual tour module at <https://www.claflin.edu/admissions-aid>, though it utilizes stationary 360° images and an embedding of Google Maps. It also contains a page with written directions to navigate to Claflin University from surrounding cities and an image of Claflin's within South Carolina at <https://www.claflin.edu/about/location-directions>, though the image caters to aesthetics more than practicality. This study was conducted for the purpose of developing a web application that provides a 3D map of Claflin's campus with wayfinding tools and intuitive computer controls. The target population for this study are new and prospective students, faculty, staff, and visitors. The 3D map of Claflin University was made using Unity Engine and C# coding with Unity Libraries.

Summary of the Findings

The final product is a web application that enables users to freely explore Claflin University's campus with a user-friendly UI, intuitive controls, and a simple layout that is perfect for presentations. Instead of using Google maps to view satellite photos of

Campus, Claflin's virtual tour of static images, or Claflin's location directions webpage that caters to aesthetics, everyone can use the Unity program that is more advanced than the latter. The 3D map accounts for not only a two-dimensional mapping of the buildings, but also the third dimension which allows for accurately simulated wayfinding. Walking, jumping, and flying around buildings makes spatial wayfinding more familiar once the user(s) navigate through Claflin University's campus. Additionally, flight paths for drones, presentations, and other demonstrative media can be produced using 3D maps. Projects, events, and showcases can directly incorporate a 3D recreation of Claflin's campus into their presentations to garner more attention and make information easier to understand visually.

Global Impact of Computing Solution on Individuals, Organizations & Society

This study has produced results that can be accessed online, so its potential impact spans the globe. The closer to Claflin University, the greater the impact, as locals are more likely to visit Claflin than individuals who are across the globe. The impact may be the greatest within Claflin's campus itself, but the impact is also great at other universities and conference centers where one may utilize a 3-dimensional map to display Claflin's campus. Individual users of the 3D map will be able to wayfind Claflin's campus when they want, and where they want. Organizations pertaining to Claflin University, including Claflin itself, will be able to utilize the 3D map for their own operations, including planning, presentations, and showcases.

Recommendations

To enhance the 3D mapping of Claflin using Unity engine, developers can update the scene to include any structures that are constructed, destroyed, or altered. This requires knowledge about how to use Unity, as well as C# programming with Unity libraries. Extra control schemes can be added to the program, enabling user input from multiple sources such as controllers, cell phones, and voice controls. GPS tracking and gyroscope can also be incorporated to control the position of the user in real time using AR technology. The exact dimensions of the structures included in the program are not accurate to reality, as measurements of Claflin's buildings are not publicly available. Upon receiving exact measurements and positions for Claflin's buildings, the program can be scaled to replicate campus precisely and accurately.

Conclusions

This study succeeds in creating an innovative means of wayfinding Claflin's campus virtually. This matters because prospective students, faculty, staff, and visitors can be influenced by the navigability of campus, and displaying how navigable Claflin is virtually important for anyone who is not near Claflin. Additionally, new students, faculty, and staff can navigate Claflin's campus with ease from any location. By using the 3D map, they will be able to spatially navigate through campus without the aid of current Panthers. Existing software and hardware can assist with navigating through Claflin's campus, but not as efficiently as the 3D maps.

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Appendix A: PlayerController Script

```
// THIS IS A DRAFT OF THE FINAL CODE FOR THE PROJECT
using System;
using System.Collections.Generic;
using UnityEngine;
#if UNITY_EDITOR
using UnityEditor;
#endif

public class PlayerController : MonoBehaviour
{
    public static PlayerController Instance { get; protected set; }

    public Camera MainCamera;
    public Transform CameraPosition;

    public GameObject greyTint;
    public GameObject pauseMap;
    public GameObject miniMap;

    private Renderer rendGreyTint;
    private Renderer rendPauseMap;
    private Renderer rendMiniMap;

    [Header("Control Settings")]
    public float MouseSensitivity = 10.0f;
    public float PlayerSpeed = 5.0f;
    public float JumpSpeed = 5.0f;
    public float fly = 0f;
    public float sprint;

    Vector3 pausePos;

    bool flyMode = false;

    float m_VerticalSpeed = 0.0f;
    bool m_IsPaused = false;

    float m_VerticalAngle, m_HorizontalAngle;

    public float Speed { get; private set; } = 0.0f;

    public bool LockControl { get; set; }

    public bool Grounded => m_Grounded;
```

```

CharacterController m_CharacterController;

bool m_Grounded;
float m_GroundedTimer;
float m_SpeedAtJump = 0.0f;

void Awake()
{
    Instance = this;
}

void Start()
{
    rendGreyTint = greyTint.GetComponent<Renderer>();
    rendPauseMap = pauseMap.GetComponent<Renderer>();
    rendMiniMap = miniMap.GetComponent<Renderer>();

    rendGreyTint.enabled = false;
    rendPauseMap.enabled = false;
    rendMiniMap.enabled = true;

    Cursor.lockState = CursorLockMode.Locked;
    Cursor.visible = false;

    m_IsPaused = false;
    m_Grounded = true;

    MainCamera.transform.SetParent(CameraPosition, false);
    MainCamera.transform.localPosition = Vector3.zero;
    MainCamera.transform.localRotation = Quaternion.identity;
    m_CharacterController =
GetComponent<CharacterController>();

    m_VerticalAngle = 0.0f;
    m_HorizontalAngle = transform.localEulerAngles.y;
}

void Update()
{
    bool loosedGrounding = false;

    if (!m_CharacterController.isGrounded)
    {
        if (m_Grounded)
        {
            m_GroundedTimer += Time.deltaTime;
            if (m_GroundedTimer >= 0.5f)
            {

```

```

        loosedGrounding = true;
        m_Grounded = false;
    }
}
else
{
    m_GroundedTimer = 0.0f;
    m_Grounded = true;
}

Speed = 0;
Vector3 move = Vector3.zero;
if (!LockControl)
{
    // Jump
    if (m_Grounded && Input.GetButtonDown("Jump") &&
!flyMode)
    {
        m_VerticalSpeed = JumpSpeed;
        m_Grounded = false;
        loosedGrounding = true;
    }

    // Toggle flight mode
    if (Input.GetKeyDown(KeyCode.E))
    {
        flyMode = !flyMode;
        Debug.Log("Flymode = " + flyMode);
    }

    if (loosedGrounding)
    {
        m_SpeedAtJump = PlayerSpeed;
    }

    // Move around with WASD
    move = new Vector3(Input.GetAxis("Horizontal"), fly,
Input.GetAxisRaw("Vertical"));
    if (move.sqrMagnitude > 1.0f)
        move.Normalize();

    float usedSpeed = m_Grounded ? PlayerSpeed :
m_SpeedAtJump;

    move = move * usedSpeed * Time.deltaTime;

    move = transform.TransformDirection(move);

```

```

        m_CharacterController.Move(move);

        // Turn player camera
        float turnPlayer = Input.GetAxis("Mouse X") *
MouseSensitivity;
        m_HorizontalAngle = m_HorizontalAngle + turnPlayer;

        if (m_HorizontalAngle > 360) m_HorizontalAngle -=
360.0f;
        if (m_HorizontalAngle < 0) m_HorizontalAngle +=
360.0f;

        Vector3 currentAngles = transform.localEulerAngles;
        currentAngles.y = m_HorizontalAngle;
        transform.localEulerAngles = currentAngles;

        // Camera look up/down
        var turnCam = -Input.GetAxis("Mouse Y");
        turnCam = turnCam * MouseSensitivity;
        m_VerticalAngle = Mathf.Clamp(turnCam +
m_VerticalAngle, -89.0f, 89.0f);
        currentAngles =
CameraPosition.transform.localEulerAngles;
        currentAngles.x = m_VerticalAngle;
        CameraPosition.transform.localEulerAngles =
currentAngles;

        Speed = move.magnitude / (PlayerSpeed *
Time.deltaTime);

        // Fly mode
        if (flyMode)
        {
            fly = Input.GetAxis("Fly") * 2;
        }

        // Ground mode
        else
        {
            fly = 0;

            // Fall down / gravity
            m_VerticalSpeed = m_VerticalSpeed - 10.0f *
Time.deltaTime;
            if (m_VerticalSpeed < -10.0f)
                m_VerticalSpeed = -10.0f; // max fall speed
            var verticalMove = new Vector3(0, m_VerticalSpeed
* Time.deltaTime, 0);

```

```

        var flag =
m_CharacterController.Move(verticalMove);
        if ((flag & CollisionFlags.Below) != 0)
            m_VerticalSpeed = 0;
    }
}
else
{
    transform.position = pausePos;
}

// Toggle the game being paused or unpaused
if (Input.GetKeyDown(KeyCode.M) ||
Input.GetKeyDown(KeyCode.P) || (Input.GetKeyDown(KeyCode.Mouse0)
&& Cursor.lockState == CursorLockMode.None))
{
    rendGreyTint.enabled = !rendGreyTint.enabled;
    rendPauseMap.enabled = !rendPauseMap.enabled;
    rendMiniMap.enabled = !rendMiniMap.enabled;
    LockControl = !LockControl;
    Cursor.visible = !Cursor.visible;
    if (Cursor.lockState == CursorLockMode.Locked)
    {
        pausePos = transform.position;
        Cursor.lockState = CursorLockMode.None;
        Debug.Log("Pause");
    }

    else
    {
        Cursor.lockState = CursorLockMode.Locked;
        Debug.Log("Unpause");
    }
}

}

public void DisplayCursor(bool display)
{
    m_IsPaused = display;
    Cursor.lockState = display ? CursorLockMode.None :
CursorLockMode.Locked;
    Cursor.visible = display;
}
}

```


Appendix B: BeaconController Script

```
// THIS IS A DRAFT OF THE FINAL CODE FOR THE PROJECT
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;

public class BeaconController : MonoBehaviour
{
    public GameObject beacon;

    GameObject[] allBuildings;

    public Text buildingNameText;

    private Renderer rendBeacon;

    private int buildingSelector = 0;

    // Start is called before the first frame update
    void Start()
    {
        // Populates an array of GameObjects with the buildings
        // currently in the Hierarchy
        allBuildings =
        GameObject.FindGameObjectsWithTag("Building");

        // Obtains the renderer for the GameObjects
        rendBeacon = beacon.GetComponent<Renderer>();

        buildingNameText.text = "Selected Building:\n" +
        allBuildings[buildingSelector].name;
    }

    // Update is called once per frame
    void Update()
    {
        // TODO, create toggle for beacon by checking for "B"
        // button presses
        if (Input.GetKeyDown(KeyCode.B))
            rendBeacon.enabled = !rendBeacon.enabled;

        // Scrolls the building selector up for the beacon while
        // the program is paused
    }
}
```

```

        if ((Input.GetKeyDown(KeyCode.UpArrow) ||
Input.GetKeyDown(KeyCode.W)) &&
PlayerController.Instance.LockControl)
            MoveBeacon(1);

        // Scrolls the building selector down for the beacon
while the program is paused
        else if ((Input.GetKeyDown(KeyCode.DownArrow) ||
Input.GetKeyDown(KeyCode.S)) &&
PlayerController.Instance.LockControl)
            MoveBeacon(-1);

    }

    // Iterates the building selector, then moves the beacon and
updates the UI text
    void MoveBeacon(int i)
    {
        buildingSelector += i;

        if (buildingSelector > allBuildings.Length - 1)
            buildingSelector = 0;
        else if (buildingSelector < 0)
            buildingSelector = allBuildings.Length - 1;

        rendBeacon.transform.position =
allBuildings[buildingSelector].transform.position;

        buildingNameText.text = "Selected Building:\n" +
allBuildings[buildingSelector].name;
    }
}

```

Appendix C: Conclusion Updates

Conclusion Update V1

Index	What you did	When/Date	Comments
1	Created the Conclusion Update	09-22-23	Version 1
2	Updated the Project Description	09-20-23	Version 3
3	Added buildings and color coating to the project in Unity	09-20-23	
4	Updated the Project Plan	09-20-23	Version 2

Conclusion Update V2

Index	What you did	When/Date	Comments
1	Updated the System Decomposition in the Description Template	09-27-23	Version 4
2	Added a comment at the top of the code to specify that it is a draft	09-28-23	C# code

Conclusion Update V3

Index	What you did	When/Date	Comments
1	Updated the PlayerController script.	10-03-23	Fixed the issue of users being able to fly through buildings (which optimized the code). 204 lines of code.
2	Added the remaining buildings to the scene.	10-03-23	

Conclusion Update V4

Index	What you did	When/Date	Comments
1	Added a test beacon to be implemented in the future.	10-19-23	The beacons will draw attention to specified buildings.

Conclusion Update V5

Index	What you did	When/Date	Comments
1	Began documentation of the project as a Senior Capstone project	10-27-23	Proposal changed from “The Implementation of the Sense of Touch in Virtual Reality”
2	Added notes to the MapController Script for what should be coded Added code to the MapController Script that stores the Buildings as GameObjects	10-31-23	The MapController Script will control the Beacon and User Interface
3	Added a text box to the user interface that will display the currently selected building	11-02-23	

Conclusion Update V6

Index	What you did	When/Date	Comments
1	Added the ability to unpause the game by left clicking on the screen Fixed the Debug logging to report pausing and unpausing properly	11-04-23	Changes made in the PlayerController Script
2	Implemented the ability to activate/deactivate the Beacon GameObject Implemented the ability to move the Beacon GameObject to the currently selected building Implemented the User Interface displaying the currently selected building	11-05-23	Changes made in the MapController Script The text displaying the currently selected building next to be fixed

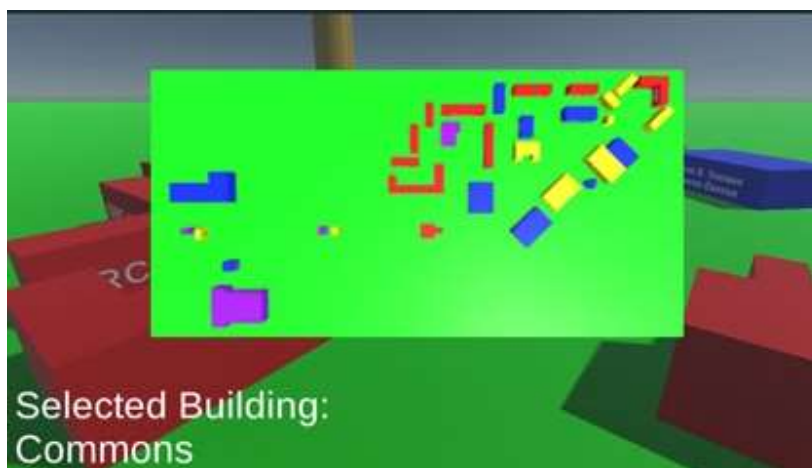
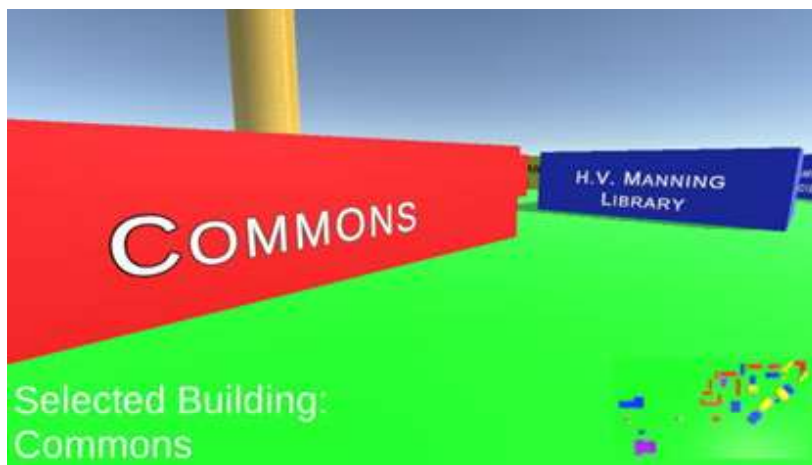
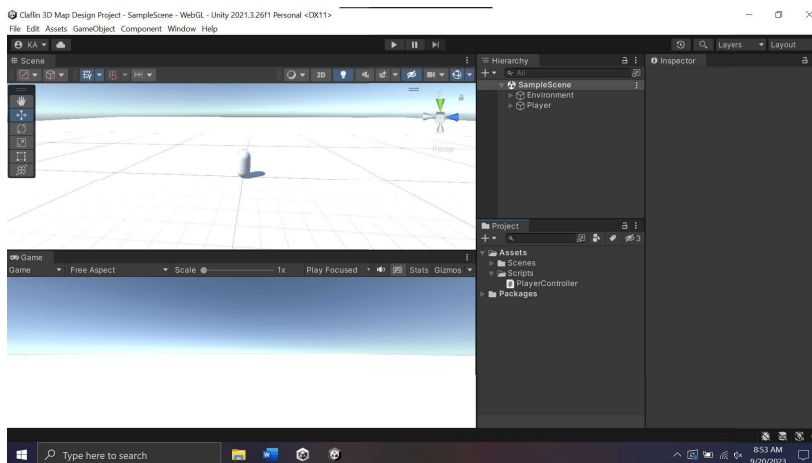
Conclusion Update V7

Index	What you did	When/Date	Comments
1	Released the Beta Test V2 and received user feedback	11-10-23	https://play.unity.com/mg/other/claflin-3d-map-beta-v2

Conclusion Update V8

Index	What you did	When/Date	Comments
1	<p>Added the pause menu and minimap</p> <p>Changed the player's model to be invisible to prevent shadows from being cast</p> <p>Greatly lowered camera sensitivity</p>	11-16-23	Adjusted the PlayerController script (C#, 221 lines of code)
2	<p>Changed the name of the MapController script to BeaconController</p> <p>Changed the name of specific variables in the BeaconController script to specify that it is for the beacon</p>	11-16-23	C#, 63 lines of code
3	Changed the keybind for pausing from ESC to M or P	11-16-23	<p>M for "map", P for "pause"</p> <p>C#, 221 lines of code</p>

Appendix D: Prototype Screenshots



Appendix E: Timeline Chart

Task #	Description	Start Date	End Date
1	Create a Project Design Document for my Claflin 3D Map	08-20-23	08-22-23
2	Create a Project Design Description	08-22-23	08-24-23
3	Create a PowerPoint presentation of the Project Design Document	08-24-23	08-29-23
4	Begin the creation of the Claflin 3D Map Player Controls and consult my group for assistance	08-29-23	09-12-23
5	Upload Beta V1 of the Claflin 3D Map on Unity Play	09-12-23	09-15-23
6	Receive and analyze Beta tester feedback	09-15-23	09-18-23
7	Add primitive structures to represent the main buildings on Claflin's campus	09-18-23	09-26-23
8	Add primitive structures to represent the distant buildings on Claflin's campus	09-26-23	09-29-23
9	Add primitive structures to represent buildings that are separated from the main area of Claflin's campus	09-29-23	10-04-23
10	Add a waypoint system to select and deselect buildings to be highlighted with a beacon effect	10-04-23	10-09-23
11	Upload Beta V2 of the Claflin 3D Map	10-09-23	10-13-23
12	Receive and analyze Beta tester feedback	10-13-23	10-15-23
13	Add a pause menu map that shows an overhead view of the area	10-18-23	10-22-23

14	Modify the pause menu map to show the current position of the user and waypoints	10-22-23	10-27-23
15	Add a minimap to the screen for while the game is not paused	10-27-23	10-31-23
16	Upload Beta V3 of the Claflin 3D Map	10-31-23	11-03-23
17	Receive and analyze Beta tester feedback	11-03-23	11-06-23