**Mapping Claflin University in 3D Using Unity Engine**

**BY**

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**A Proposal Submitted in Partial Fulfillment of the Requirements**

**For the Degree of Bachelor of Computer Engineering in the**

**Department of Mathematics and Computer Science**

**Claflin University**

**Orangeburg, South Carolina**

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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.

**PROBLEM 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-dimentional 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-dimentional 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.

**PROPOSAL SUMMARY**

**DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE**

**Kurt Abraham B.S. CLAFLIN UNIVERSITY, 2024**

**Mapping Claflin University in 3D using Unity Engine**

**Proposal Advisor: Dr. Ramier Sriram**

**Proposal Date: March 12, 2024**

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.

**KEYWORDS AND ABBREVIATIONS**

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

**Abbreviations**

UI – User Interface

AI – Artificial Intelligence

SDK – Software Development Kit

IDE – Integrated Development Environment

GIS – Geographic Information System

HTML – HyperText Markup Language

CSS – Cascading Style Sheets

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**BACKGROUND AND LITERATURE REVIEW**

**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-dimentional 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**

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 Wiconsin-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-dimentional map of Claflin University can be a powerful asset. As technology continues to evolve, so should Claflin University’s campus experience and assets.

**SPECIFIC AIMS**

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.

Aim #1: Create an interactive map of Claflin University’s campus using the Unity Engine.

Aim #2: Analyze prospective students, faculty, staff, and visitors’ feedback on the effectiveness of the interactive map.

**EXPERIMENTAL DESIGN**

**Aim #1:** Create an interactive map of Claflin University’s campus using the Unity Engine.

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 a 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. The ability to pause the program and lock the mouse while the program is unpaused was also added.

A screenshot of the Claflin 3D map


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

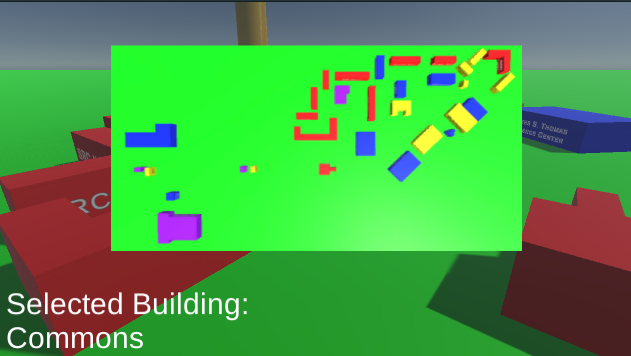


Figure 2. A screenshot of the Claflin 3D map Pause Menu

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.

**Aim #2:** Analyze prospective students, faculty, staff, and visitors’ feedback on the effectiveness of the interactive map.

The study will check for participants’ feedback regarding the user friendliness, accuracy, and quality of the interactive map. The size of the target population is estimated to be two thousand individuals, which consists of 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.

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. After this study is over, all participant names and feedback will be safely discarded to ensure the safety of their information.

**SIGNIFICANCE**

The goal of this proposal is to create an interactive map of Claflin University’s campus using the Unity Engine. This study is imperative because the ease of wayfinding through campus is important for prospective students, faculty, staff, and visitors. This study could potentially reduce the amount of time needed to navigate through Claflin University’s campus and find their desired building.

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**APPENDIX I: 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 II: 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;

}

}