2017

The GlobeTrotters

PROPOSAL FOR MAGLEV GLOBE ENGINEERS

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Sponsored By:
Morris Cerullo World Evangelism

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I. Introduction

Abstract:

MCWE has requested for a levitating globe that users can interact with to explore and learn about different regions of the world. The user will be able to use non-contact methods, such as gesture and voice commands, to navigate the globe and select areas of interest. Information about the area will be collected through various API sources which will be stored on a local database. The Raspberry Pi will then present the information on an external display while the globe rotates to the location selected by the user.

Project Description:

Levitating interactive globe

The globe will enable the user to provide gesture inputs and make vocal requests for various geographical facts. It will present the user with geographic and statistical data about the various countries and cities of the world upon request while it rotates to the requested country. The globe is designed with a focus on ease of use and accommodating people with disabilities.

Features

- Raspberry Pi 3 and PIC microcontroller powered
- 12-inch acrylic globe surface
- Electromagnetic levitation
- Laser projected azimuthal equidistant maps
- Non-contact IR based gesture inputs with velocity control
- Voice enabled user input and feedback using Amazon Web Services
- QGIS enabled graphical user interface elements
- DSI connected 7-inch 800 x 480 LCD display
- Ultrasonic sensor for user detection and greeting

II. Design

Hardware Block Diagram

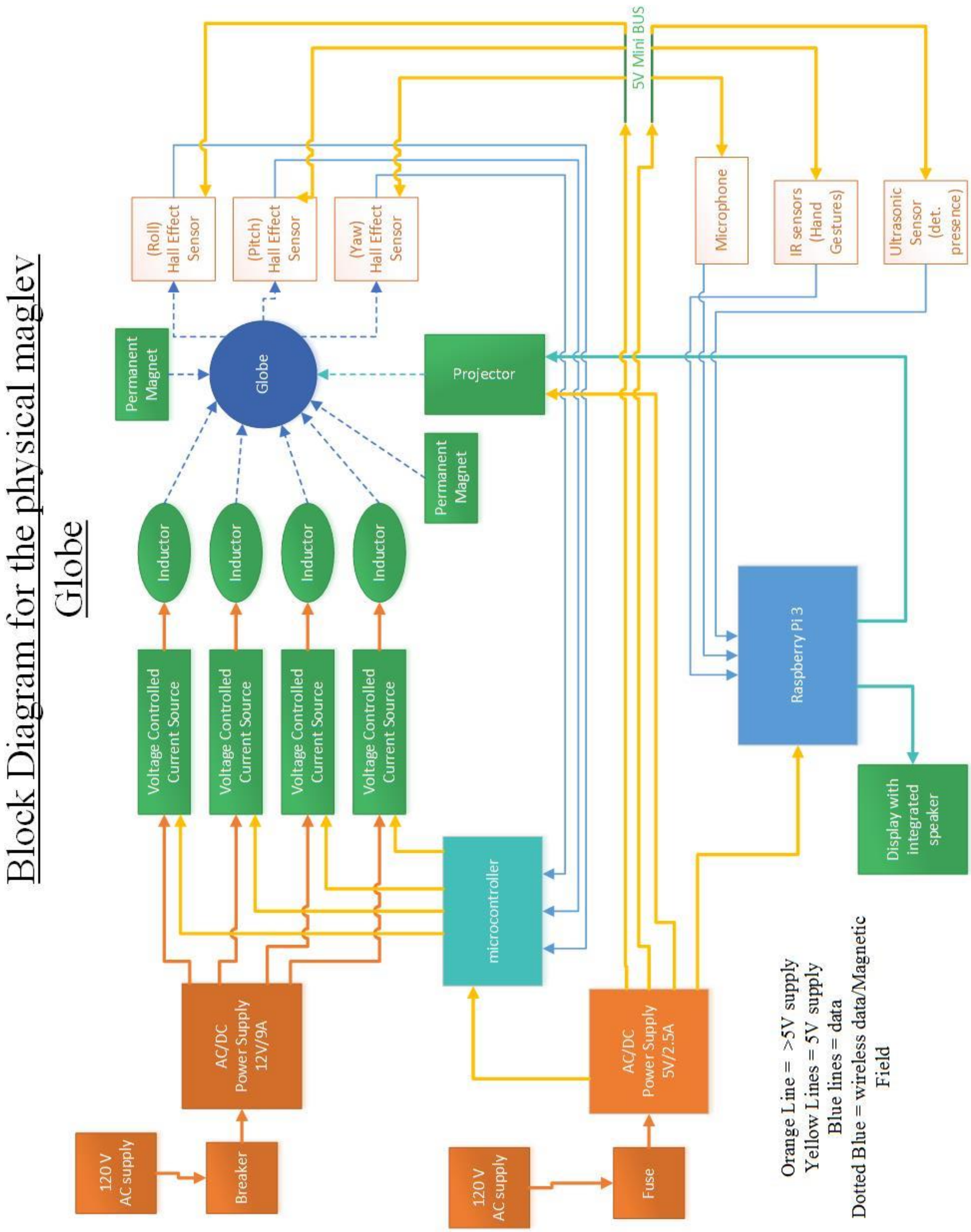


Figure 1 | Top Level Hardware Hierarchy

Software Block Diagram

Software Block Diagram Flow Charts

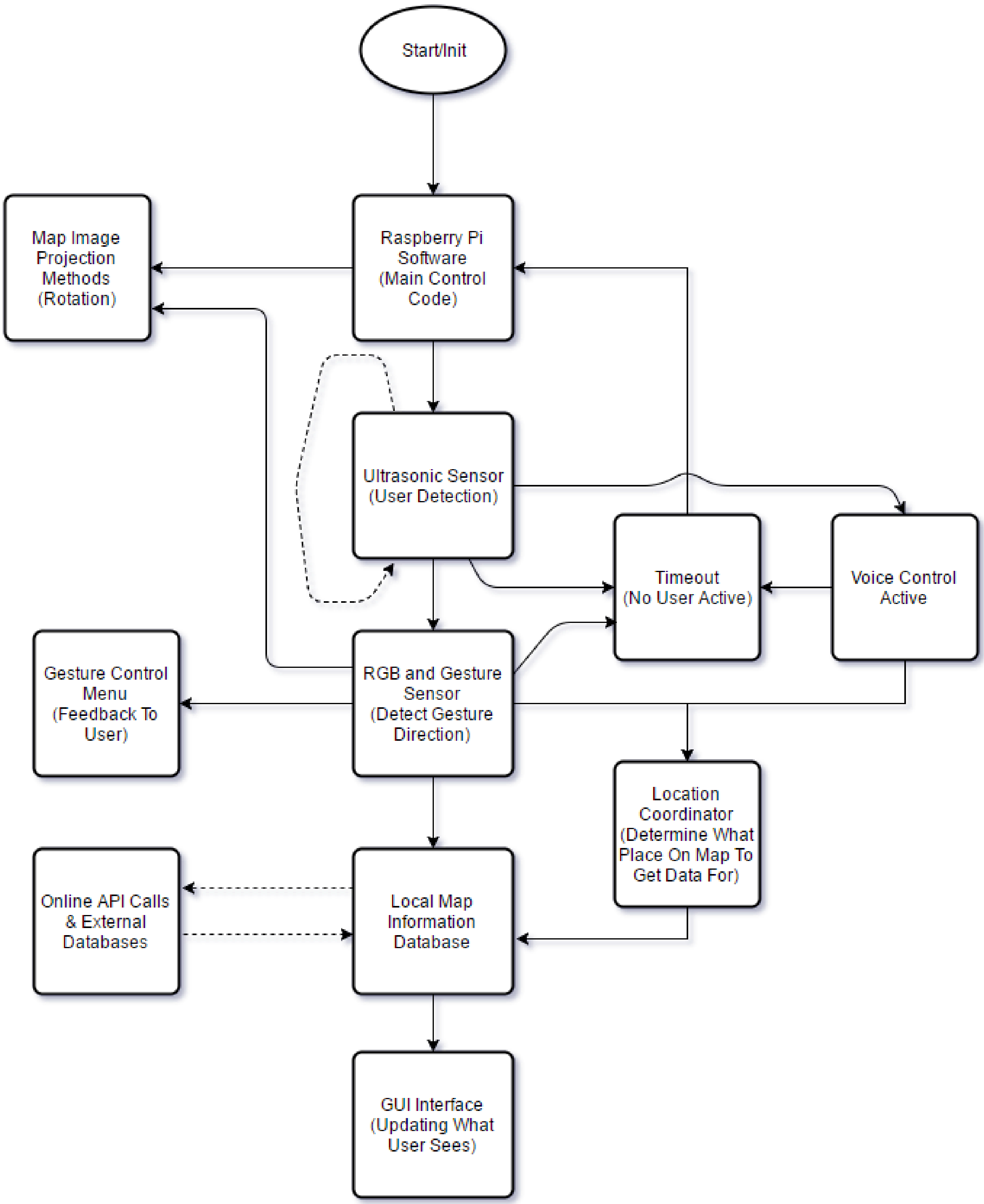


Figure 2 | GUI, Projection, and Map Data Processing View

Levitation Microcontroller

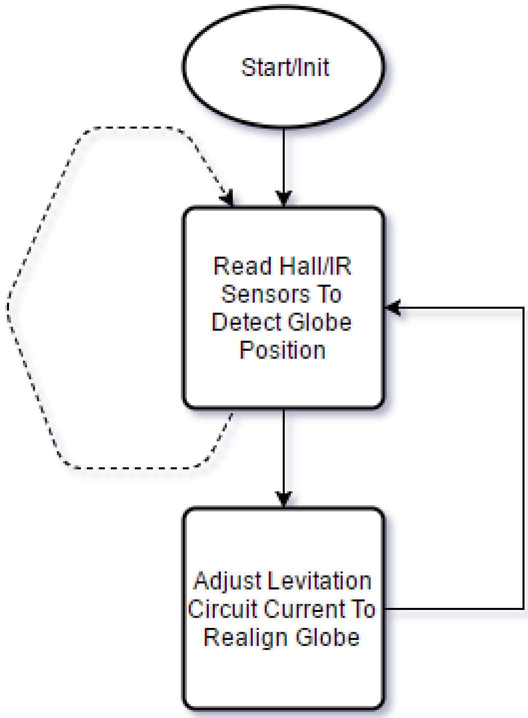


Figure 3 | Top Level Control View

Mock Up Illustrations

Figure 4 | General View

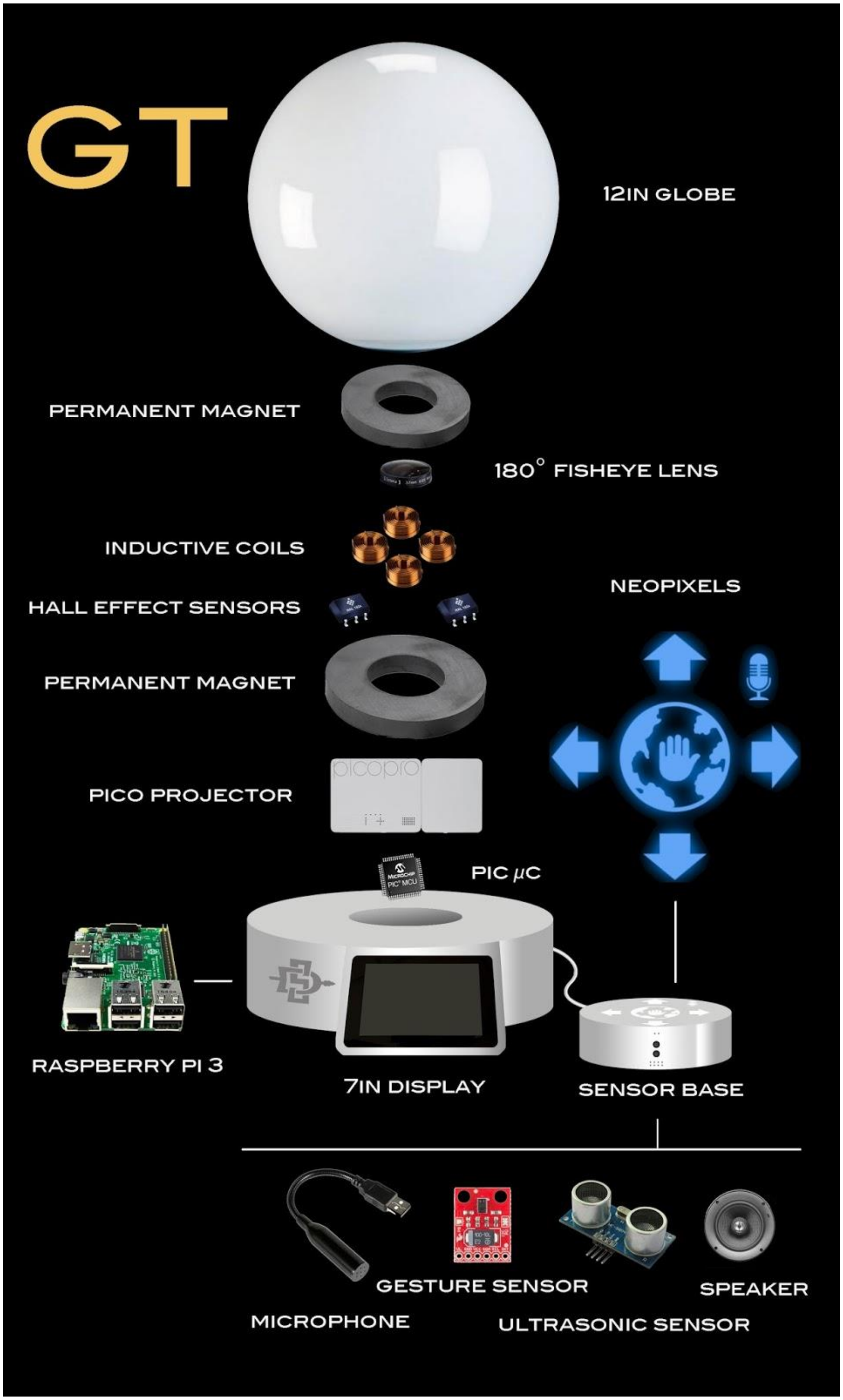


Figure 5 | Drill Down View

Performance Requirements

Hardware

Power Supply

The two Power Supply's for the system will continue to operate continuously provided the line power stays on. The power supply for the electronics will provide a continuous DC supply of 5V/3A. The power supply for the larger maglev system will provide a continuous DC supply of 12V/9A.

Sample Rate

The current and voltage sensors will operate at a sampling rate of 3 kHz. This will allow detection of signals up to the 15th harmonic.

Hall effect sensors

Latching Hall effect sensors will be able to provide feedback into the system with a switching time fall and rise of 1.5 microseconds allowing enough time to correct for disturbances within the system.

APDS-9960 Digital Proximity, Ambient Light, RGB and Gesture Sensor

UV and IR blocking filters - Programmable gain and integration time - Very high sensitivity – Ideally suited for operation behind dark glass

Microphone

The microphone will be able to pick up speech about 10 feet away from the sensor. The holding time for the sensor is 30ms.

Magnasonic PP71 Mini Portable Pico Video Projector

Will provide an adequate projection onto the acrylic globe.

Raspberry Pi 3

Provide adequate timing for proper response to I/O ports, and other function. See raspberry pi 3 datasheets from manufacturer.

PIC16(L)F18325/18345

Provide adequate timing for proper response to I/O ports, and other function. See datasheets from manufacturer for more detail.

Software

- Requests to APIs will timeout in the range of 3 - 5 seconds
- Parsed JSON response will be stored in MySQL database within 7 - 8 units of time after the response is received
- Globe will respond to user interaction and display location-specific information under 5 seconds
- Software applications will be multithreaded in Python

III. Testing and Verification

Testing Procedures

Levitating test
Due to the use of Hall effect sensors, we will demonstrate the globe's magnetic levitation by simply having a ring magnet for the levitating portion of the system as well as a larger ring magnet for the base part of the system. We will expose the globe to different scenarios, for example weight increase/decrease and maldistribution. We will also test for other disturbances to the system due to human interaction, and forces due to the environment— to analyze the stability of the levitation and how well the mechanism corrects itself under disorder.

Voice test
The second test is to show the globe moving to a specific location based only on voice commands. Changing between three places will complete the test. For example, when someone says "Go to USA", the globe will rotate to the United States of America, once the globe has stopped rotating we will provide another command and repeat the same process for different geographic locations. As we expand the registry of voice commands, an adequate test will be incorporated for every new command.

Sensor test
This test will be similar to voice commands, but instead focusing on gesture controls. Our tests will measure the globe's reaction to our gesture controls in different settings, such as varying the amount of light in the room, and proximity to the sensors. We will observe how well the sensor inputs integrate into the project, and what the response time will be.

Display test
The display must show the information of the location that is being projected on the globe (min. of 2 second stop time to display image to prevent display from looking like it is glitching out from passing so many countries at once).

Rotating test
The projection for the globe is implemented using an interactive graphics library. For this reason, our tests must measure the frame rate of the projection under heavy use of the Raspberry Pi's processor. The goal is to optimize the algorithms so that the globe's rotation looks as smooth and natural as possible. As a constraint, the globe must continue to rotate while it is idle. By introducing this constraint, we are making the projection a finite-state machine, so we will incorporate adequate testing techniques to ensure that the timing and response of the program work well.

Benchmarks

Software Benchmarks

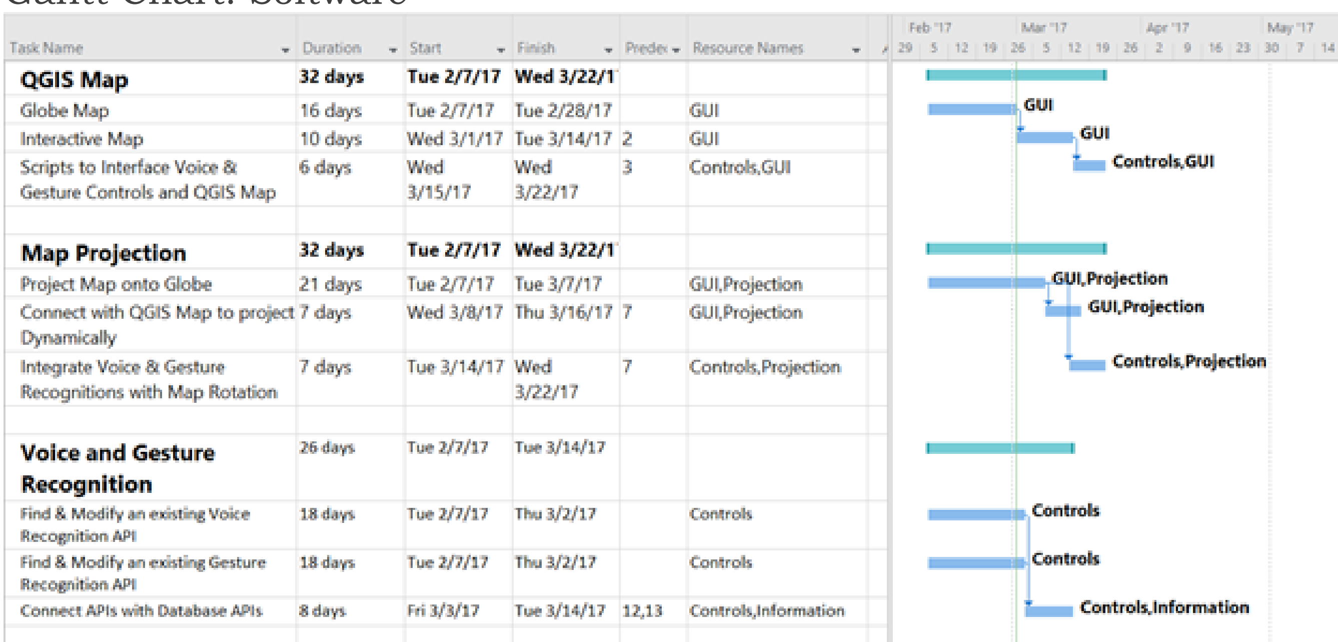
- The projected images of the map will transition to give the appearance of rotation
- The globe will allow non-contact commands to rotate to a specified area
- The globe will present location-specific information on a GUI
- The globe will have Wi-Fi connectivity and be able to retrieve information from the internet
- The globe will continuously rotate when idle and no user is detected

Hardware Benchmarks

- Stability achieved by using the hall effect sensors for feedback
- Voltage controlled Current Sources will respond fast enough to support feedback.
- Microcontroller I/O timing achieved fast enough for minimum power consumption
- The physical globe will levitate via the maglev system.

IV. Program Management

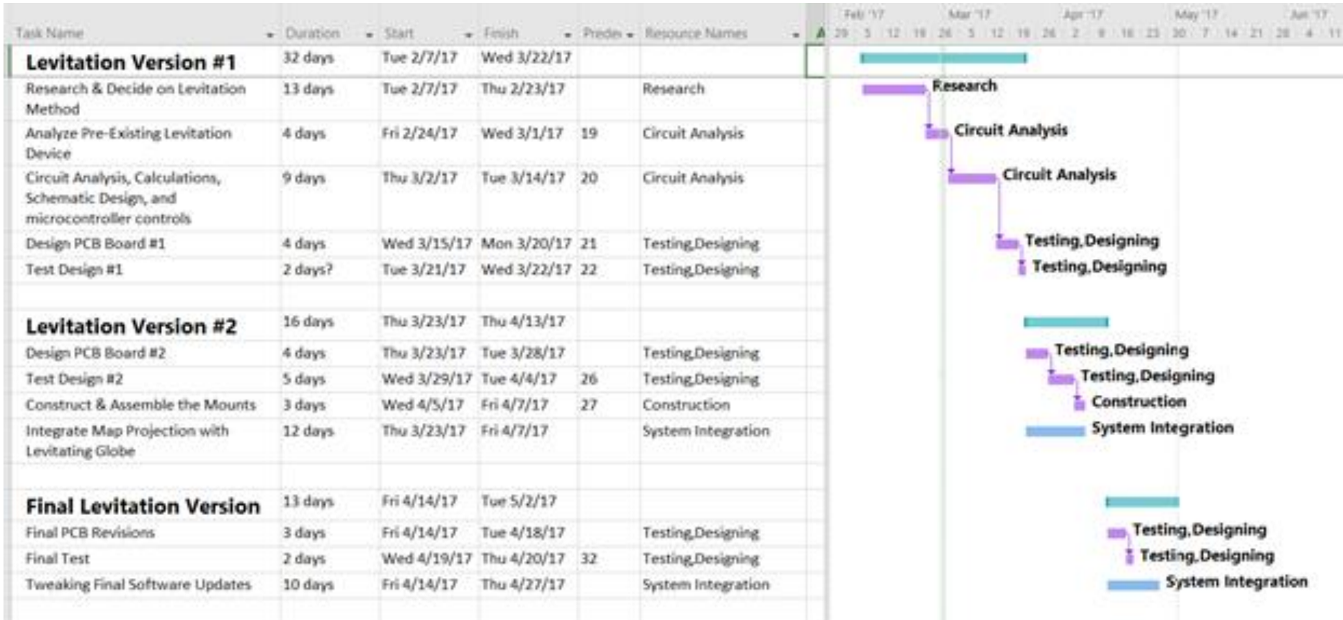
Gantt Chart: Software



Task Name	Duration	Start	Finish	Predecessors	Resource Names
QGIS Map	**32 days**	**Tue 2/7/17**	**Wed 3/22/1**		
Globe Map	16 days	Tue 2/7/17	Tue 2/28/17		GUI
Interactive Map	10 days	Wed 3/1/17	Tue 3/14/17	2	GUI
Scripts to Interface Voice & Gesture Controls and QGIS Map	6 days	Wed 3/15/17	Wed 3/22/17	3	Controls,GUI
Map Projection	**32 days**	**Tue 2/7/17**	**Wed 3/22/1**		
Project Map onto Globe	21 days	Tue 2/7/17	Tue 3/7/17		GUI,Projection
Connect with QGIS Map to project Dynamically	7 days	Wed 3/8/17	Thu 3/16/17	7	GUI,Projection
Integrate Voice & Gesture Recognitions with Map Rotation	7 days	Tue 3/14/17	Wed 3/22/17	7	Controls,Projection
Voice and Gesture Recognition	26 days	Tue 2/7/17	Tue 3/14/17		
Find & Modify an existing Voice Recognition API	18 days	Tue 2/7/17	Thu 3/2/17		Controls
Find & Modify an existing Gesture Recognition API	18 days	Tue 2/7/17	Thu 3/2/17		Controls
Connect APIs with Database APIs	8 days	Fri 3/3/17	Tue 3/14/17	12,13	Controls,Information

Figure 6 | Software Tasks

Gantt Chart: Hardware



Task Name	Duration	Start	Finish	Predecessors	Resource Names
Levitation Version #1	32 days	Tue 2/7/17	Wed 3/22/17		
Research & Decide on Levitation Method	13 days	Tue 2/7/17	Thu 2/23/17		Research
Analyze Pre-Existing Levitation Device	4 days	Fri 2/24/17	Wed 3/1/17	19	Circuit Analysis
Circuit Analysis, Calculations, Schematic Design, and microcontroller controls	9 days	Thu 3/2/17	Tue 3/14/17	20	Circuit Analysis
Design PCB Board #1	4 days	Wed 3/15/17	Mon 3/20/17	21	Testing,Designing
Test Design #1	2 days?	Tue 3/21/17	Wed 3/22/17	22	Testing,Designing
Levitation Version #2	16 days	Thu 3/23/17	Thu 4/13/17		
Design PCB Board #2	4 days	Thu 3/23/17	Tue 3/28/17		Testing,Designing
Test Design #2	5 days	Wed 3/29/17	Tue 4/4/17	26	Testing,Designing
Construct & Assemble the Mounts	3 days	Wed 4/5/17	Fri 4/7/17	27	Construction
Integrate Map Projection with Levitating Globe	12 days	Thu 3/23/17	Fri 4/7/17		System Integration
Final Levitation Version	13 days	Fri 4/14/17	Tue 5/2/17		
Final PCB Revisions	3 days	Fri 4/14/17	Tue 4/18/17		Testing,Designing
Final Test	2 days	Wed 4/19/17	Thu 4/20/17	32	Testing,Designing
Tweaking Final Software Updates	10 days	Fri 4/14/17	Thu 4/27/17		System Integration

Figure 7 | Hardware Tasks

Milestones

Task	Date	Requirements
Software Individually Complete	Fri 3/17/17	Complete the QGIS Maps (both for the Globe & Monitor), Control Systems, and Projection Separately
Software Integration at 50%	Wed 3/22/17	Able to control the QGIS Maps with Gesture and Voice Recognition Controls
Software Integration at 100%	Thu 4/13/17	Able to Project the QGIS Maps onto the Globe and able to control it with Gesture and Voice Recognition
Levitate an Object	Fri 3/24/17	Able to Levitate any small object
Levitate the Globe	Fri 4/7/17	Able to Levitate the weight of the Globe with the additional add-ons (lens & magnets)
Levitate the Projected Globe	Fri 4/28/17	Able to levitate the projected Globe and control it through voice and gesture controls

Figure 8 | Milestone Deadlines

V. Budget

Cost Analysis

Area	Amount
Research	$150
Sensors	$200
Magnets	$100
Microcontrollers/Raspberry Pi	$250
Projecting	$300
Physical Appearance	$85
Base Materials	$365
Miscellaneous	$50
Total	$1500

Figure 9| Budget Breakdown

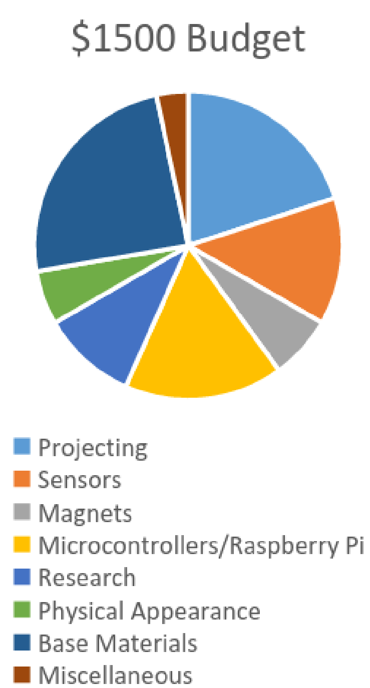


Figure 10| PI Chart Budget Breakdown

VI. Promo Flyer

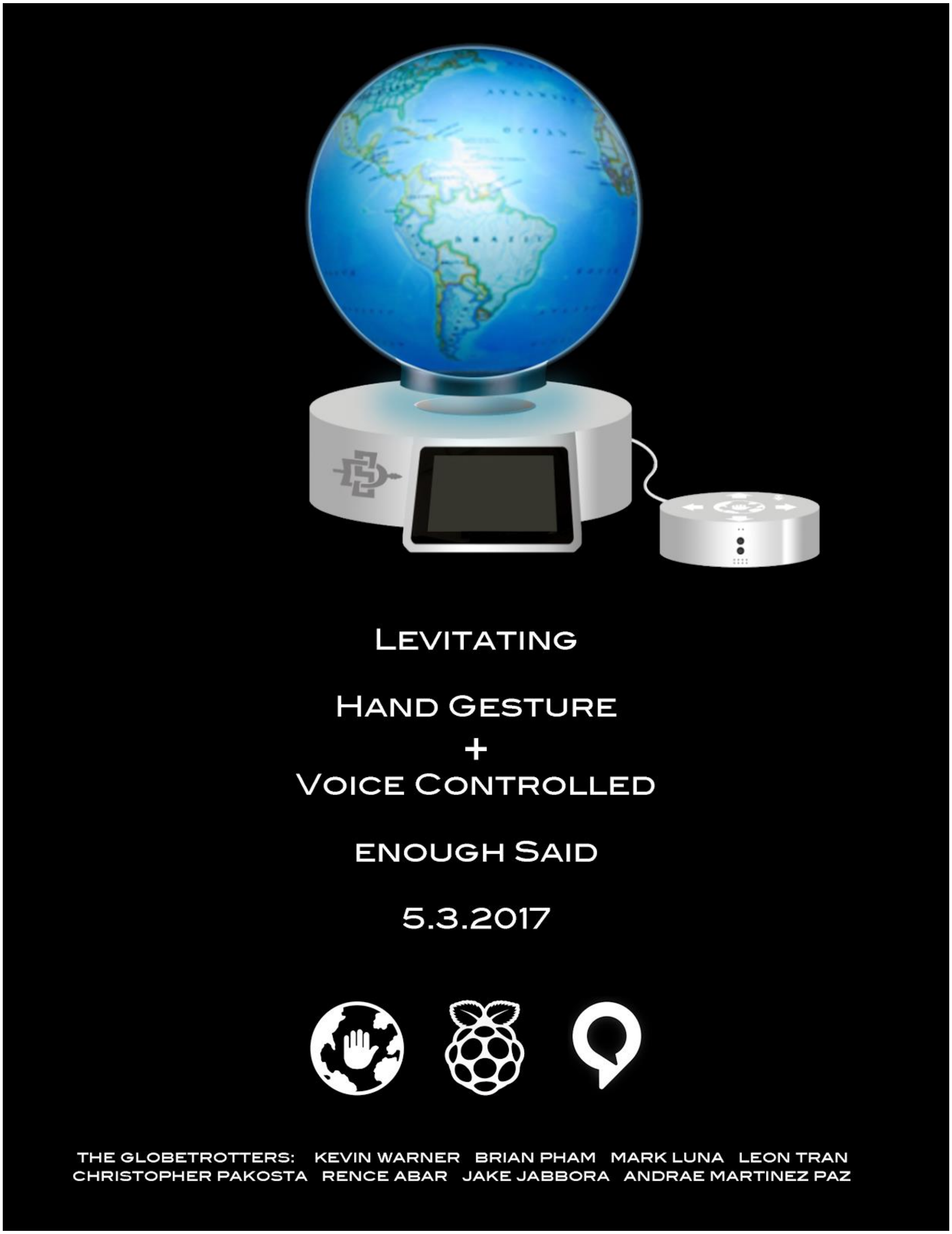


Figure 10| Flyer