3D Dynamic Geo-Display Device

Team ID: 2016443

Speakers:

Jingfu Wang
Hao Wu
Jieming Lu

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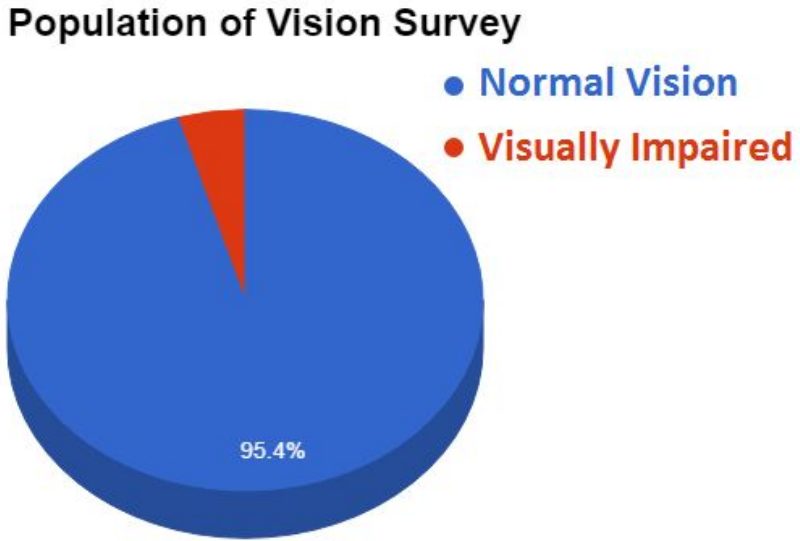
Problem

285 million people are estimated to be visually impaired worldwide:

39 million are blind and 246 million have low vision



Education

About **90%** of the world's visually impaired live in low-income settings.

Motivation

It is **difficult** for visually impaired people to learn geography

Learning geography is **important** for students with impaired sights

- Spatial recognition abilities
- Abilities to gather information about their environment

Reference

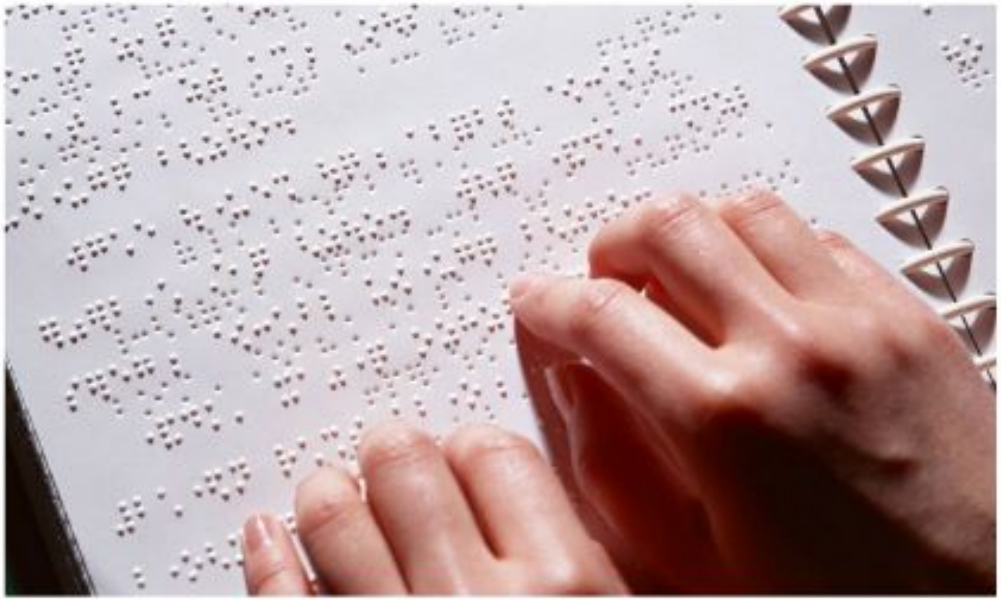
“Models are recommended or even essential during learning activities for the visually impaired, especially when the subjects are natural phenomena that are too large to grasp”

- ICEVI (International Council for Education of people with Visual Impairment)

Background

Current Market

- Tactile books (Low Literacy)
- Talking books
- Carved terrain model



Tactile Books

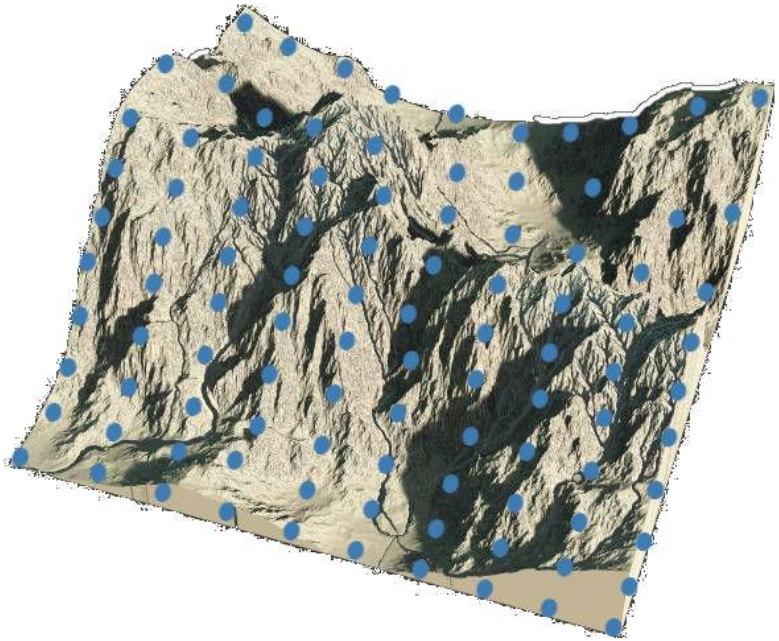
Project Goal

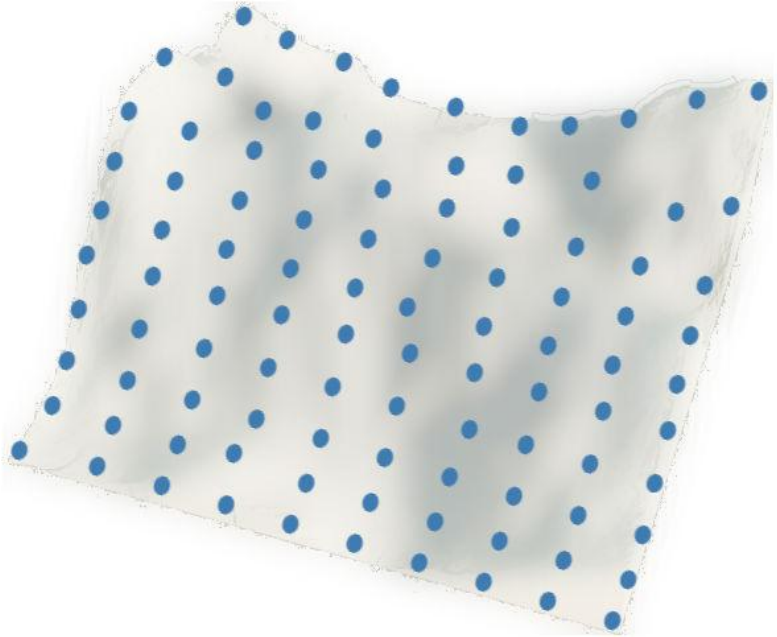
Given the elevation data of an area, our system shall dynamically create a physical 3D model representing the terrain of this area.

Project Requirements - Function

1. Interactive map GUI as front-end, allows area selection (1 lat × 1 lon)
2. During runtime, load raw terrain data from authoritative online sources (MGDS - Marine Geoscience Data System)
3. Uniformly sample a 10 × 10 matrix of elevations of an area, and proportionally display these elevations with the hardware component

Project Requirements - Function Cont’d





Project Requirements - Constraint

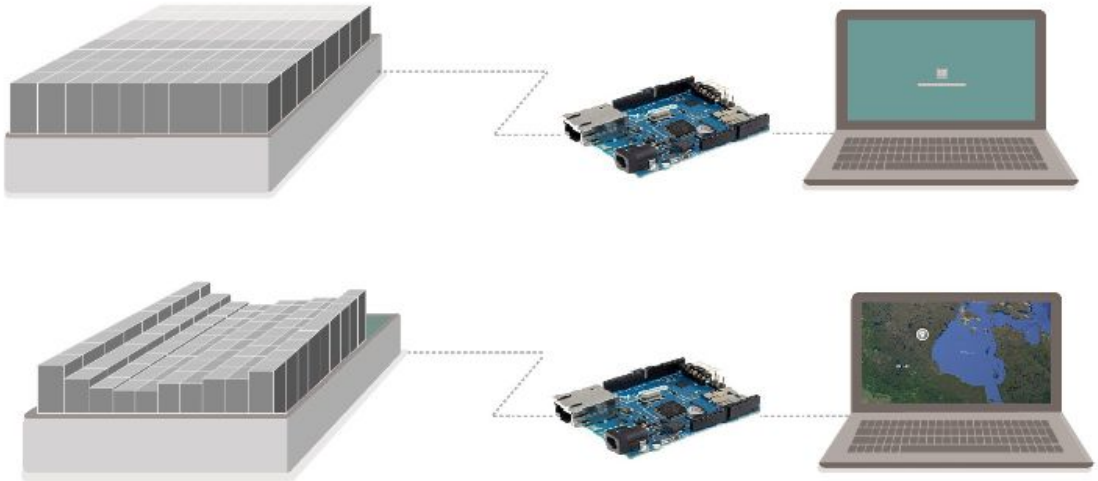
- The maximum size of 3D model system is 50cm x 50cm x 20cm
- The maximum total material cost of 3D model system is $650

Project Requirements - Objective

- Increase range of heights that the display can reach (Better accuracy)
- Increase model resolution/display more data points
- Generate new 3D terrain model completely within 2 minutes
- The map GUI should implement the pan and zoom functionality
- Implement a search functionality at front-end

System Overview

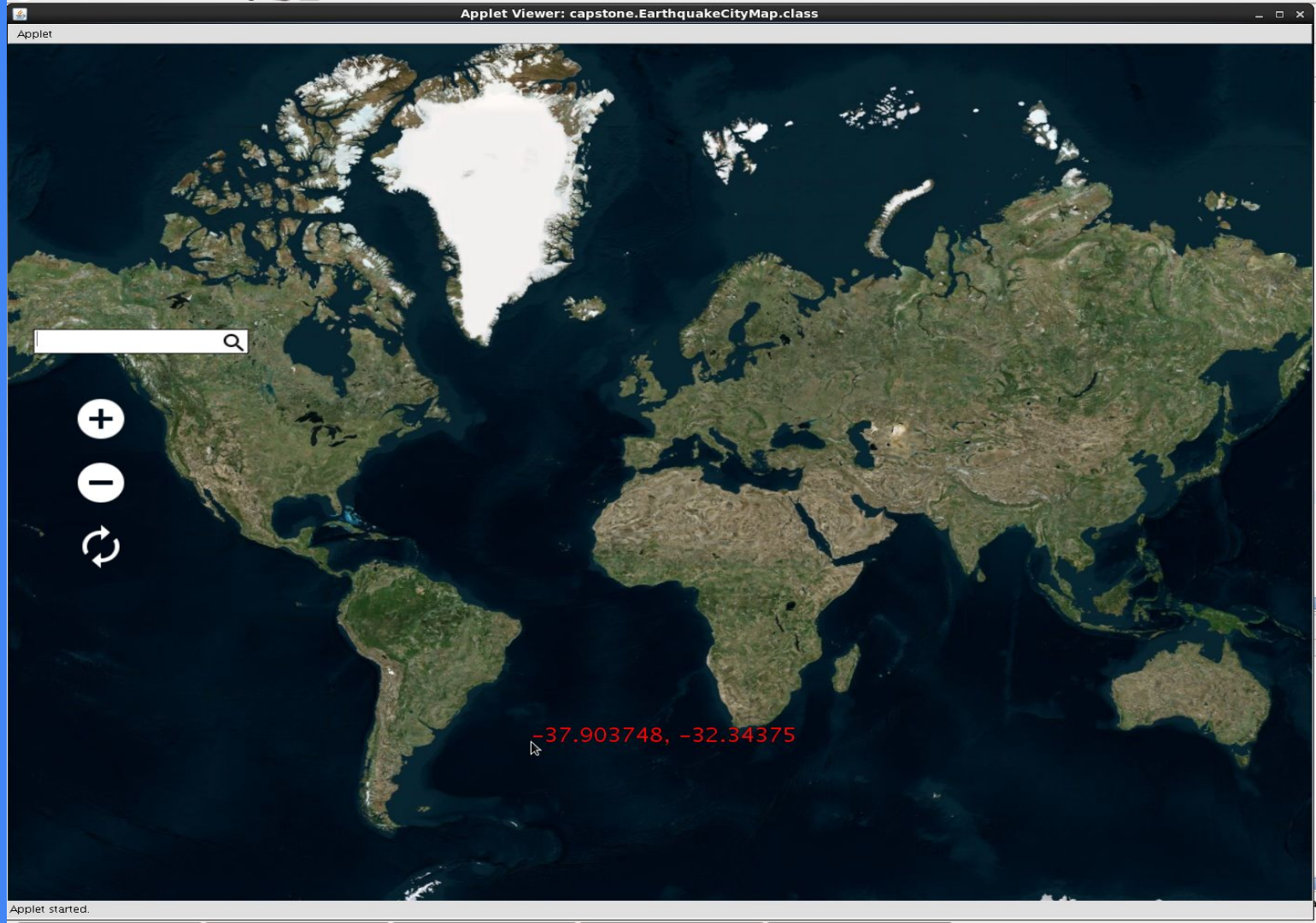
- Software
  - User Interface
  - Data gathering from GMRT Tool of MGDS
  - Data Processing
- Control
  - Arduino Mega 2560
- Hardware
  - Shift Registers
  - L293D H-Bridge Chips
  - Matrix of Extensible Pillars/Stepper Motors



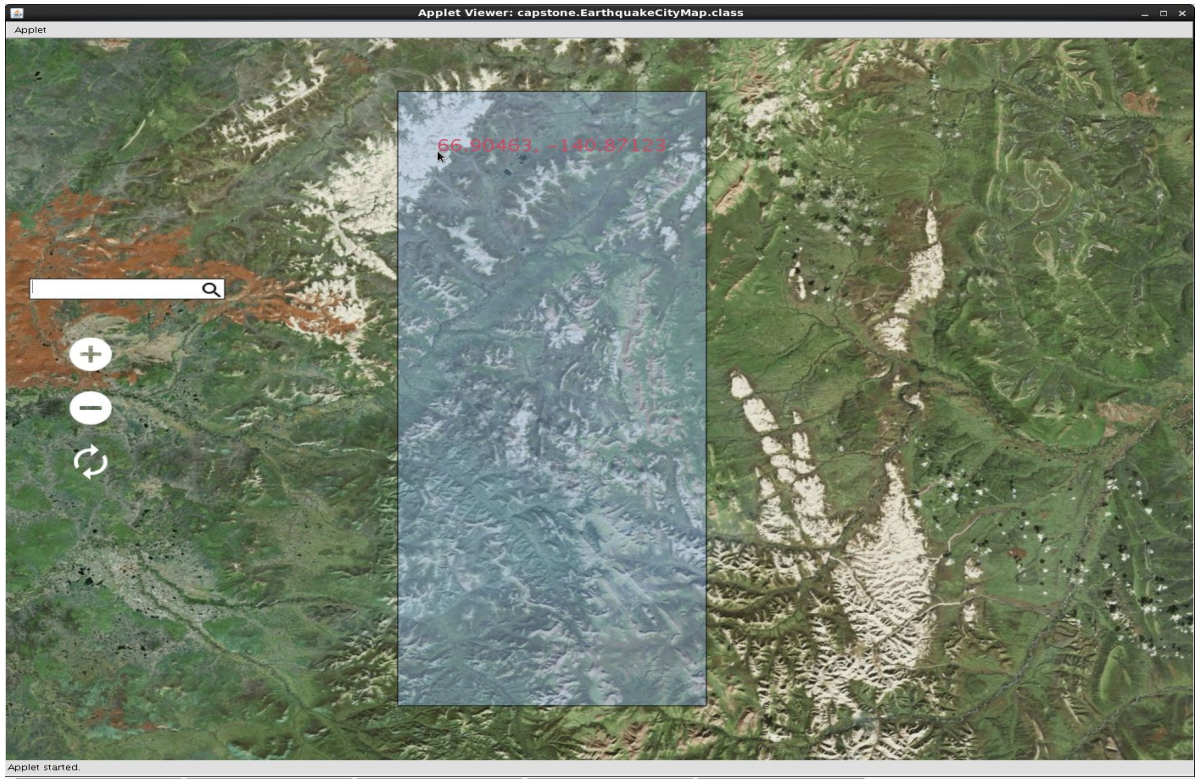
Frontend

Standard zoom/pan map

Shows latitude/longitude under cursor



Select an Area to Display on Frontend



Data Processing on Frontend

```
457 columns of data
454 rows of data
Time elapse: 1 sec
Elevation Matrix
365.0 244.05 244.0288 251.3733 308.1971 237.67252 215.82358 203.59975 187.46178 115.19346
295.79257 259.07364 213.0 189.1832 197.23021 153.32808 184.30383 152.0 106.07362 75.0
273.99432 236.01959 197.0 166.99721 120.98895 166.99998 134.98317 75.0 75.0 75.0
251.42456 201.04811 181.88908 130.58806 91.0 75.0 75.0 75.0 75.0 75.0
204.41711 182.0 166.92607 75.0 75.0 75.0 75.0 75.0 75.0 75.0
266.35233 136.31949 90.78914 75.0 75.0 75.0 75.0 75.0 75.0 75.0
186.97098 75.0 75.0 75.0 75.0 75.0 75.0 75.0 75.0 75.0
220.04446 103.06694 87.03384 75.0 75.0 75.0 75.0 78.011604 90.0 95.0
208.2769 210.60927 197.0 196.0 192.0 182.0 118.700516 179.96799 194.15985 180.0
183.28258 193.0 182.0 181.0 174.67567 182.0 190.31583 180.32433 176.0 175.5361
Matrix of Steps
25000 14573 14571 15204 20103 14023 12139 11086 9694 3464
19033 15868 11896 9843 10537 6752 9422 6637 2678 0
17154 13880 10517 7930 3964 7931 5170 0 0 0
15209 10866 9214 4792 1379 0 0 0 0 0
11156 9224 7924 0 0 0 0 0 0 0
16495 5286 1361 0 0 0 0 0 0 0
9652 0 0 0 0 0 0 0 0 0
12503 2419 1037 0 0 0 0 259 1293 1724
11489 11690 10517 10431 10086 9224 3767 9048 10272 9051
9334 10172 9224 9137 8592 9224 9941 9079 8706 8666
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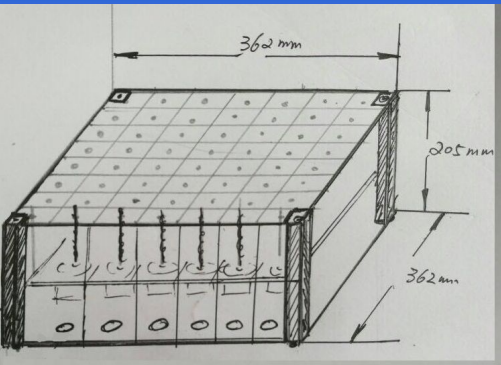
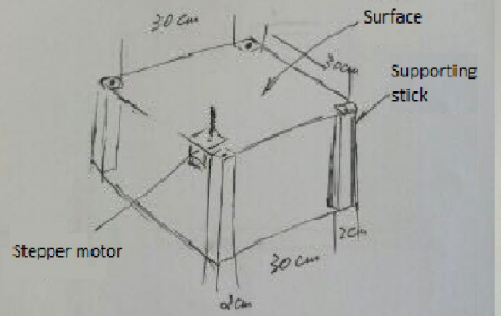
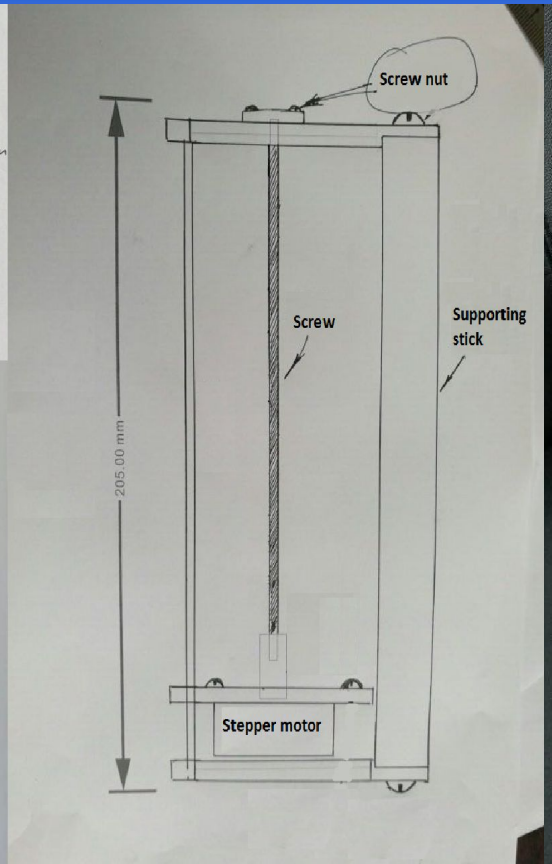
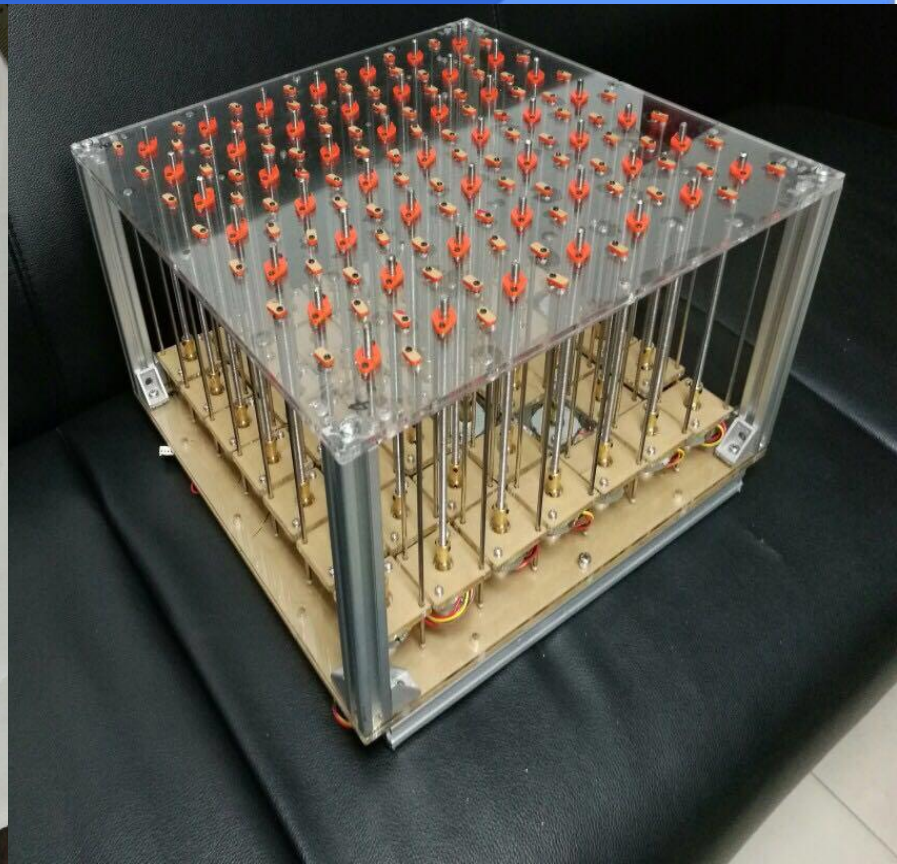
Hardware Display









Final Display

Conclusion

The importance of education for visually impaired students can not be overlooked. Our system adds immense value in helping visually impaired students overcome their difficulty in learning geography.

Reference

[1] International Council for Education of People With Visual Impairment, *“Geography In a Different Way”*, Accessed on Oct 16, 2016, [online] Available: http://icevi.org/publications/ICEVI-WC2002/papers/11-topic/11-brvar.htm

[2] Visual impairment and blindness, *World Health Organization*, Accessed on Jan 18, 2017, [online] Available: http://www.who.int/mediacentre/factsheets/fs282/en/