Secure Testing Headset

Design Document

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Client: Cornerstone strategies
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Executive Summary

Development Standards & Practices Used

We will be using C code with adhering to standard style guidelines as defined at https://www.cs.swarthmore.edu/~newhall/unixhelp/c_codestyle.html. We may use a printed circuit board, if we do it will adhere to IPC standards found here http://www.ipc.org/4.0_Knowledge/4.1_Standards/PCBA-Checklist.pdf. Materials used for the housing of the product will either conform to California proposition 65 regarding levels of toxic chemicals present or will come with a warning regarding their use. Our power supply will meet the US power plug standards and work in a standard NEMA 5-15 outlet.

Summary of Requirements

- Headset with user interaction
- Securely receives and transmits data
- Can be used to take an exam

Applicable Courses from Iowa State University Curriculum

List all Iowa State University courses whose contents were applicable to your project. (to be completed later)

New Skills/Knowledge acquired that was not taught in courses

List all new skills/knowledge that your team acquired which was not part of your Iowa State curriculum in order to complete this project. (to be completed later)

Table of Contents

List of figures/tables/symbols/definitions (to be added later as we go)

1 Introduction

1.1 Acknowledgement

We would like to thank Rachel Schoenig on behalf of Cornerstone Strategies, Dr. Diane Rover on behalf of Iowa State University and Prof. Doug Jacobson.

1.2 Problem and Project Statement

Test taking students are cheating on our clients tests in their home. We want to limit this. Our focus centers around a wearable headset capable of delivering the test while possibly monitoring the environment.

- Online tests aren't secure
- Classes are going virtual
- Current solutions still allow for people to cheat
- Tests are required to confirm that people are qualified
    - Incentive for people to cheat
        - For personal gain
        - Monetary
        - To get the test information
- Tests cost a lot of money to develop
    - Make sure questions can't be stolen & distributed
- There is an unnecessary distance between the test and camera and the student's face

    - Camera in laptop gives different view than user has
    - High density testing area makes wandering eyes easy
    - Known weaknesses, how to improve upon these
        - Camera in eye
        - Testing camera on head (cannot see below)
        - vm in background capturing/transmitting info
        - Ensure identity of test taker
        - Try to break it
        - Our solution wouldn't be as needed if increase in popularity of open book/note exams
        - Compare to existing techniques
            - ProctorU, Prometric, PSI, Proctor360
            - Record and review later
            - AI (not allowed everywhere)
            - Gaze tracking
    - Perception of security (ask users)

1.3 Operational Environment

- Expected to be used indoors
- Need to be durable, droppable
- Should be water-resistant, but not an essential requirement
- Refer to risk-mitigation section for further details on potential operational risks

1.4 Requirements

- A way to monitor the environment
- A way to select an answer as well as progress to the next question
- A way to communicate with a secure environment that houses the test
- Must have a way to display battery levels to the user
- Power supply that can independently last 2 hours and is rechargeable
- Can be used while charging
- Has a battery backup
- Secure content transfer
- Recorded exams with possibility for live proctor
- Users input for multiple choice
- Cheat-resistant and cheat-evident
- Comply with Question & Test Interoperability (QTI) Standards
- Reasonable price for students to afford

1.5 Intended Users and Uses

- Students
- Anyone who needs to qualify in a certification
- College entrance exams (ACT/SAT)
- College exams
- Certification exams (Pilot/BAR exam)

1.6 Assumptions and Limitations

Assumptions:

- Used only by English speakers in the U.S.
- The device will be used from remote locations (not necessarily in a testing center)
- The device will communicate with a server
- User will have wifi access

Limitations:

- Prototype cost under $1000 unless we receive outside funding (i.e. from ETG)
- The device will be a wearable headset
- The device will conform to QTI standards
- Communications between the device and a server must be done securely
- Device must be tamper-evident (we can tell if it has been tampered with) or tamper-proof
- Interaction with the test will be on the headset (no external handheld device)

1.7 Expected End Product and Deliverables

The end product shall be a device that allows for an exam to be displayed on a screen that is minimally sized. The device shall have inputs in the form of buttons and a selector wheel that will be able to select answers in the exam. The test case to prove the minimum viable product criteria has been satisfied is an exam that has no need for notes or note taking capabilities, as such the device may be enclosed but enclosure is not required. The device will not be powered by a battery for minimum viable product. The device shall be durable enough to survive minor damage and should be tamper evident so that testing security can be determined at a later date. Delivery date for the device shall be no later than May 11, 2021.

A document shall be provided that explains how to use the device. This document shall include how the inputs affect the device and how to navigate any menus that would be required. The document shall also include guidelines for emergency cases for the device such as how the device handles a disconnect from its power supply or a network connection.

2 Project Plan

2.1 Task Decomposition

Tasks and subtasks, as well as interdependence among tasks, are listed below:

- **hardware (existing headset or board from scratch)**
  - **buttons signalling user response**
  - **wifi connection**
  - **data transfer**
    - **secure data transfer**
  - **charging (battery and plugged in to power)**
- **screen/optics**
  - **display an image**
  - **update image based on user interaction (ensure high enough frames/second)**
- **software**
  - **receive data from a server and display**
  - **quality user interface for exam**
  - **notify user of low power**

Each of the above tasks has some dependence on the other tasks as described here. The hardware to be used must be obtained before buttons can be implemented or data can be transferred to and from the device. The screen/optics must be established before the software for viewing the test is relevant. The list of items above is arranged in a way that shows loose dependencies between tasks. Certain steps can also be taken to begin work on a given task that is farther down the list (somewhat dependent on an earlier/incomplete component). For example, software may be able to be worked on before the hardware is complete assuming there is some sort of testing environment to be used in the meantime.

2.2 Risks And Risk Management/Mitigation

- **could be hacked (buy security software)**
- **Our team lacks required knowledge for implementation (gain expertise from ISU experts)**
- **Cost of development is too great (limit features to things we can afford)**
- **Project requirements not adequately reflected in task breakdown (clarify tasks early and often with industry contact)**
- **Project is not on pace with project schedule (build in buffer time)**
- **Project scope is too great for given time frame (narrow scope as much as possible)**

2.3 Project Proposed Milestones, Metrics, and Evaluation Criteria

The list below includes the milestones, and in parentheses is the criteria for different tasks:

- data transfer technique

- data sent to headset (no lost data)

- data sent from headset to server (no lost data)

- secure transfer (no man in the middle attacks possible)

- notifies user and test distributor if test tampered with (successfully notifies user when man in the middle attack happens

- hardware (existing headset or board from scratch)

- hardware fits inside headset

- headset fits on someone's head comfortably (can be worn by different people for an extended period of time)

- hardware connected with headset software

- hardware connected with server (data is sent to hardware and back to server without losing anything

- software (integrated into the following items)

- user interaction (buttons)

- button does simple task

- button selects an option (is displayed on screen as being selected)

- goes to next question

- user can scroll up and down on a question

- answer saved

- screen/optics

- hello world, see something on screen

- test questions seen

- interaction with exam (go to next question)

- charging

- successfully charges

- user can see charge level

- user notified of low charge

- user warned of charging before exam starts

- backup battery has enough energy to save and transmit data safely before dying

2.4 Project Timeline/Schedule

- Define problem
- Brainstorm ideas
- Narrow down to single design
- Build design
    - Screen
    - Charging
    - UI
    - Software used for viewing test

  - Controls (buttons)
  - Data transfer
- Test
- Reiterate over design
- Present

2.5 Project Tracking Procedures

We plan on using Gitlab as our code repository and to track software issues. We plan on using Trello to manage our tasks and keep track of deadlines. We will be using Webex Teams and email to communicate between team members, the industry connection, and the faculty advisor. We plan to work in an Agile environment. The metrics we will use to track progress will be whether or not the tasks are done as well as to what extent the tasks pass all unit tests.

2.6 Personnel Effort Requirements

Task	Person-Hours
Define problem	8
Brainstorm ideas	6
Build design: Screen	40
Build design: Power Systems	30
Build design: UI	30
Build design: Software	40
Build design: Data Transfer	35
Build design: Controls	20

Figure 2.6.1: The above chart determines how many hours are expected to complete each task.

We have various tasks, mostly split up with some tasks before the development of the product such as defining the problem and brainstorming ideas. Figure 2.6.1 shows all of the tasks and their expected time. For defining the problem, we expect it to take roughly 8 person-hours. We expect to have a meeting with our industry contact, go over the idea, and together define the problem we're trying to solve. Brainstorming ideas is the next step before our development, we expect it to take roughly 6 person-hours, enough for the team to come together and pitch ideas all together.

The following tasks on the table are all for the development of the product. These times are estimations on the number of person-hours it will take to complete each portion. We expect the Screen and the Software to take 40 person-hours each, as these two tasks will be a large portion of the project. Working on Data Transfer, being able to transfer data from a server to the device securely, we expect will take 35 person-hours. Working on the UI, taking the data transferred from the server and displaying on the screen, we expect will take 30 person-hours. Implementing controls on the device we expect to take 20 person-hours. Finally we expect constructing the power systems, such as a battery, charger, and power supply for the device to take 30 person-hours.

2.7 Other Resource Requirements

The following list includes all additional parts required for the project:

- Headset casing (3D printed or existing)
- Screen
- Chip for connecting to server (bluetooth, wifi, etc)
- Buttons
- Battery
- LEDs (for testing purposes)
- Charging port and charger

2.8 Financial Requirements

The only monetary resources available include $1000 from the client (Cornerstone Strategies). Additional money needed would have to be requested from senior design funding, assuming that the investment would be something desirable to have for future semesters of senior design.

3 Design

3.1 Previous Work And Literature

Include relevant background/literature review for the project

– If similar products exist in the market, describe what has already been done

– If you are following previous work, cite that and discuss the **advantages/shortcomings**

– Note that while you are not expected to "compete" with other existing products / research groups, you should be able to differentiate your project from what is available

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

3.2 Design Thinking

Detail any design thinking driven design "define" aspects that shape your design. Enumerate some of the other design choices that came up in your design thinking "ideate" phase.

3.3 Proposed Design

Include any/all possible methods of approach to solving the problem:

– Discuss what you have done so far – what have you tried/implemented/tested?

– Some discussion of how this design satisfies the **functional and non-functional requirements** of the project.

- If any **standards** are relevant to your project (e.g. IEEE standards, NIST standards) discuss the applicability of those standards here

- This design description should be in **sufficient detail** that another team of engineers can look through it and implement it.

3.4 Technology Considerations

Highlight the strengths, weakness, and trade-offs made in technology available.

Discuss possible solutions and design alternatives

3.5 Design Analysis

– Did your proposed design from 3.3 work? Why or why not?

– What are your observations, thoughts, and ideas to modify or iterate over the design?

3.6 Development Process

Discuss what development process you are following with a rationale for it – Waterfall, TDD, Agile. Note that this is not necessarily only for software projects. Development processes are applicable for all design projects.

3.7 Design Plan

Describe a design plan with respect to use-cases within the context of requirements, modules in your design (dependency/concurrency of modules through a module diagram, interfaces, architectural overview), module constraints tied to requirements.

4 Testing

Testing is an **extremely** important component of most projects, whether it involves a circuit, a process, or software.

1. Define the needed types of tests (unit testing for modules, integrity testing for interfaces, user-study or acceptance testing for functional and non-functional requirements).
2. Define/identify the individual items/units and interfaces to be tested.
3. Define, design, and develop the actual test cases.
4. Determine the anticipated test results for each test case
5. Perform the actual tests.

6. Evaluate the actual test results.
7. Make the necessary changes to the product being tested
8. Perform any necessary retesting
9. Document the entire testing process and its results

Include Functional and Non-Functional Testing, Modeling and Simulations, challenges you have determined.

4.1 Unit Testing

– Discuss any hardware/software units being tested in isolation

4.2 Interface Testing

– Discuss how the composition of two or more units (interfaces) are to be tested. Enumerate all the relevant interfaces in your design.

4.3 Acceptance Testing

How will you demonstrate that the design requirements, both functional and non-functional are being met? How would you involve your client in the acceptance testing?

4.4 Results

– List and explain any and all results obtained so far during the testing phase

- Include failures and successes
- Explain what you learned and how you are planning to change the design iteratively as you progress with your project
- If you are including figures, please include captions and cite it in the text

5 Implementation

Describe any (preliminary) implementation plan for the next semester for your proposed design in 3.3.

6 Closing Material

6.1 Conclusion

Summarize the work you have done so far. Briefly re-iterate your goals. Then, re-iterate the best plan of action (or solution) to achieving your goals and indicate why this surpasses all other possible solutions tested.

6.2 References

List technical references and related work / market survey references. Do professional citation style (ex. IEEE).

6.3 Appendices

Any additional information that would be helpful to the evaluation of your design document.

If you have any large graphs, tables, or similar data that does not directly pertain to the problem but helps support it, include it here. This would also be a good area to include hardware/software manuals used. May include CAD files, circuit schematics, layout etc,. PCB testing issues etc., Software bugs etc.