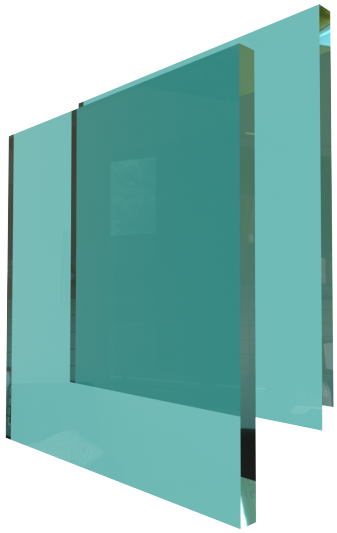
Department of Computer Science & Engineering
The University of Texas at Arlington

Project Charter
CSE 4316: Senior Design I
Fall 2021



Senior Design Bois
Glass Interfaces

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Revision History

Revision	Date	Author(s)	Description
0.1	10.01.2020	GH	document creation
0.2	10.05.2020	AT, GH	complete draft
0.3	10.12.2020	AT, GH	release candidate 1
1.0	10.20.2020	AT, GH, CB	official release
1.1	10.31.2020	AL	added customer change requests
1.2	10.02.2021	NP, LN, ZM, TN	problem statement, methodology, value proposition written
2.1	10.09.2021	NP, LN, ZM, TN	implement most sections besides related work and background

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1 Problem Statement

Glass is a commonly used material in a wide range of contexts including furniture, packaging, construction, and art. Currently in electronic contexts, glass is commonly used as a display intermediary (LCD screens), but not as an independent and digitally interactive artifact. With the rise of IoT, smart cars, and smart homes, glass plays a role beyond aesthetics and function; it can act as a transparent interface. Since glass interfaces and interactions are not well defined, exploration of what could be done with devices may reveal broad insights.

2 Methodology

We are developing a glass interface game. The game will cover a range of interactions afforded by glass interfaces. By playing and developing games, we explore a deeply interactive system that will define the functions of a glass interface.

3 Value Proposition

Currently, glass is already used in many spaces. For example, it is a popular choice for premium packaging and construction. The glass in these spaces already have well-defined uses that we can enhance with digital interactivity. We want to focus on making foundational glass interfaces that can be extended to these spaces. For example, a smart office space with many glass doors can be digitally enhanced. It can have status indicators for air quality visible right on the glass. For packaging, smart glass can sense the status of its contents.

4 Development Milestones

Outline of project milestones and completion dates over the course of the academic year:

- Project Charter first draft - October 2021
- System Requirements Specification - October 2021
- Architectural Design Specification - November 2021
- Validate Requirement Expectations - November 2021
- Critical Design Review - November 2021
- Demonstration of Working Circuit Glass - December 2021
- Operational Readiness Review - December 2021
- Demonstration of Touching Glass Interface - January 2022
- Demonstration of Displaying The Full Interaction on Glass Interface - February 2022
- Demonstration of Running Interaction 1 - March 2022
- Demonstration of Running Interaction 2 - April 2022
- Demonstration of Running Interaction 3 - April 2022
- Final Project Demonstration - May 2022

5 Background

Glass is a material that is commonly used and available in many places. It has unique interactive properties of being transparent, clear, and rigid. Currently, much work is focused on glass as a projective medium, but less on glass as an interface itself. For example, some bespoke devices such as the Google Nest are using mirrors as a display medium. Mirrors rely on glass as medium to create "transparent" displays which meld reality and virtual. Other uses of glass as an interactive element are on phone screens. These LCD displays are interactive with multi-touch, but they are not transparent. Building on the current work regarding ubiquitous computing, we hope to provide interactions that augment this current glass context. For example, any existing glass door could be augmented with interactivity. Some other useful business cases include making smart packaging in glass bottles, interactive new media installations, security, and smart windows in smart homes. To implement these features, we rely on a transparent substance called indium tin oxide (ITO). ITO enables any object to be electronically sensitive. This is what would enable our interactions. All this together presents a common problem: in what ways can glass be maximized as a medium? That is what this project is hoping to explore. By creating rich interactions by game, it may be possible to outline and facilitate the creation of these glass interactions.

6 Related Work

Much current work on glass circuit comes closer to using film, acrylic, and other transparent mediums to fabricate the circuits [1–3, 5]. There are fabrication methods for printing circuits on glass, but these are limited to a hobbyist dimension. To expand, many hobbyist rely on metallic tapes and cutout techniques to imprint a circuit on top of glass. While these techniques are suitable for hobbyist, it is not fit for projects in the industry at scale because of its cumbersome crafting process. There is one instance where an experience practitioner utilized traditional PCB chemicals to fabricate the circuit, but that requires experience. The resultant artifact was successful, but the glass size was very small. Additionally, industrial interest in this seems to lay on ceramics instead of glass as a transparent medium [6]. Interest in ceramics is similar to glass where experts are focused on the material affordances. There has been previous work for glass circuits here at UTA in the Hybrid Atelier lab. Some glass interface prototypes have been created demonstrating capacitive touch and embedded LEDs. The fabrication process in the Hybrid Atelier relies on the Voltera to print a circuit design on top of glass [4]. This bridges the constraints between a cumbersome DIY project to an industrial process. Current constraints in that project is scale: the glass pieces and prototypes are small. We hope to enhance this by developing a companion app and extending the prototypes to a larger scale. We hope to merge these insights into creating a glass interface that explores beyond these problems. One additional problem dimension in the previous examples is exploring the IoT space. There has been little exploration in turning these prototypes into internet-connected smart devices.

7 System Overview

The glass interface will be implemented by using a microcontroller, sensors, and LED's, to interface a glass circuit. Ideally, there will be three different interfaces for the user to choose from on the glass circuit. One of the sensors that will be used is a capacitive touch sensor that will use the user's touch as input to interface the LED's on the glass circuit. The microcontroller will use the I2C peripheral on the Tiva TM4C123GH6PM microcontroller to transmit the data from the sensors. A temperature sensor may also be used to change the color of LED's based on temperature.

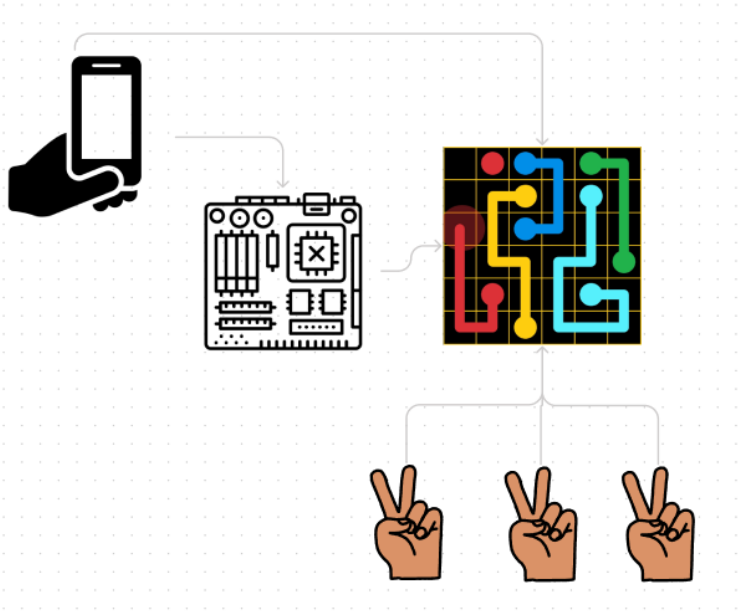

Figure 1: High Level Overview

8 Roles & Responsibilities

All of the group members are stakeholders including Dr.Conly. An additional stakeholder will be the University of Texas at Arlington Computer Science and Engineering Department for sponsoring us. There will be one product owner,Long Nguyen,and one scrum master, Nathen Paul, in our team. These roles will rotate per semester.

For UX and Design of the glass interface, Long Nguyen and Nathen Paul will be focusing architectural design of the glass interface system. Both of them have experience in Human-Computer Interaction and are knowledgeable when it comes to UX/UI design. For software application development, Nathen Paul, Long Nguyen, and Thinh Nguyen will be fulfilling these roles as they have had previous in mobile and web application development. Finally, Zane Malacara will be designing and building the circuit that will be used to drive the LED's, as well as programming the peripherals of the microcontroller to conform to the design specifications.

9 Cost Proposal

We will try to keep our expenditures within the $800 we were given. This money is from the CSE Department, and it will mainly go to material (glass) and component costs (micro controllers). Much of the software we use is open source, but we may use some funds for better developer tooling.

9.1 Preliminary Budget

Include a high level budget table for components, fabrication, software licensees, development hardware, etc. This should be in a tabular format broken up into appropriate line items.

10 Facilities & Equipment

The team has contacted the instructor to set up a lab space. Ideally the lab space will have room to have a power supply, soldering iron, 3D printer, and an oscilloscope for testing and building circuits, and an epilog laser cutting for cutting components of our wood panel frame.

EXPENSE	BUDGET ($)
Material	150
Software	0
Components	50
Miscellaneous	50

Table 1: Overview of project budget

11 Assumptions

Regarding the implementation, testing, and prototyping of our glass interface system, here are a few critical assumptions

- A suitable indoor lab space location will be available by the 2nd sprint cycle for us to begin testing out mock-up glass circuits.
- Limited space capacity for people in lab spaces due to the ongoing pandemic and health ordinances to contain any potential spread of coronavirus.
- Able to secure required material for our project in time including glass and electronic components despite backed-up supply chain caused by the COVID-19 pandemic and tariffs.
- Are able to print multiple 3D glass circuits without any technical issues occurring with the Ultimaker S5 3D printer.
- Able to deliver a final prototype of our glass interface in accordance with the timeline outlined in development milestones section.
- Glass as a material will work similarly or as expected compared to traditional PCBs
- The $800 budget given for our project is ample amount of financial funds needed for our project.

12 Constraints

The following list contains key constraints related to the implementation and testing of the project.

- Final prototype demonstration must be completed by May, 2022
- Must get hardware ASAP due to widespread hardware shortage
- The team can only use glass as a surface.
- The team does not yet know the problems that come with working with glass
- Total development costs must not exceed $800

13 Risks

This section should contain a list of at least 5 of the most critical risks related to your project. Additionally, the probability of occurrence, size of loss, and risk exposure should be listed. For size of loss, express units as the number of days by which the project schedule would be delayed. For risk exposure, multiply the size of loss by the probability of occurrence to obtain the exposure in days. For example:

The following high-level risk census contains identified project risks with the highest exposure. Mitigation strategies will be discussed in future planning sessions.

Risk description	Probability	Loss (days)	Exposure (days)
Budget is not sufficient at this stage	0.2	20	4
Projects scope expansions come up unexpectedly	0.20	14	2.8
Misunderstanding glass material and fabrication	0.30	9	2.7
Delays in shipping from overseas vendors	0.75	20	15.0
Lab space is not available	0.15	10	1.5

Table 2: Overview of highest exposure project risks

14 Documentation & Reporting

14.1 Major Documentation Deliverables

These deliverables are major grade components of the course. Completing these documents should generally be the sprint goal during the applicable sprint period. Refer to current and previous course syllabi and schedules to estimate the due dates of these items. Remove this explanatory paragraph from your draft, but leave the heading.

14.1.1 Project Charter

The initial version of this document will be delivered October 9th, 2021. We are assuming the final version of this project should be ready Spring 2022.

We will adjust this document as more project details are discovered. We will update the document by situation if it affects project foundations.

14.1.2 Product Backlog

We list tasks the group vote the ones that will go on the backlog. We are using Linear to keep and maintain our stories.

14.1.3 Sprint Planning

Each sprint will be planned the weekend before each sprint. We plan on doing four sprints per semester. In this case, it is a total of eight sprints.

14.1.4 Sprint Goal

The group together will decide the sprint goal. We will demonstrate our progress to the Senior Design class and Professor Conly.

14.1.5 Sprint Backlog

The project group determines this. Each week, the project group will review both backlogs and adjust as needed.

14.1.6 Task Breakdown

Individual tasks will be assigned as a group each week. The group will voluntarily claim tasks. Time on tasks will be documented individually.

14.1.7 Sprint Retrospective

The sprint retrospective will be held the weekend the sprint is complete. It will be documented on Notion as a group.

14.1.8 Individual Status Reports

Each individual member will report the task they were assigned on Linear. This will be reported as required by Dr. Conly. Key items in the report include current tasks and time estimates.

14.1.9 Engineering Notebooks

We're using Notion and we're updating our notebooks as we observe changes. It's likely 1 page will be complete per month. The whole team will review project notebooks every month. Long Nguyen will sign the document as a "witness."

14.2 Closeout Materials

14.2.1 Source Code

We will use Github to maintain all of our code. Our project is using the MIT license.The license will be in the LICENSE file. Our source code will be provided as is from our Github repository. Folks who are interested may download our code as a zip from Github.

14.2.2 Source Code Documentation

We are still researching solutions.

14.2.3 Hardware Schematics

We will be creating glass circuit boards that will have LED's and sensors on the glass circuit. A more detailed schematic will be designed at a later date

14.2.4 User Manual

We will most likely create a ditigal model showcasing on the interact with our glass interface. A setup video may be needed.

REFERENCES

[1] Brown Dog Gadgets. Acrylic and paper PCB design circuit.

[2] CNLohr. Part 3: Getting glass circuit boards to work!

[3] HelioxLab. Creating easy glass circuit boards at home.

[4] Ivan Jaimes. Glass circuit boards: Circuits on stained glass art.

[5] Tom Nardi. Creating easy glass circuit boards at home.

[6] Sunny Patel. The ultimate guide to ceramic PCBs.