Report on "Periscope booth" project
Study group: International Design Project 2016: Team A

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Introduction

The idea of out project was to develop a strong connection of two universities through adding a device, which allows people from each university take a look at what happens in another university. Thus, the concept of a land periscope was born. At first, it also allowed two-sided audio connection and functions of weather station but those functions were rejected due to difficulty of the project. So, the basic parts of the project were (for one city):

Booth

Ip-camera (made of web-cam and Raspberry Pi)

Feedback devise (Periscope itself with sensor to register its position and rotating platform for camera on the other side)
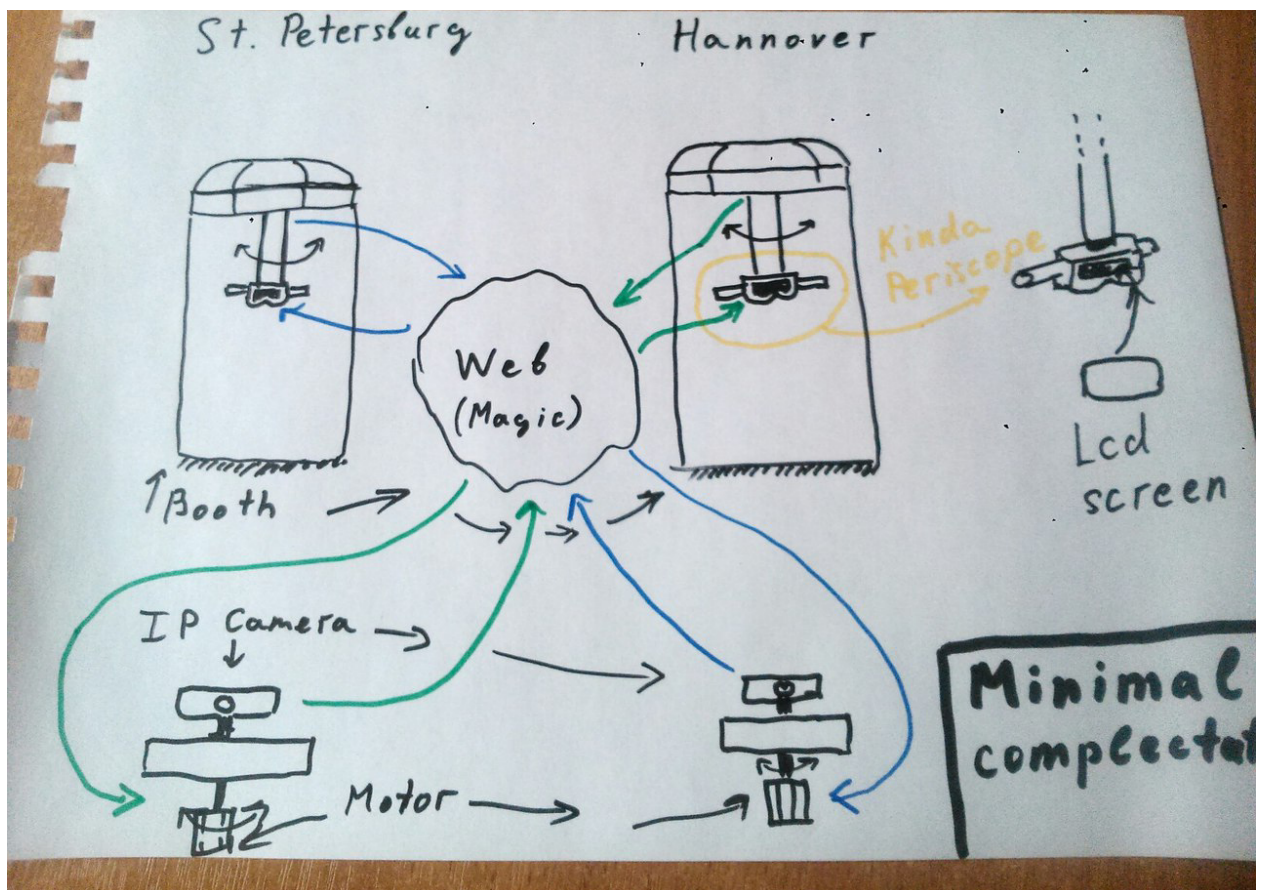
Output device (LCD-Display)

Fig 1. Concept sketch

Project development

Before we started making drawings and 3D-models we've done a brainstorm session on which we made sketches of different nodes of our device and then

passed them around to find mistakes and improve ideas of each other. In the end of the first day we got plenty of edited sketches and formed a plan of project realization.

Mechanical design

To make 3D-models which would be used for making parts we used SolidWorks and Autodesk Inventor. For making 2D-drawing we used CorelDraw. The parts were designed in such a way so they'd be easily machined on CNC milling machines and laser cutters of Fab Lab Polytech. Tasks were separated between members of the team so everyone would be involved.
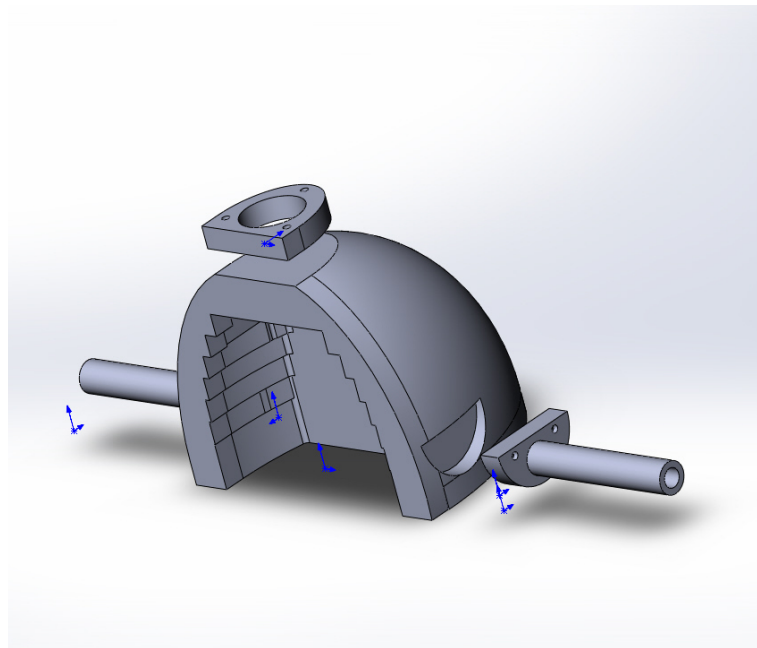

Fig 2. Assembly of periscope helmet made in SolidWorks

After first attempt of making booth and periscope in Russia some changes were made: first of all, wooden booth was changed to booth made of structural profile so the construction would look more modern and also this kind of construction is firmer; wooden mount of periscope which was also booth's celling was reduced in size because it was very heavy; helmet's construction was also changed because it was heavy and fragile (Russian version was cracked by young visitors in Fab Lab).

Electronic design.

We planned to make a pair of devices to stream and translate motion commands from one device to another, which are located in different cities. To achieve our goals we used two single-board computers Raspberry Pi, two potentiometers, two webcams and two servo motors. Each device has one Raspberry Pi with running program that can:

Read the rotation angle from potentiometer and somehow send it to another device

Read video data from webcam and send it to another device

Rotate angle motor as the received rotation angle changes

In addition, we realized that we couldn't use Raspberry Pi for video playback because if it has display on, board became unable to work with potentiometer and angle motor due to board pins shortage. That is why the final idea was to use any third-party device like smartphone which is necessary to plug in the periscope to play video. All in all, electronic part of our project splitted into four parts:

Making an internet server for data exchange between Raspberry Pi'es;

Making a program for Raspberry Pi, which reading video data from webcam and sends it to server;

Making a program for Raspberry Pi, which reads data from potentiometer and sends it to server;

Making a program for Raspberry Pi, which gets rotation angle from server and rotates motor as received angle changes.

The sad thing is that we totally failed to create any kind of server for exchanging data, so we had no working device to the end of a project. However, we learned a lot when we were working with the rest parts.

To make the second part possible we had to use already developed closed-circuit television software for Linux named "motion". We succeeded in applying it to Raspberry Pi, but we had no internet server working, that is why was able to stream only to the local network. For the same reason we decided to make a single device which will rotate his own camera when the resistance value of potentiometer changes. So we had potentiometer and angle motor both connected to the same Raspberry Pi. We developed a program that gets potentiometer resistance value in real-time (from 0 to 1023) and contains an algorithm that rotates angle motor. Unfortunately, we had bad quality motors. That is why the rotation was not perfect in terms of smoothness.

Production and assembly

Due to lack of milling machines and laser cutters in Hannover we had to use them in Fab Lab Polytech, assemble the first version in Russia and then, after learning what mistakes we have done and fixing them, make parts for the second version and bring it to Germany.

These are the machines that we used for making our project:

Flexicam – large milling machine that can mill plastics and plywood and has 1.5x2 m of working space;

K2 – smaller cnc milling machine which also is able to mill plastics and plywood but has a smaller working space (0.5x0.7 m);

Stepdir – large laser cutter to cut plastics and plywood with 1.5x2 m of working space;

Epilogue laser cutter with working space of 0.3x0.6 m with better quality of engraving than Stepdir.

To make programs for milling machine we used ArtCam program and laser cutters accept files directly from CorelDraw without generating g-codes for them.

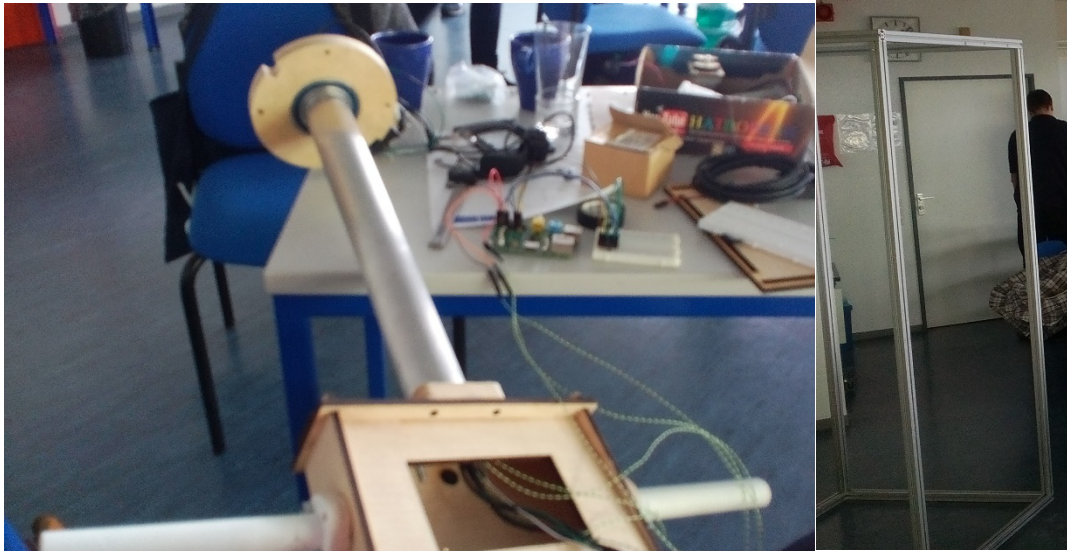Fig 3. Russian version of the project

Fig 4. Redesigned periscope helmet and booth

Project application

As we thought about commercial part of our project, we realized that it could be used for making lookout points all over the world in places especially in high spots as rooftops, towers, spires and so on so people won't have to climb ladders to the observation point.

MVP of this project would be a camera on the observation point, which is controlled from the ground by periscope with LCD screen, and to complete the project there should be created a whole network of booths and cameras.

Impressions on week in Russia and Germany

As we already contacted each other during introduction Skype sessions and process of brainstorming, it was not very hard to get to work with new team. Sure, lingual barrier was a real deal but it seems that we could deal with it quite nice even if it required making drawings and using translator. Also it was fun get to know each other in informal conditions – while visiting museums and walking around the city of St. Petersburg. It was quite a hard task to keep everyone occupied and to create an entirely new device in such extreme situation when a lot of people at the same time try to use the same instruments and machines and, most of all – the same wifi, it was really a big issue because it was more than our four projects and every single one was internet of things themed so wifi was really crowded. Anyway, we dealt with all the issues and difficulties and finished first week with booth, helmet, camera which could translate pictures in wifi and a large to-do list for next part of our project.

While being in Germany we dealt with lack of machines but we were prepared for it as we made all the mechanics in St. Petersburg right before gathering in Hannover. This week was more about assembling and programming.

Mostly programming. And here lack of skill got into our way and trying to troubleshoot bugs and errors which we have never encountered days before final presentation got us very nervous and frustrated but we did our best to overcome those issues even if it required having night-long streaks in hotel hallway with Raspberry Pi attached to a hotel TV. Even as our project wasn't perfect and hadn't all the functions it supposed to have, working on it was a very interesting and unforgettable experience.

Fig 5. Ilya working on program in the hallway

Conclusion

In two design sessions and two months of separate work our team mastered our skills in 2D and 3D modelling (SolidWorks, Autodesk Inventor, AutoCad, Corel Draw), usage of laser cutters and CNC milling machines (with generation of g-codes using ArtCam), created two versions of periscope booth prototype and developed skills of communication in international work groups so it'll be easier for us to make work in similar situations next time.