GNG2101

Design Project User and Product Manual

Giving Back Control – Environment Control Using Z-wave

Submitted by:

<GNG2101[Z] – Group Z23>

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
BLE	Bluetooth Low Energy
STL	Stereolithography
DWG	Drawing

1 Introduction

For people with disabilities, there are many seemingly normal daily actions that take considerable effort or are impossible to do. Being able to turn on a fan to cool off, being able to hail an elevator, and being able to turn on and off a light are a few examples among many. This project seeks to tackle a portion of that problem, by allowing any user to use their eyes to control environment devices through the Z-wave protocol using Tobi Eye tracking.

This document overviews the design, usage, configuration, and maintenance of our final prototype for the user. It will go through the process of installing the physical device on a Tobii I-13 device or similar, the process of pairing and unpairing z-wave nodes, the process of controlling z-wave nodes, and finally troubleshooting steps and procedures.

2 Overview

In our everyday lives, there are many processes that we take for granted. However, these processes are often difficult or impossible for those with limited mobility or disabilities to control. Furthermore, given that every disability is different, off the shelf solutions are usually clunky to use, not accessible to the user, and overly expensive. This is the problem that will be attempted to be solved in this project. After careful consideration about the needs of our user, who is quadriplegic and wishes to use his eyes to interact, a problem statement was "A resilient and durable medical grade product is needed that allows a quadriplegic user to control environment devices using the Z-Wave protocol through his I-13 Device using Tobii Eye tracking."

In our project, the user wishes to control various aspects of his immediate environment. To accommodate those with limited mobility, the device can be controlled with only their eyes using Tobii Eye tracking. This project tested with a Tobii Eye Tracker model 4C, however, with minimal modification, other solutions from Tobii or other accessibility companies should be able to be easily incorporated into the system.

Our product is a trailblazer in its segment. As is common in the accessibility industry, there were no other product on the market that we could find that fulfilled the client needs. Our benchmarking therefore focused on investigating methods for fulfilling the requirements. Our final solution consists of a Aotec Z-Stick Gen 5 that communicates with environment devices through the Z-wave protocol. To secure the system to the client's Tobii I-12/I-13 device, an enclosure was designed that houses the Z-wave stick and provides ingress protection against water and dust. Inside the Z-wave grid software, configuration was



2.1 Conventions

- Z-Wave: A low power, mesh network protocol for communicating with devices in ones immediate environment
- (Z-wave) Host: A device that acts as the controller for environment devices. In this project, the Host is the Aotech Z-Stick Gen 5.
- (Z-wave) Node: A device that is being controlled by a host in the z-wave network. In this project, one node is the smart switch. However, many nodes are available on the market, including but not limited to fans, dimmers, stairlifts, elevators, blinds, garage doors and more.

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2.2 Cautions & Warnings

Z-wave Stick Generation: The Aotech Z-Stick Gen 5 only supports z-wave protocol generation 5. It is possible that potential future nodes are not able to communicate with the stick, requiring a swap or alternate host device.

3 Getting started

3.1 Accessing/setting-up the System

The system is set up by powering on the Grid 3 Sofware.

Device configuration details are included later in the document.

3.2 System Organization & Navigation

System navigation can be performed by using a mouse or touchscreen on the I-13 device

3.3 Exiting the System

The system is exited by powering down the Grid 3 Sofware.

4 Using the System

We will be using the Smartbox Grid 3 software to handle everything software related. There are two focal sections in which you will be using the software: the configuration section and the action section. The configuration section is where you will be adding and removing the Z-Wave devices to configure the Z-Wave stick to your liking. The action section is how you will be using the Z-Wave stick to turn the devices you have connected the Z-Wave stick on and off.



4.1 Configuration

Initially, you will begin at the menu where you will see different applications to use to control your Z-Wave devices. For this instance, we will be using the Simple Servus Environment Control under Servus Environment Control. Before we can use that application, we must add the Z-Wave device we want to control. On the top left of the screen, you can click the hamburger menu to open some more options. In this case, we want to click the Settings option. After you click the Settings button, you will see a list of different settings to control on the left. To add a Z-Wave device, you click the Environment Control option and then you should see a screen that has the word Accessories on the top. Above that, you will see the transmitters button. You click the

transmitters button and you will be led to a screen with an empty box. You then must click the Add button, and choose the Z-Wave option. Then you will see a Z-Wave button appear on the screen under Transmitters. You can click the Z-Wave button twice or click on it once and then click the Configure button. Both options will take you to the screen where you will be connecting the devices to the Grid 3 software. You click the Add button, and it should detect the Z-Wave device you want to add to the Grid 3 software.

When you want to change the template of the Simple Servus Environment Control, you click on the hamburger menu on the top left and then click the Edit Grid option. From there you will be able to move the buttons around, delete them, or add more.

4.2 Action

After configuring the Grid 3 software to control the Z-Wave devices you want to control, you will be able to start using the software to control those devices around you. You can start this by going to the Servus Environment Control menu and then selecting Simple Servus Environment Control. You will be led to a screen with the buttons you have edited in the configuration stage. Using the eye tracking software, if you look at a certain button, after a certain amount of time, it should activate the switch, turning the Z-Wave device on or off.

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

In our testing, there were only a few errors that we encountered.

- 1. Z-Stick not detected in Grid 3 software
 - a. Wrong COM Port is selected
 - i. Select a different COM port in the Z-Wave configuration window in grid 3
- 2. Z-Stick not communicating with the node.
 - a. Unplug the Z-Stick and plug it back in
 - b. Restart Grid 3 software

6 **Product Documentation**

6.1 Final Prototype

6.1.1 BOM (Bill of Materials)

Item	Link	Unit Price	Total (incl. Tax)
Aotec Gen 5 Z-Wave Stick	<u>Link</u>	\$59.99+8.99	\$77.95
		Shiping	
USB Right Extension	<u>Link</u>	\$7.99	\$9.12
Double Sided Velcro	<u>Link</u>	\$3.09	\$3.49
PLA Filament: Enclosure (102g)	N/A	\$0.025/g =\$2.55	\$2.55
PLA Filament: Lid (25g)	N/A	\$0.025/g =\$0.63	\$0.63
TPE Filament: Lid Seal(15g)	N/A	\$0.10/g = \$1.50	\$1.50
Self-Tapping Screw x4	N/A	\$0.10 *6 = \$0.60	\$0.60
Cable Management Clips	Link	\$0.20 * 5	\$1.13
		Total:	\$97.17

6.1.2 Equipment list

- Soldering Iron (Used for securing the threaded inserts)
- 3D printer (Ultimater 2+ was used)
- Screwdrivers
- Tobii Eye tracking device
- Device to run Grid 3 software.

6.1.3 Instructions

Instructions for building the prototype can be divided into two sections, the first involves the enclosure and hardware, and the second involves the software and configuration.

6.1.3.1: Enclosure Instructions.



Included in the project filed on makerepo, and in this document are the CAD files for the enclosure. These files are given in the .stl extension for direct 3D printing, as well as the .dwg files if modifications are needed.

These designs were indented to be printed with PLA filament. The intended infill should be greater than 30%. Testing revealed that any fill lower than that would result in bending the lid, which would then fail to make a tight seal against the enclosure.

After the 3D print is complete, it is time to secure the threaded inserts into the holes. If threaded screwed are used instead of the machine screws, this step can be skipped. Insert the tip of the soldering iron into the threaded portion of the insert, and then press the insert into the 3d printed enclosure. The PLA plastic should soften, and the insert will descend into the plastic. After the top of the insert is flush with the top of the side walls, remove the soldering iron and the plastic will solidify, securing the insert.



Then, attach the USB extension cable to the end of the Z-Stick. It is recommended that a knot is tied in the cable on the interior side to relieve potential strain on the cable. Place the USB cable and the Z-stick inside of the enclosure. If there is some wiggle room for the z-wave stick, it is recommended that a bit of Velcro be used to secure it while still allowing for it to be removed.

After the Z-wave is secured, use the 6 M3 screws to secure the lid onto the enclosure. Be sure to tighten the screws so that there is no visible gap present.

Attach the Velcro double sided tape. Indentations may be cut into the Velcro to allow for access to the screw after hand. Peel off the adhesive cover and attach to the device.

Use the included double-sided cable management clips to secure the cable to the Tobii I-12/I-13 device to prevent it from getting snagged.



6.1.3.1: Sofware Configuration Instructions.

- 1. Download Grid 3 software and follow the application instructions to create an account
- 2. Plug the Z-Wave USB stick into your computer
- 3. Go to Menu > Settings > Environment Control> Transmitters
- 4. Click on add and select Z-Wave and Configure
- 5. The transmitter will appear in the port section
- 6. If there isn't a port number displayed then click Detect
- 7. Download the grid set file and upload it to the App by going to Menu>Add grid sets>Grid set file.
- 8. Make sure the Z-Wave device is on
- 9. If your z-wave device is already paired it should show up under the Devices section under the z-wave transmitter page.

- 10. If not you can pair the device by:
 - a. Ensuring your device and z-wave stick are on and ready to pair
 - b. Got to **Menu>Settings>Environmental control** and click on the previously added transmitter
 - c. Click on add under the devices section and select the device
- 11. To test out the device you can click on the device and Transmit Now button.
- 12. With the Z-Wave stick (Aetoec Gen 5), device(binary power switch) and the grid set provided
- 13. To communicate with another device, follow steps 8-11
- 14. Now go to Menu > Setting > Environment Control > Accessories > Add and click on the type of device you would like to add then Next.
- 15. Under Transmitter, select Z-wave
- 16. Under actions you will need to configure the action buttons to a signal
- 17. Copy and paste the Lamp cell and change the icon and name to your new device
- 18. In the next page change the On/Off commands by removing the existing one and clicking on **Add Command**
- 19. Click on the accessory allocated to the new device and the action button you want the command to execute.
- 20. Repeat last step for every action

7 Conclusions and Recommendations for Future Work

In conclusion, this project aims to give back control to certain individuals who may have had that freedom involuntarily taken away from them. Given that this project had quite a narrow scope and straightforward implementation, most of the effort was spent on testing and optimizing the solution.

In the future, several potential improvements to our design could be implemented. Firstly, alternate communication technologies can be investigated, from other mesh-based networks like ZigBee, direct methods like Bluetooth Low Energy (BLE) or Wi-Fi, and finally the server-client model that was suggested by the client. Out of these solutions, we believe that the server-client model yields the most potential. It will allow for one universal server for a facility or building, and all the controllable devices can be added in one pairing process, instead of having to add each device separately. This approach was not explored in our project due to lack of budget and expertise, but we envisioned it to be the ideal solution.

8 Bibliography https://thinksmartbox.com/product/grid-3/

APPENDICES

9 APPENDIX I: Design Files Table 2. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Enclosure_dwg.dwg	Enclosure_dwg.dwg	7/24/2022
Enclsoure_stl.stl	Enclosure_stl.stl	7/24/2022