Project Deliverable C

Conceptual Design and Project Plan

GNG2101C - Introduction to Product Development

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Faculté de Génie - Faculty of Engineering
University of Ottawa

Group C32

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Abstract

The following document is the conceptual design of team C32 in lab section C of the GNG2101 course in the 2021 Winter Term and the University of Ottawa's Faculty of Engineering. The document contains the design components for an accessible glucometer, designed by each group member. Components were chosen collectively during a group meeting on January 16th, 2021. During the latest meeting which took place January 28th, 2021, the best individual designs were chosen to create a final conceptual design for our project.

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1 Introduction

Taking one's blood sugar is a tedious task that becomes extremely difficult when the patient has use of only one arm. This document proposes eighteen different solutions to make that process easier for someone with use of only one arm. Each solution is analyzed in terms of each major component: device frame, lancing device and glucometer. The most promising designs were then compared using the benchmarks that were previously set up, and the best design then selected.

2 Subsystem

2.1 Test papers helper

In terms of the appearance framework, the client requested that in the new design, the whole blood glucose testing process should be completed with one hand as far as possible. In terms of overall structure the main body is divided into three parts. The first part is to store the test paper inside the box and design an automatic system in the internal structure so that the patient can get the test paper only by touching the external button, so as to ensure that the test paper is completely clean as far as possible. The second part is the clip at the bottom of the box to connect the glucose meter, which is used to facilitate the storage and use of the glucose meter during the entire process. The third part is to design a shelf outside the box to put the blood collection device so as to realize the integration of the whole equipment.

2.2 Lancing device helper

Lancing device need to ensure the safety of blood collection for patients in use, and the design can clearly see the different keys and the names of the keys to ensure the correct use of patients according to the steps. In terms of design, it is also necessary to ensure that patients can adjust the length of the needle according to their own needs and that it is very easy to use.

2.3 Glucometer helper

The design of the glucose meter is divided into two parts. The first part is the shell design, the whole equipment for the protection of the elderly and disabled needs to be designed as simple as possible in the external case. Considering that most diabetics are older or have hearing or visual problems, the device will come with speakers and text modes on the keys to enhance the overall device experience. Because of the mobility and cognitive deficits of some stroke patients, the meter is likely to stop working after a long period of time, or the process can be so complicated that they have to squeeze their fingers to restore blood flow and the whole device needs to be as easy to use as possible, so the whole process needs to be very convenient. In terms of external materials, some durable materials should be selected as far as possible in order to maintain the equipment for a long time. The second part is the internal system design. Visualization is also needed in this section to take into account the memory and use abilities of the elderly and the disabled. In the whole system needs to achieve the data memory ability and the system automatic analysis ability. For the protection of these people, if there is any abnormality in the measurement data, the system can automatically alarm so as to realize the effect of quick treatment without delay.

3 Individualized conceptual designs

3.1 Abdullah Abdulmajeed's designs

3.1.1 Design A: Suitcase Glucometer

The device could be compartmentalized in a suitcase design with separate fixed locations for a standard glucometer and a standard lancing device. The suitcase maximizes portability without compromising single hand accessibility. This would also cut cost, as the device would only be a suitcase that uses adjustable clamps to hold glucometer components in place and provide support such that someone could use a glucometer using one hand. The suitcase would also feature storage pouch compartments for lancets and test strips.

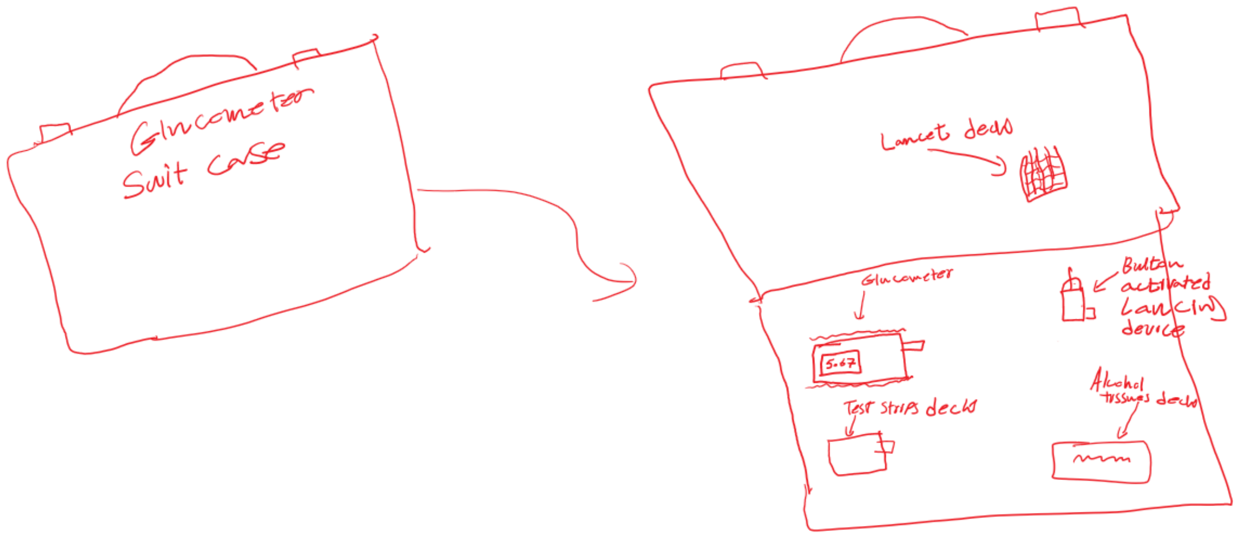


Figure 1: Abdullah Abdulmajeed's Design A

subsystem details: Figure 21 Figure 24

3.1.2 Design B: Cased arduino glucometer

This concept model is based on an Arduino design. The glucometer and the lancing device will sit in an openable box that will provide stability and hold in place all the components such that the device can be operated with one hand.

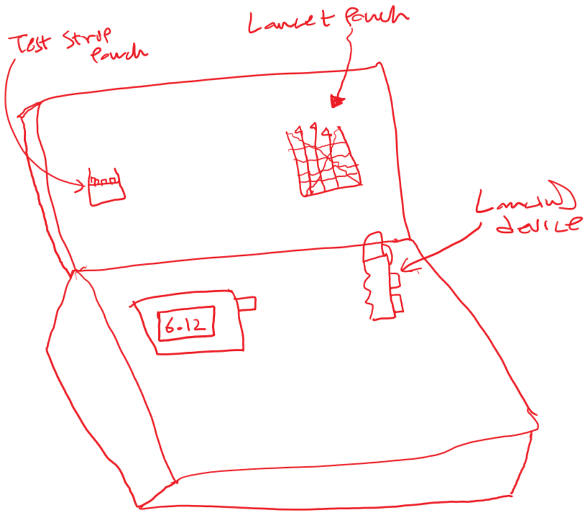


Figure 2: Abdullah Abdulmajeed's Design B

subsystem details: Figure 22 Figure 25

3.1.3 Design C: Ergonomic Glucometer

Ergonomically designed frame specifically designed to be used with one hand. Houses both the lancing device and an Arduino nano based glucometer. Features an openable plastic clip on lid that can be uncovered to replace the lancet and an open hole in the middle to insert test strips.

Figure 3: Abdullah Abdulmajeed's Design C

subsystem details: Figure 23 Figure 26

3.2 Bowen Zeng's designs

Multiple designs based on 3 subsystems, each subsystem has 3 individual concepts. Therefor we have 3*3*3 = 81 combinations for our product, here are 3 typical combinations:

3.2.1 Design A: Most executable

Combination: 1-1-1 subsection F.10

- subsystem 1: subsection F.1
- subsystem 2: subsection F.4
- subsystem 3: subsection F.7

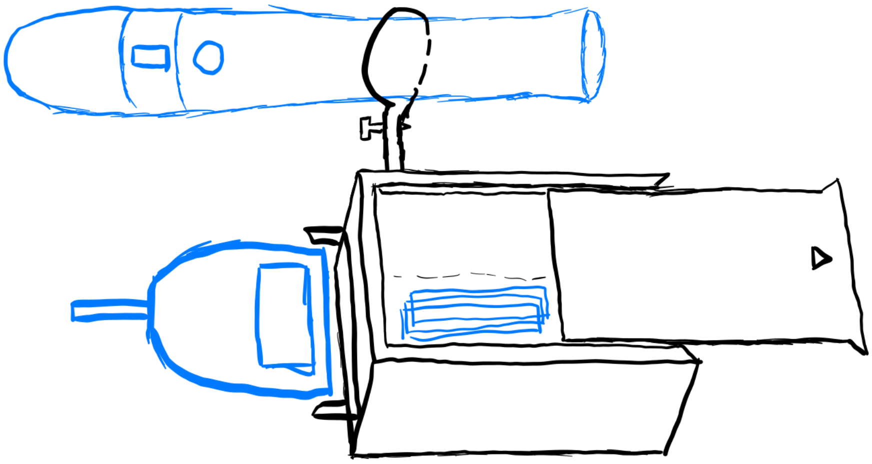


Figure 4: Bowen Zeng's Design A (Using combination code 1-1-1)

3.2.2 Design B: Ultimate solution 1

Combination: 3-2-3 subsection F.11

- subsystem 1: subsection F.3
- subsystem 2: subsection F.5
- subsystem 3: subsection F.9

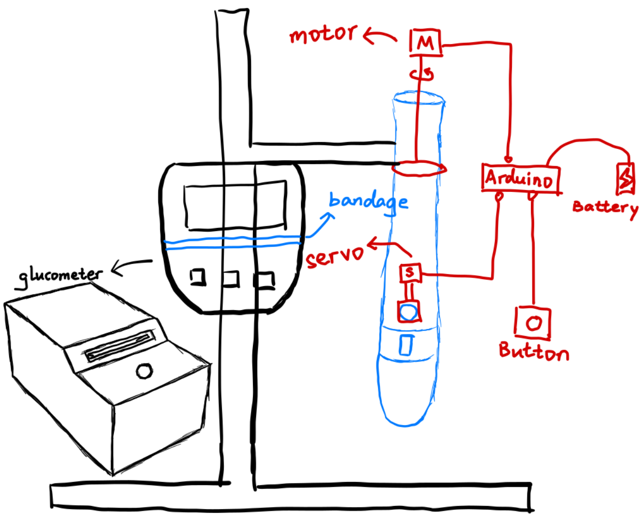


Figure 5: Bowen Zeng's Design B (Using combination code 3-2-3)

3.2.3 Design C: Ultimate solution 2

Combination: 1-2-3 subsection F.12

- subsystem 1: subsection F.1
- subsystem 2: subsection F.5
- subsystem 3: subsection F.9

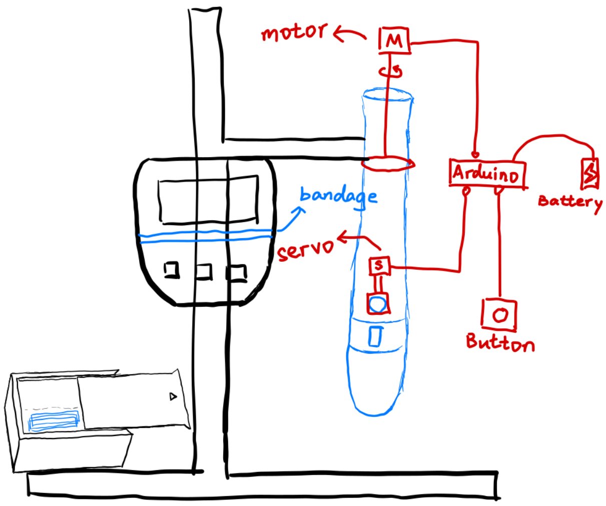


Figure 6: Bowen Zeng's Design C (Using combination code 1-2-3)

3.3 Christopher Zhang's designs

3.3.1 Design A: Tool rig

This device is a modified glucometer that utilise analog buttons and speakers to be more easily operated by visually impaired. As well as a mildly altered lancing device that has threading on the back end the reason for the threading is so that the third part of the design is utilized. Inspired third hand soldering tool, the idea of this design is to be a second hand. It's held down by suction cups and is for the most part just a plastic frame with specialized tools, which includes a cavity to hold the canister for test papers to hold it in place, a slot for the gluco meter to hold that in place when inserting the test paper and giving samples. And lately two holes, one that is threaded so that the user can thread the lancing device on to it to keep it in place for the purposes of replacing the lancet or keeping it in place during use, the second hole is used for removal and reapplication of the cap utilizing a suction cup and spring load ejection slide. This design in regards to how it meets some of the metrics such as accuracy or storage are reliant on the product used with it as the purpose of this design is more of an add-on and less of a modification. Instead of changing how the procedure is done rather it assists making it more user friendly.

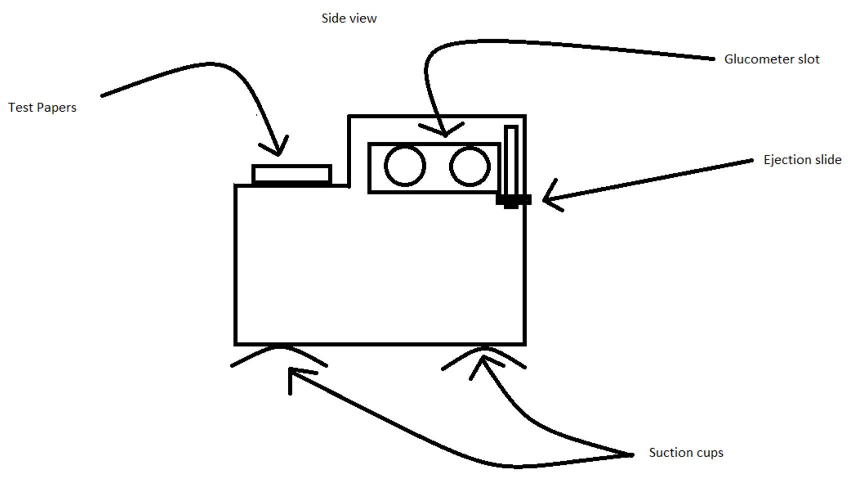


Figure 7: Christopher Zhang's Design A side view

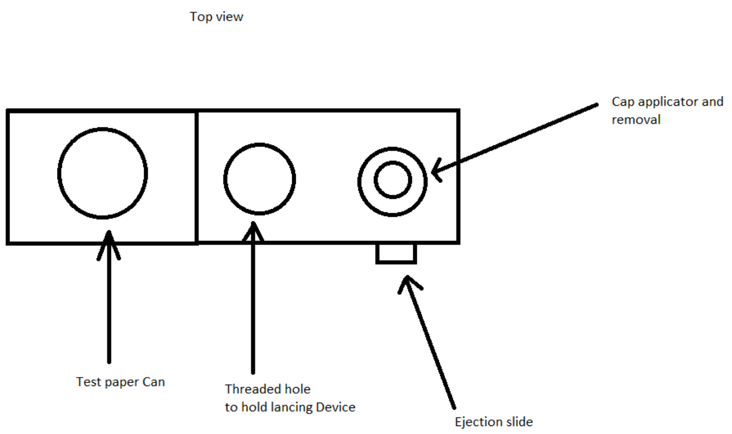


Figure 8: Christopher Zhang's Design A top view

subsystem details: Figure 32 Figure 35

3.3.2 Design B: Non-invasive glucomete

This design is an "all-in-one" design that is to say that they are all interconnected into one device with a wire that joins the glucometer and the sample analyzing clamp utilizing a contact pad. Using this alternate method of measuring the glucose levels could require no invasive procedures on the client. Similar to the prior design the glucometer also uses analog buttons and a speaker for the same reasons. This design omits a lot of what operating a lancing device troublesome and is overall a good design however, questions about how accurate, response time and whether it is even executable under the constraints that have been set arise.

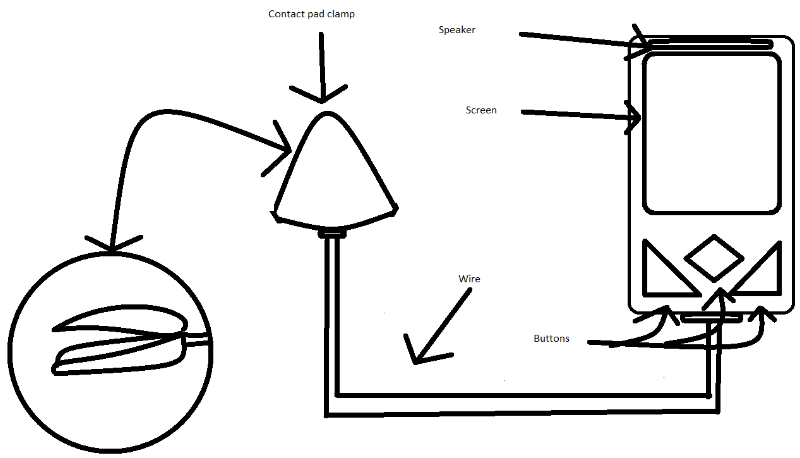


Figure 9: Christopher Zhang's Design B

subsystem details: Figure 33 Figure 36

3.3.3 Design C: Refractometer

The last device is a refractometer glucometer that has what will be referred to as a "clothespin style" lancing device. The idea of this design was to cut out the action and need of a testing paper as well as the tedious action of removing and putting back on the cap. Making it an overall much more smooth process. The idea was to have the patient provide a sample and put into the refractometer and have it be tested. Doing it this way would cut out a large amount of steps. Similar to the previous designs the glucometer also uses analog buttons and a speaker. This design is by far the most complex and while it achieves a lot of the performance based metrics it may face issues in regards to following constraints.

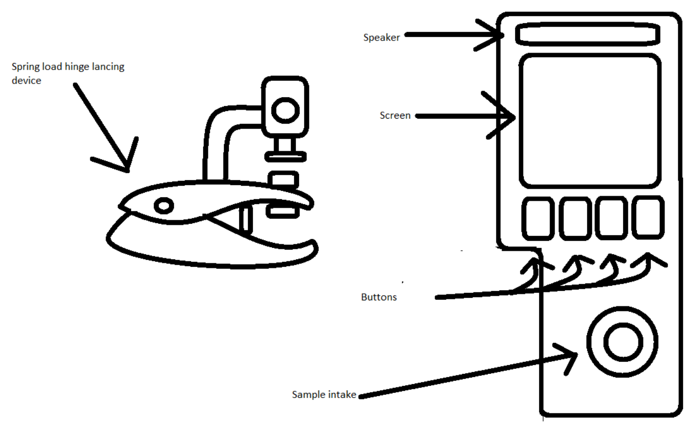


Figure 10: Christopher Zhang's Design C

subsystem details: Figure 34 Figure 37

3.4 Colin Jiang's designs

3.4.1 Design A: Portable box

Functions:

1. Filled with glucometer related stuff and portable
2. Can stick on the table, can be operated with one hand
3. Changeable holder for different types of lancing and glucometer device

The whole device will be a box which is made with different parts:

1. A changeable ditch which can hold tight the lancing device, so that people can lance their finger on it directly. The ditch can have multiple designs in order to fit in different widths of the lancing device, ensuring that the lancing device won't move when operating it. The front part of the lancing device is outside of the box.
2. The space will also be a ditch for glucometers. Description is the same with the lancing device. When installed into the box, the glucometer can not move at all, but people can still press the button to operate it
3. It's a hole inside the box, people can put needles or test chips inside it. normally it's closed by the lid. When people want to use it, just press the button, and open the corresponding lids. Tap the lid in order to close it. This mechanic can be found in some types of children's bottles.
4. How does the box stick on the table?For now I can only think of using the rubber holder under the box

Since the box will expose the front side of lancing device or the glucometer, it's better to make a cover for the box to provide a good maintenance for the devices

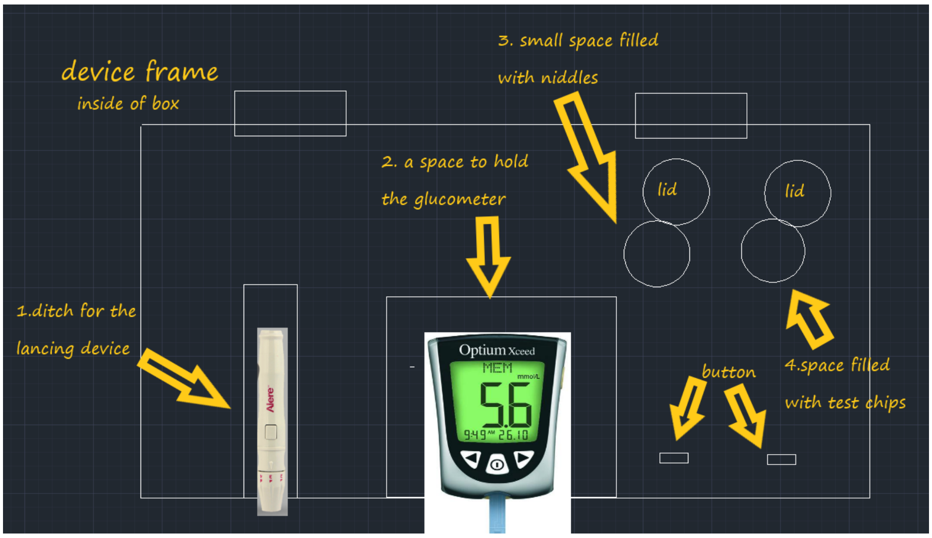


Figure 11: Colin Jiang's Design A

subsystem details: Figure 28 Figure 30

3.4.2 Design B: Semi circle shaped glucometer container

Functions:

1. Store the necessary parts of glucometer
2. Can be easily used when place on a table
3. Is programmable and can only used with one button

Glucometer and lancing device are also in a container, but the container has a semi-circle shape. Normally the lancing device is inserted into the container, and glucometer is also held inside the container. Needles and test strips can be stored inside the semi circle.

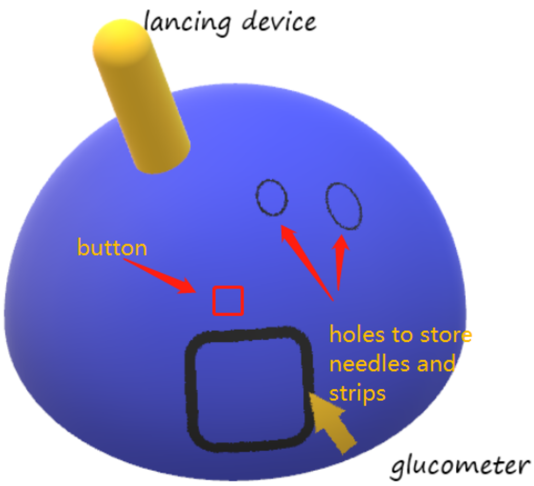


Figure 12: Colin Jiang's Design B

subsystem details: Figure 29 Figure 31

3.4.3 Design C: The glucometer working table

Functions:

1. Organized arrangement for glucometer and lancing device
2. Lancing to the fingers with the robotic arm, really flexible
3. No need to use your hands to operate the whole process

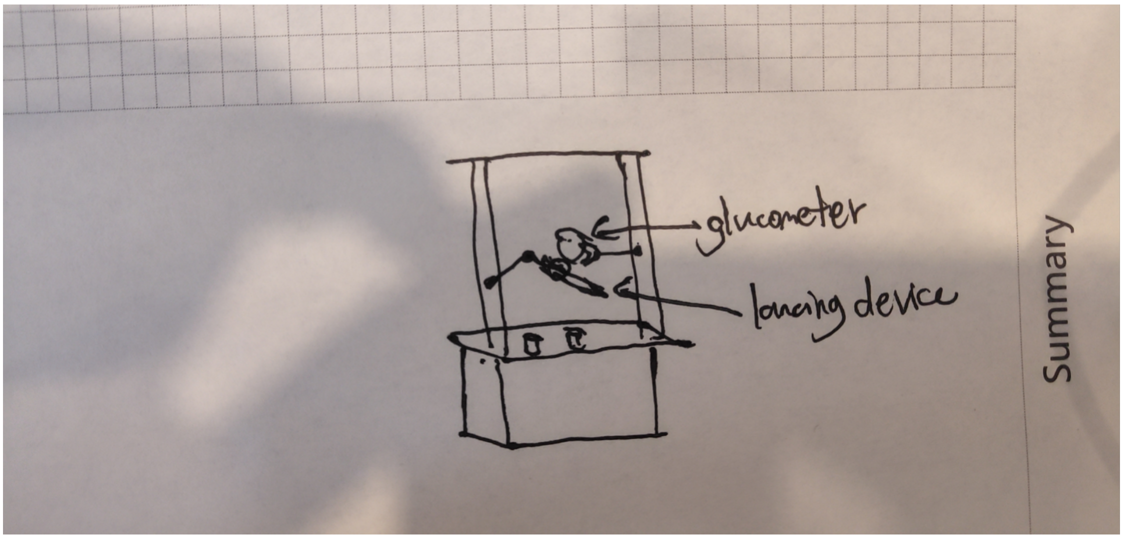


Figure 13: Colin Jiang's Design B

3.5 Jerry Wang's designs

3.5.1 Design A: Blood Glucose Meter Watch

And the idea of this machine is to put a watch band on the back of the glucose meter and turn it into a glucose meter watch. Place the blood collection device on the top of the watch and fix it with a telescopic shelf. At the end there are speakers for the elderly or people with visual impairments.

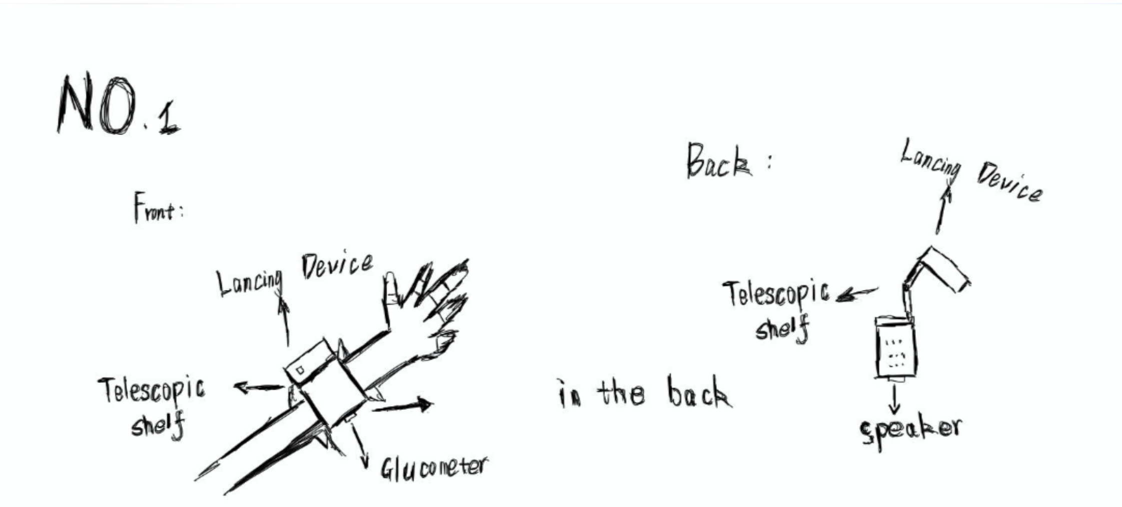


Figure 14: Jerry Wang's Design A

subsystem details: Figure 38 Figure 41

3.5.2 Design B: Clamshell Glycemic Meter

This model is based on a clamshell glycemic meter. When the user turns on the glucose meter, the upper part is the glucose meter and the lower part is the blood collection device. The test port is on the top of the blood glucose meter. When the user needs to collect blood, he only needs to change the needle in the lower cover. The blood collection device can be retractable to the lower outlet for collecting blood, and can be pushed back after use. Finally, the flip blood glucose meter is changed to test the direction, and finally the data is obtained from the speaker.

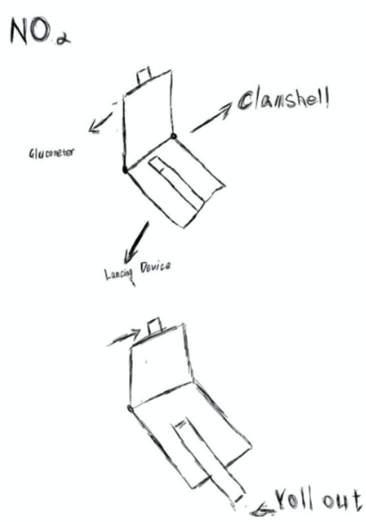


Figure 15: Jerry Wang's Design B

subsystem details: Figure 39 Figure 42

3.5.3 Design C: Push-lid-Type Glycemic Meter

This device is a push-lid-type glycemic meter similar to the push-lid-type cell phones of the past. The glucose meter is in the upper part of the device and the blood collection device box is in the lower part. The test port is at the top of the meter and the blood collection device is in the lower box. The lower and upper parts are connected to keep them stable. The user can push the lower part out to replace the device and adjust the length and then push it back, and finally push the blood sample out from the bottom of the device with the box still attached to the top. Finally, the blood collection was completed and the equipment was switched to the direction of blood glucose test.

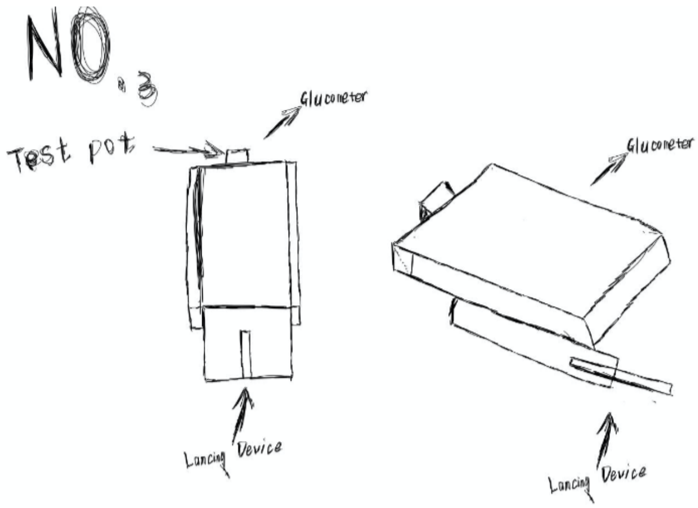


Figure 16: Jerry Wang's Design C

subsystem details: Figure 40 Figure 43

3.6 Lucas Hunter's designs

3.6.1 Design A: Fully Automatic Glucometer

The "fully automatic glucometer" attempts to combine both the lance and the glucometer into a single automated device. It has hole in the front where the user inserts a finger and presses down to activate the device. A simple lance, which is accessible from a door in the front of the device for easy lancet replacement, extends pricking the finger. The glucometer is then moved forward, causing the test-strip to a small ramp, angling it up to gather a sample of blood from the finger.

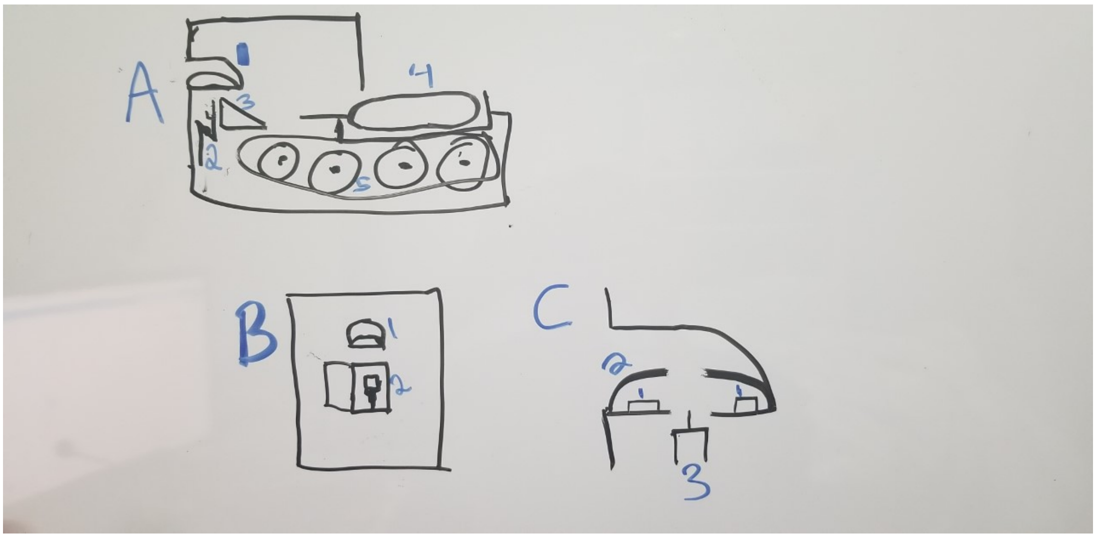


Figure 17: Lucas Hunter's Design A

subsystem details: Figure 44 Figure 47

3.6.2 Design B: Mounted Vehicle Glucometer Holder

The mounted vehicle glucometer holder, is a modified phone holder. It holds the lance (#1) at the end of the moveable arm (#3). The glucometer (#2) is secured on the base, with holders on the side of the base for strip and lancet containers (#4). The whole design is attached with a suction cup.

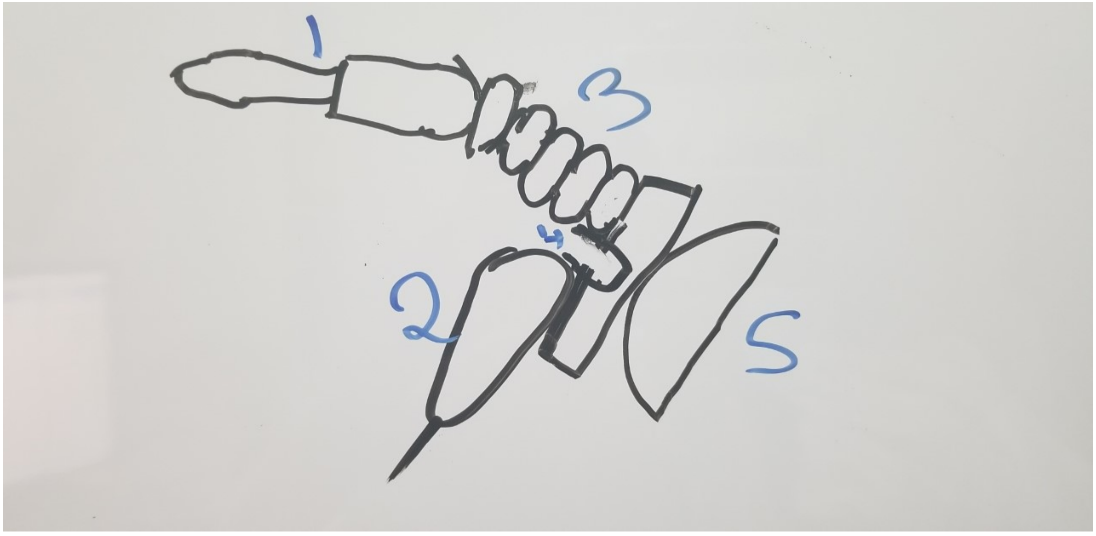


Figure 18: Lucas Hunter's Design B

subsystem details: Figure 45 Figure 48

3.6.3 Design C: Blood Tap

The blood tap circumvents the need for a lance, by having a device similar to what you get in hospitals during long visits so they can take blood work. One tube is inserted into the arm and the other open to let out a drop of blood. The flow of blood is controlled by a turning dial on the device, max flow would be extremely slow, about a drop every 2 seconds.

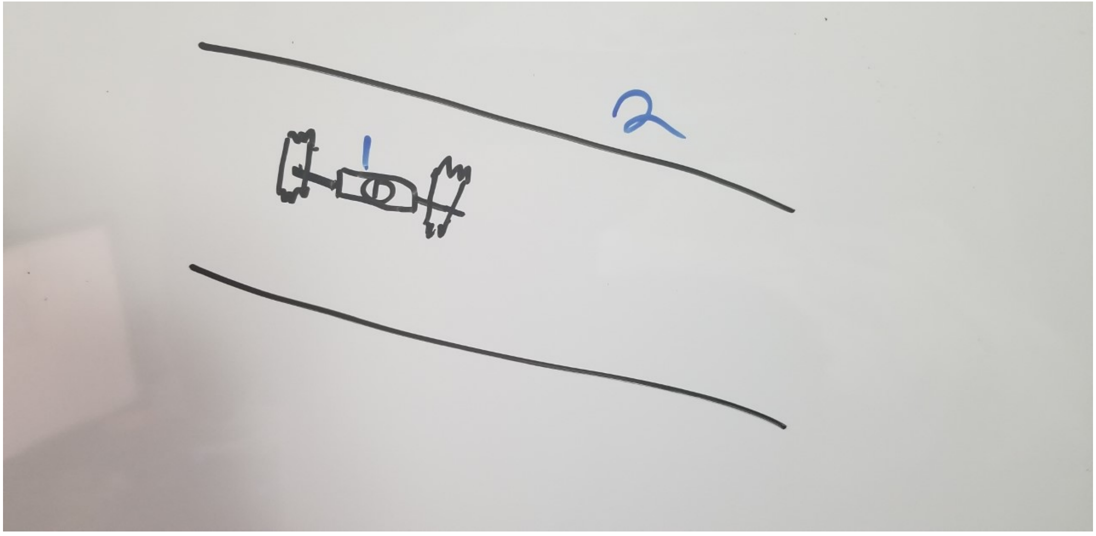


Figure 19: Lucas Hunter's Design C

subsystem details: Figure 46 Figure 49

4 Finalized conceptual design

During the general meeting, each member had to explain his concept to others in detail. After preliminary discussions, we selected 3 designs: Glucometer helper, Cased Arduino Glucometer, Clamshell Glycemic Meter. In order to further explore each design, we made an target specialization analysis:

4.1 Target specialization analyze

Legend:

- Green: 3 points
- Yellow: 2 points
- Red: 1 point

Devices	Weight	Glucometer helper	Cased Arduino Glucometer	Clamshell Glycemic Meter
Name	N/A	Bowen	Abdullah	Jerry
Image	N/A	Figure 4	Figure 2	Figure 15
Accuracy	5	Depends on base glucometer	Untested	Untested
Memory	3	Depends on base glucomete	32kb	Unknown
Result time	4	Depends on base glucomete	Within 5 seconds	Unknown
Cost (CAD)	3	Made from cheap and available materials ($30)	Custom shield PCB, Arduino Uno and Casing material ($100)	less than $100
Weight	3	light weight, under 100g	100g 150g	under 100g
Size	3	50 x 100 x 100 mm	50 x 100 x 100 mm	20 x 40 x 5 mm
Accessibility	5	Clamps will hold components in place for ease of use with one hand	Box will hold components in place for ease of use with one hand	Base can sit on a table such that user can operate the device with one hand
Durability	4	Good	Okay	Good
Total	90	87	74	61

Table 1: Design Criteria interpreted from client needs

Jerry's Clamshell Glycemic Meter is really cool, and it is portable. But the amount of engineering is too much, difficult for us to realize. Abdullah's Cased Arduino Glucometer is smart and reliable, however, the amount of engineering is still very large because it requires arduino programming and coordination of many electric components.
Finally is Bowen's Glucometer helper. Although the product design is simple, it can still fulfill the customer's needs. Because the structure is clear and concise, even students who have never tried 3D modeling can complete it with confidence. So this is our group design concept, which is most executable and reliable.

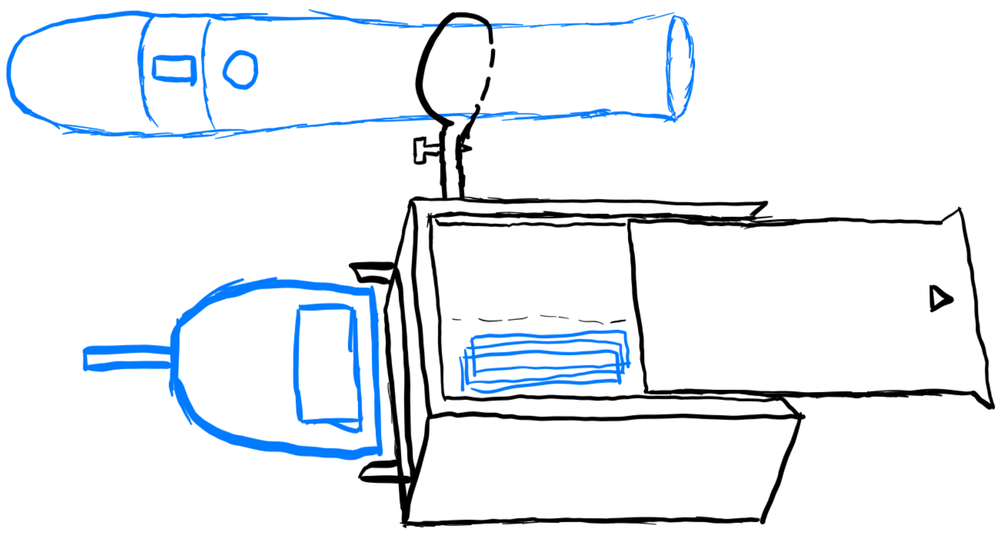


Figure 20: Final design concept

5 Transfer of knowledge

5.1 How past knowledge helped us address the issue

Going into the design phase of the project many of us had already experienced a similar situation many of us having gone through the first year version of this course. We understood the potential traps that some of us might fall into when brainstorming ideas. Whether it be undershooting the complexity of the design, such as the multiple tool rigs. Or over shooting it, such as the refractometer. But also took note of the value of purposefully brainstorming these ideas. It helped us figure out what we as a group should go for as it helped us broaden our views. We also made sure to properly think through our designs attempting to ensure that all scenarios that could reasonably occur were addressed as well as understanding that some issues that we thought may be a problem may not actually be as big an issue as we thought it might be so as to prevent unneeded details to the design.

5.2 How this experience will help us address other issues in the future

Undertaking this experience has been a very educational experience in regards to furthering our progress and also potential ensuring a fine end result. While we learned many minor lessons, such as being outspoken about a design one is passionate about may not always be a bad thing. We learned one very important lesson which is that a truly well thought out design should not be based upon sheerly one owns ideas but rather a core idea possibly brought by one individual or a group that is then furthered along the process by having new ideas be added by the rest of the group brainstorming around this core direction so as to fully flesh it out.

6 Conclusion

Eighteen different solutions were discussed in this paper. The designs varied greatly; from fully automatic designs, to containers meant to hold and secure existing glucometer equipment. Designs were considered using the following considerations: accuracy of the reading, memory storage to store previous reading, time duration to get a result, cost, weight, size, accessibility to peoples with use of one arm and durability. The final three candidate designs were “Glucometer Helper”, “Cased Arduino Glucometer”, and “Clamshell Glycemic Meter”. The “Glucometer Helper” was ultimately chosen, because it performed well in every category except size where it was mediocre. The “Glucometer Helper” was also favoured because of time restraints, such that a final product can be created in the next three months. Based on its performance in the metrics listed previously, the “Glucometer Helper” has been selected as the chosen design to create.

A Abdullah Abdulmajeed

A.1 Lancing subsystem

A.1.1 Design A

A standard lancing device is held within the suitcase. Users can place one hand over the lancing device. One finger over the lancet and one finger pushes the button to release the spring loaded lancet. The lancet in this case is also easily replaceable. Users can just screw off the lid with the device fixed in its place. Release the holding mechanism and place a new lancet. Then simply screw the lid back on and use the device. This allows our device to be compatible with lancets already on the market and makes it easily adaptable for new-users as they can retain their old gadgets.

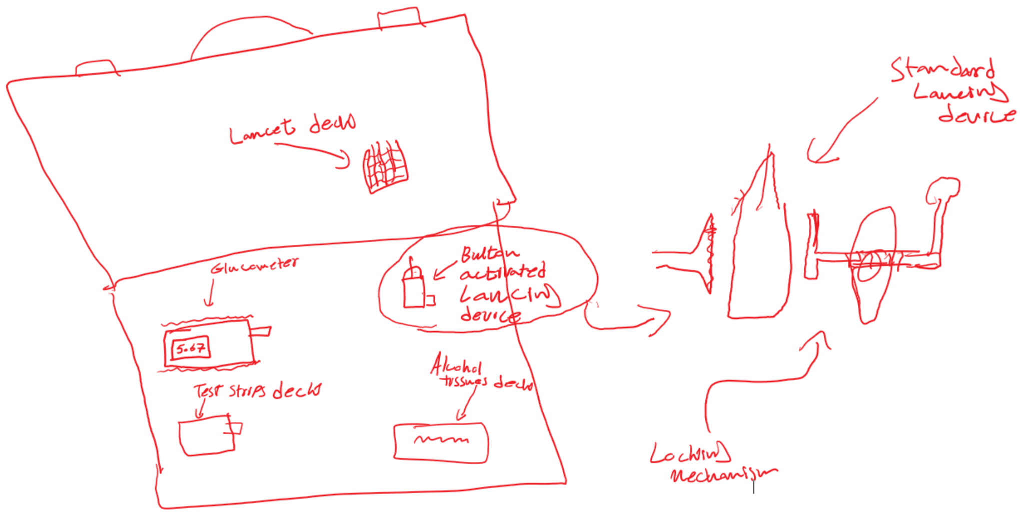


Figure 21: Abdullah Abdulmajeed's Design A (Lancing subsystem)

A.1.2 Design B

The lancing device would be fixed into the deck of the device frame box. A removable cap can be unscrewed to replace the lancet. Lancets that can be screwed onto a cylinder and inserted into a spring loaded device. The lever is pulled back to compress the spring until the lancet cylinder hits the locking mechanism. The user then places their hand over the device and press the release button to prick their finger.

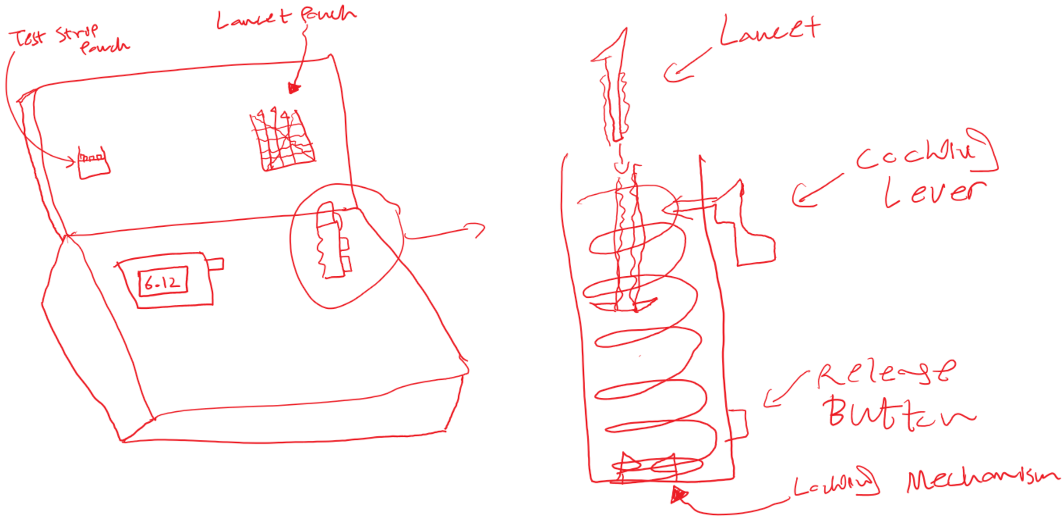


Figure 22: Abdullah Abdulmajeed's Design B (Lancing subsystem)

A.1.3 Design C

A small replaceable needle is used to prick the finger when taking measurements. The needle is spring loaded and can be released using a button. It can be easily replaced by opening the clip on plastic lid, pulling the needle and inserting a new one.

Figure 23: Abdullah Abdulmajeed's Design C (Lancing subsystem)

A.2 Glucometer subsystem

A.2.1 Design A

Similarly to the lancing device concept, the glucometer here would just be a standard glucometer. This would have the same benefits, mainly compatibility with market standards and ease of adoption for new users. There will also be a pouch for test strips storage.

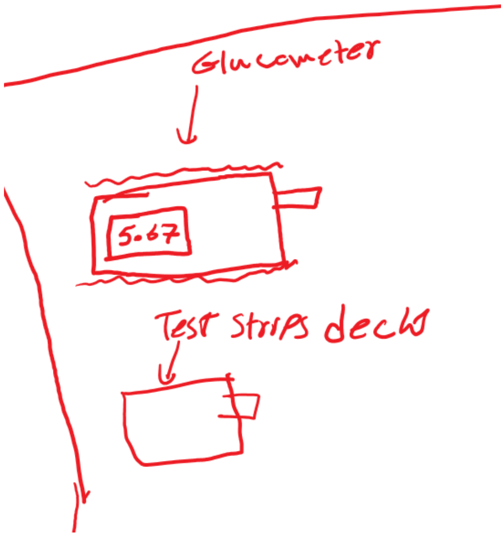


Figure 24: Abdullah Abdulmajeed's Design A (Glucometer subsystem)

A.2.2 Design B

The glucometer here is based on an arduino model and includes a shield that can take accurate blood glucose content measurements and a screen that returns the measurements quickly to the user. These components would be fixed onto the deck and therefore can be comfortably used with one hand.

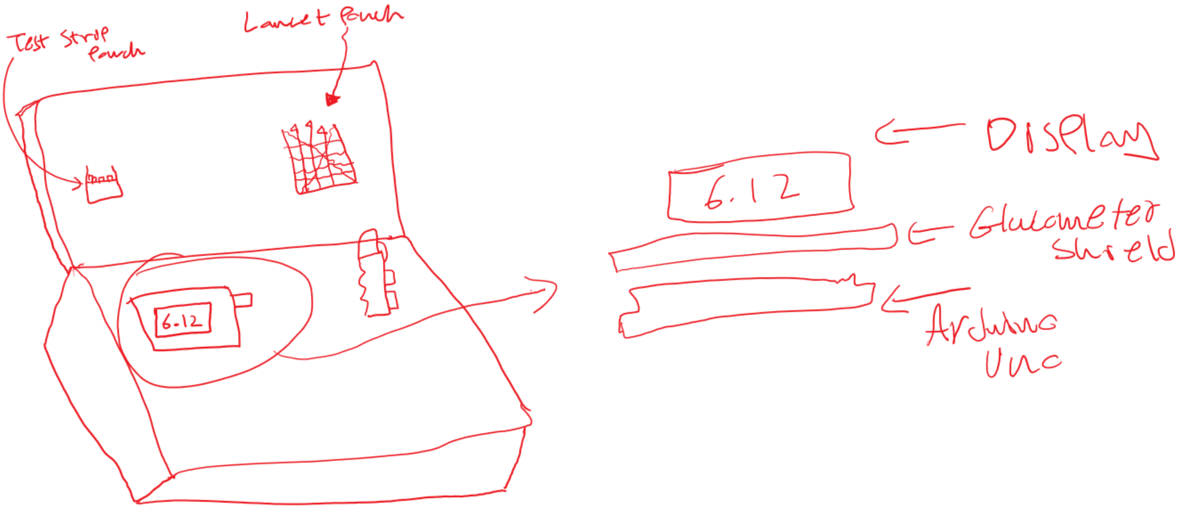


Figure 25: Abdullah Abdulmajeed's Design B (Glucometer subsystem)

A.2.3 Design C

This design is based on an Arduino nano to keep the device small and lightweight. It features a custom glucometer PCB made for the Arduino and a bluetooth module to send the results of the measurements to a compatible bluetooth device where measurements can be stored for long term data tracking.

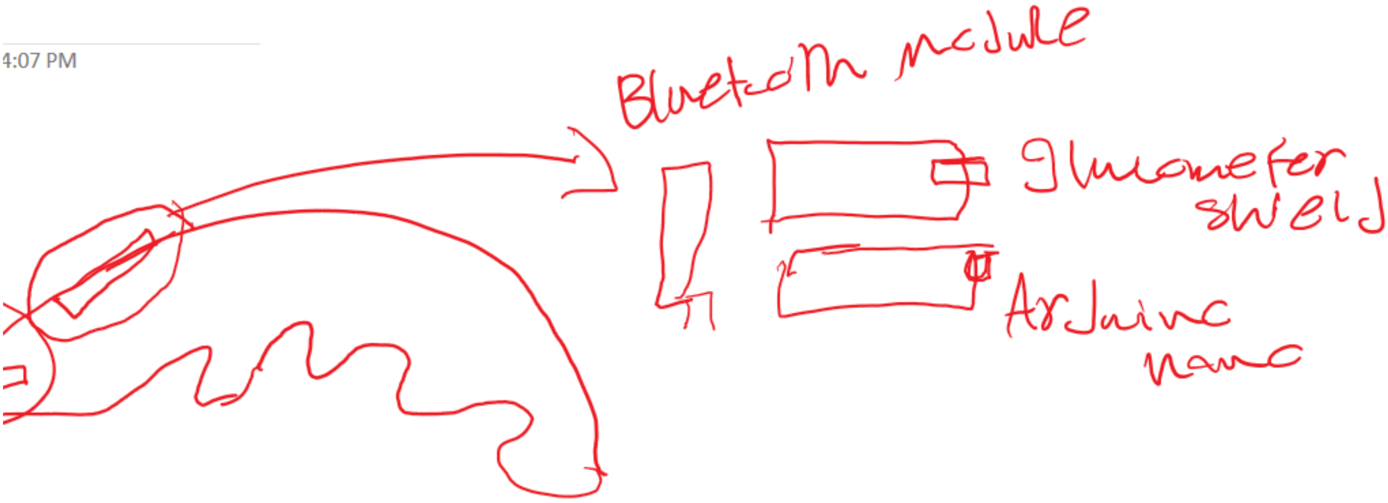


Figure 26: Abdullah Abdulmajeed's Design C (Glucometer subsystem)

B Colin Jiang

B.1 Lancing subsystem

B.1.1 Design A

The cap area will be outside of the box, so that people can remove the cap and put the needle inside easily, and adjust the depth by themselves. if the lancing device is hold firmly in the box and the box hold in tight on the table, than people just need to place middle finger on the front and use thumb to press the button In order to reset a handle, there will be two movable rubbers in the ditch. When in need, patients can use the button to release the front part of the lancing device and pull it out to reset.

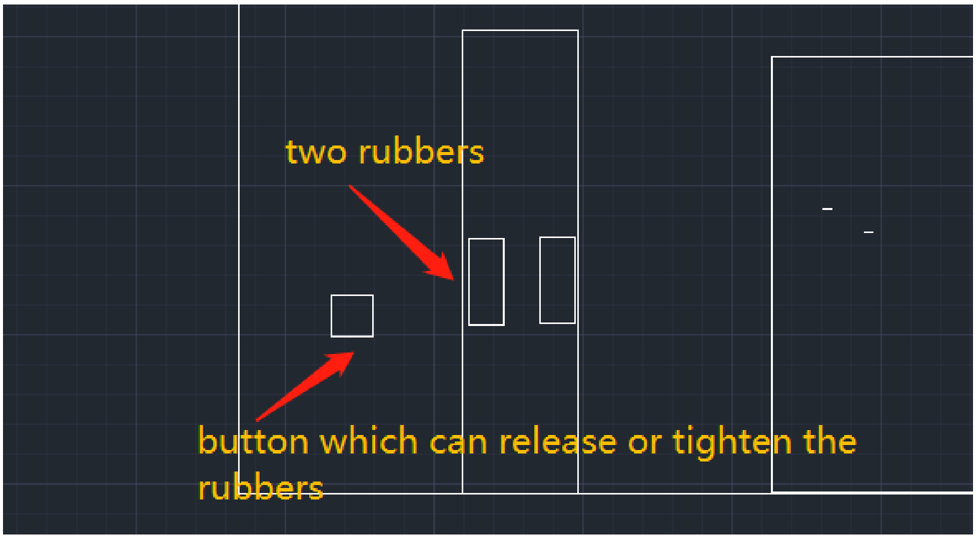


Figure 27: Colin Jiang's Design A (Lancing subsystem)

The release and tighten button can work by rotation if it's like this

Figure 28: Colin Jiang's Design A (Lancing subsystem)

B.1.2 Design B

When the lancing device is inserted into the container, it will automatically firm the bottom side but not the middle side. It ensures that the patient can drug it out to reset the handle. With the stable semi circle structure, Patients just need to press the button and put the side of their finger on it. If patients cannot do this process with one hand, one way is to program a button on the semi circle, which that, when patients press, it delays 10 or 20 seconds of the release button of the lancing device, which provides patients enough time to out their fingers on the needle

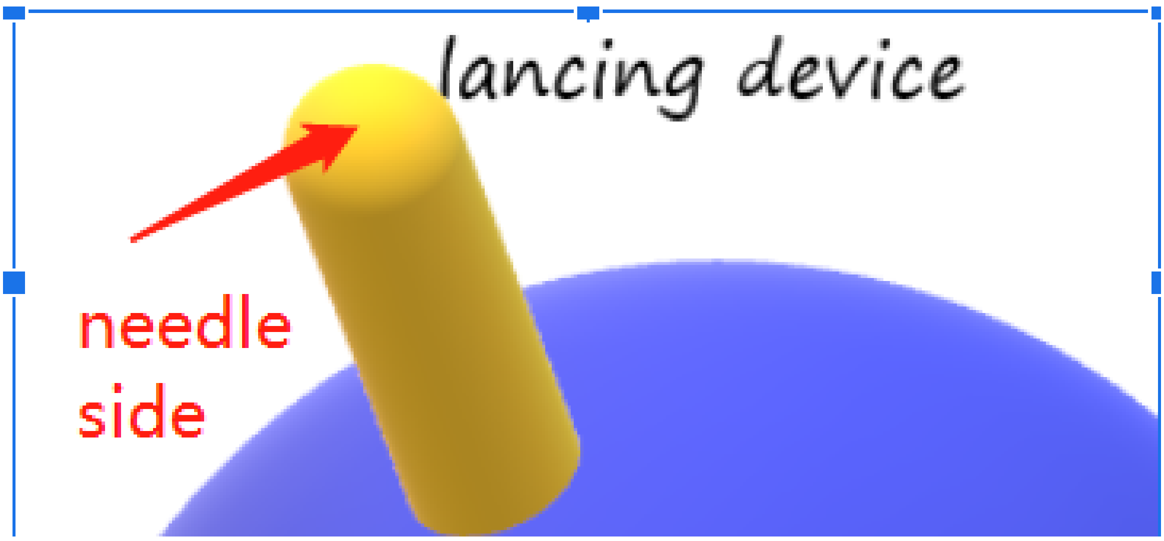


Figure 29: Colin Jiang's Design B (Lancing subsystem)

B.2 Glucometer subsystem

B.2.1 Design A

The testing parts of the glucometer should be outside of the box, so that patients can easily insert test strips and press the start button. Therefore the type of glucometer which screen of it is on the same side of the testing strip is recommended, unless you don't mind turning around the whole box just to see the result.

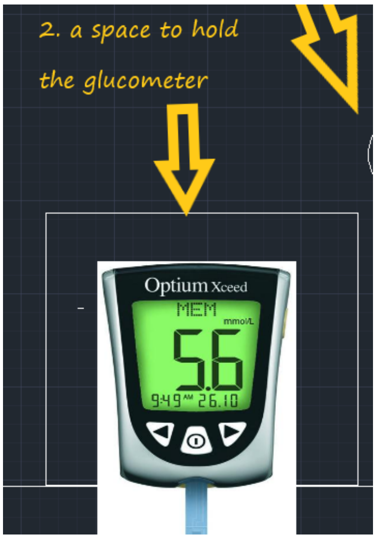


Figure 30: Colin Jiang's Design A (Glucometer subsystem)

B.2.2 Design B

The glucometer should expose the strip side so that patients can change strips easily with on hand. The semi circle should cut a part of it so that the screen can show to the patients.

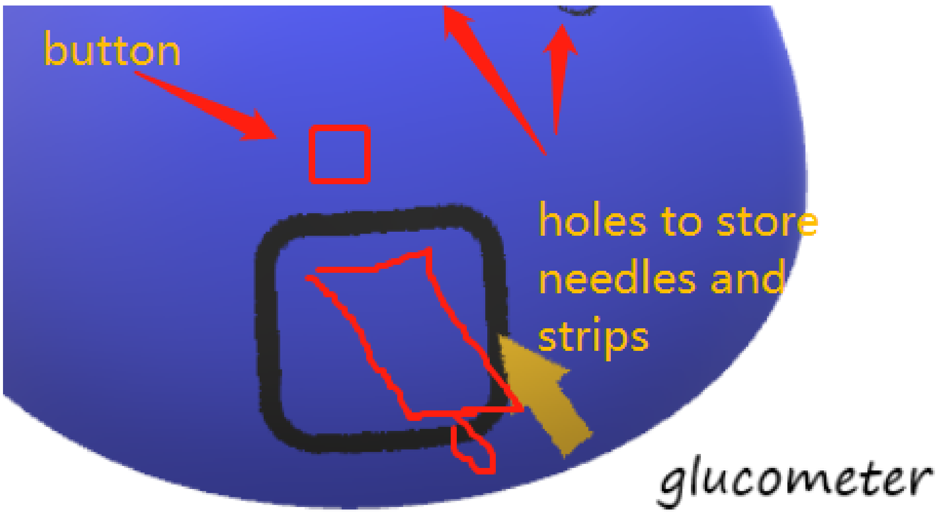


Figure 31: Colin Jiang's Design B (Glucometer subsystem)

C Christopher Zhang

C.1 Lancing subsystem

C.1.1 Design A

The Lancing device in this design does not vary too much from designs already on the market discount of the threading on the back . However, it'd be ideal if we were to ensure that all quality of life adjustments were put in such as a rotary depth setting, a trigger button that is easy to press and yet still very noticeable so as to not accidentally set it off and also an ejection slide for the lancets. The device will run off of standard lancets that can be commercially bought. This design has a lot of things going for it as it can very easily be made to follow all metrics as it can easily be made out of a pre-exist lancing device with some basic tooling to create the back end (alternatively an end cap could be made). The issue with this design is that not all lancing devices are compatible with it.

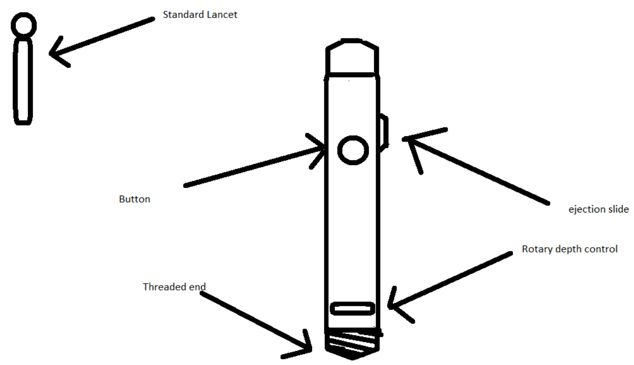


Figure 32: Christopher Zhang's Design A (Lancing subsystem)

C.1.2 Design B

Design B does not use a lancing device but as stated in uses a contact pad. As of right now it has yet to be decided where it should go for optimal results, ear or finger are being considered for either quality of sample or ease of use. But the idea is that it would be attached to the users body and from there a reading can be taken from the client. This design is one of the more hands off designs requiring no invasive actions and very little set up. The issue is reliability and cost.

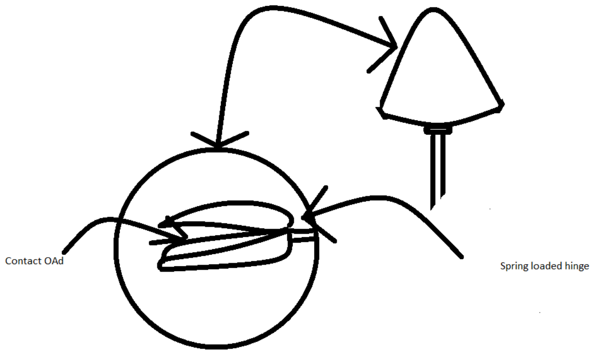


Figure 33: Christopher Zhang's Design B (Lancing subsystem)

C.1.3 Design C

The lancing device for design C was inspired by a clothespin as it is easy to operate and can very easily be operated by one hand. The idea is that the user would slot in a lancet from the top and simply close the pin on the finger of their off hand. Utilizing a solenoid it will quickly punch the lancet into the finger of the client and a spring inside the housing for the lancet will push it back out within the same action.

A bar will be put in place so as to prevent any accidental injury from the clamp closing down on the client. This design is the most complex of the three posed though it does pose a good balance between A's reliability and B's lack of setup. Thought due to the many moving parts a concern in durability arises and by extension a replacement cost.

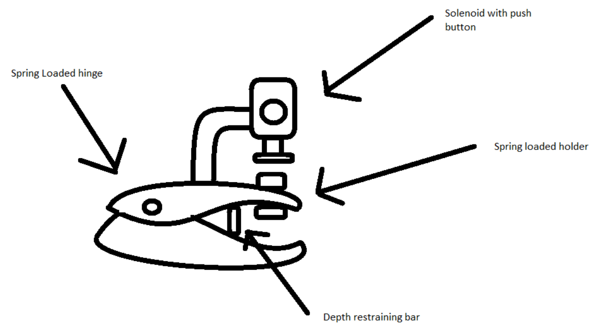


Figure 34: Christopher Zhang's Design C (Lancing subsystem)

C.2 Glucometer subsystem

C.2.1 Design A

The glucometer in design A will not vary vastly from what is already on the market. The only key requirements is the use of analog buttons and speakers to make it more easily operable for the visually imapired as well as be able to store at least 500 results and have al ong battery life. And lastly a flat top so as to more easily be secured to the suction cups pof the plastic tool frame. This Design relies entirely on what glucometer is used as the only modification that'd be done is quality of life changes such as the potential installation of a speaker or analog buttons as well as a potential reshelling so as to make it physically compatible with the tool rig.

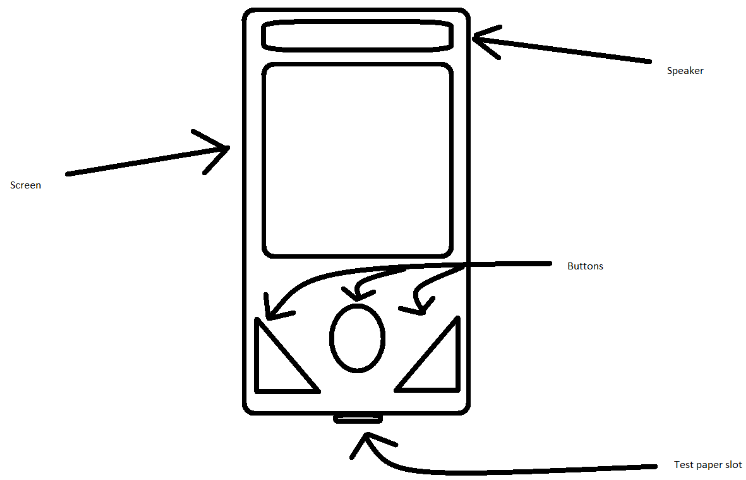


Figure 35: Christopher Zhang's Design A (Glucometer subsystem)

C.2.2 Design B

Design B's glucometer will have to be built from scratch as the process by which the sample is analyzed is not commercially available or at least very sparse. From research the way that this goal could be achieved is through a combination of ultrasonic, electromagnetic and thermal waves. Lastly like the first design it should have analog buttons, a speaker and be able to store at least 500 results. This Glucometer has the least moving parts but is still very complex as it will need to analyze a lot of things however because of the lack of moving parts durability in regards to impact will not be an issue but whether it can follow constraints is a question which ultimately invalidated choosing it.

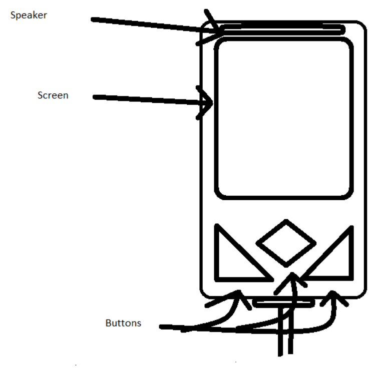


Figure 36: Christopher Zhang's Design B (Glucometer subsystem)

C.2.3 Design C

Design C's glucometer is a refractometer which instead of using a test paper measures the permeability and refractobility of a liquid sample to obtain info in this case it would be testing the refraction of a blood sample to test the sugar content. The sample will be put into a chamfered reservoir for easy deposition. Like the previous designs it will use an analog button, speakers and be able to store at least 500 results. Much like design B's glucometer this design faces the same exact issues with the added concern of its ability to resist liquids as it will commonly be put into contact with it. All of this compiled ultimately is what ruled out this design.

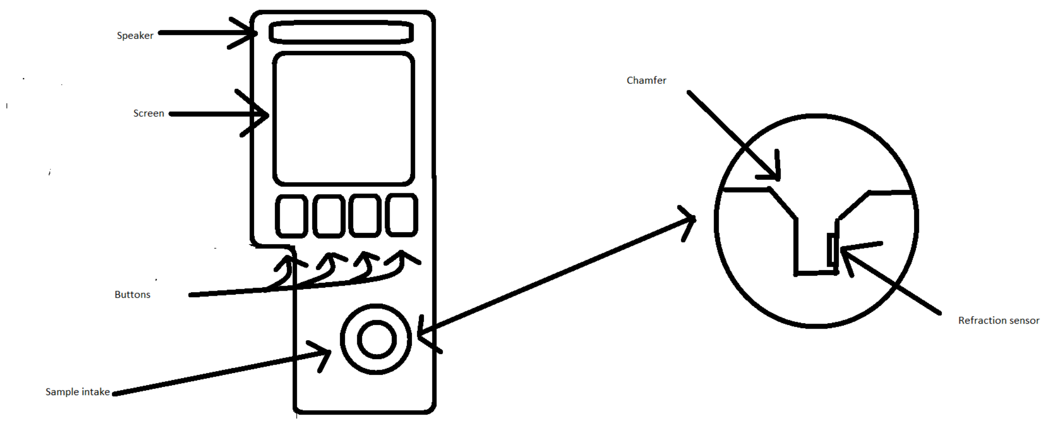


Figure 37: Christopher Zhang's Design C (Glucometer subsystem)

D Jerry Wang

D.1 Lancing subsystem

D.1.1 Design A

The device is divided into three parts: the storage of the needle box, needle button and adjust the length and needle hole. The advantage of this device is that the needle can be stored in the pen holder without the need for successive replacement, and there is a button at the end to change the needle each time it is used (similar to a disposable pencil lead).

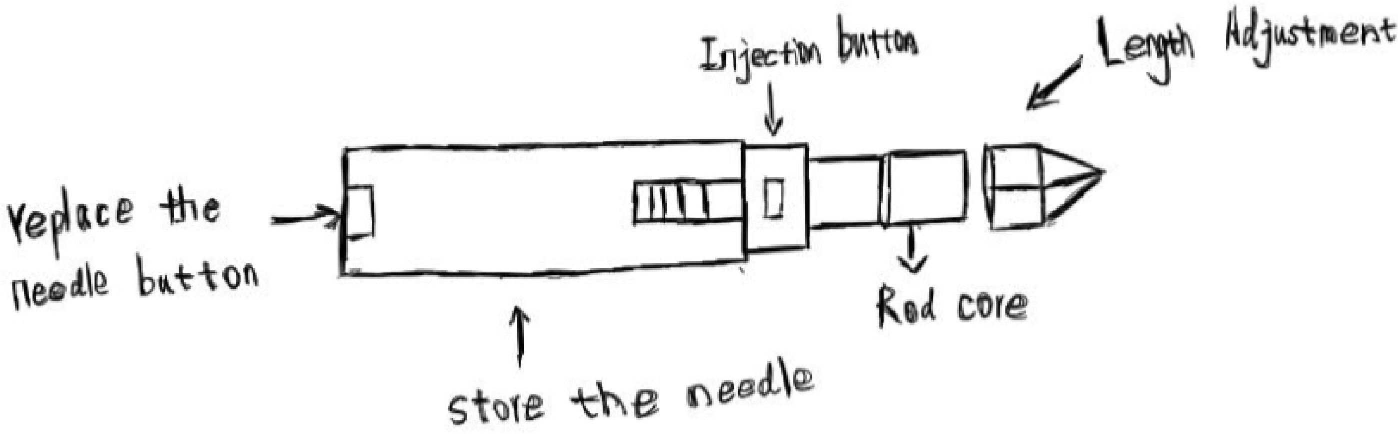


Figure 38: Jerry Wang's Design A (Lancing subsystem)

D.1.2 Design B

The device is similar to an automatic pencil. The back head can be removed and can store the needle in the pen holder. The front part adjusts the length of the needle.

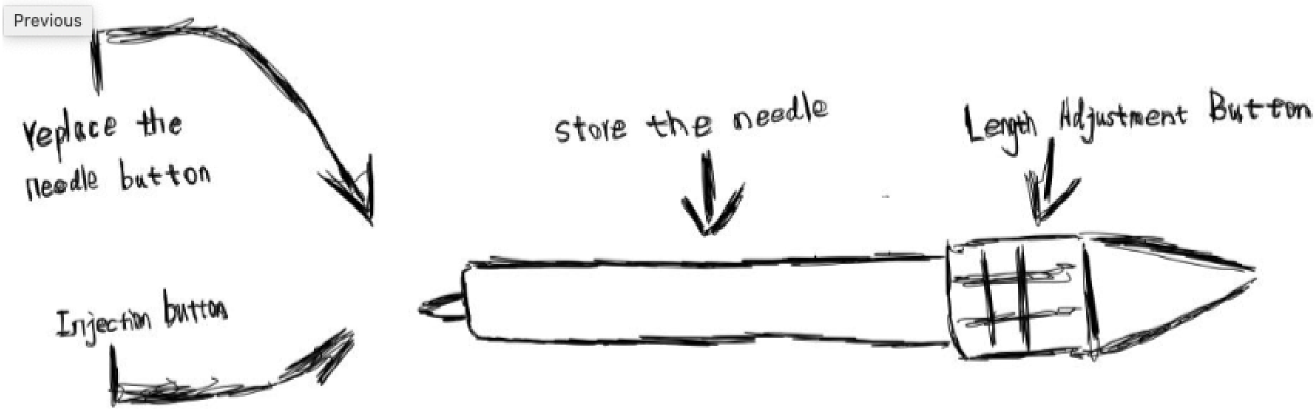


Figure 39: Jerry Wang's Design B (Lancing subsystem)

D.1.3 Design C

The advantage of this device is that it is small and easy to carry and equip. It contains a button to store the needle and push the needle, making it very easy for the user to use.

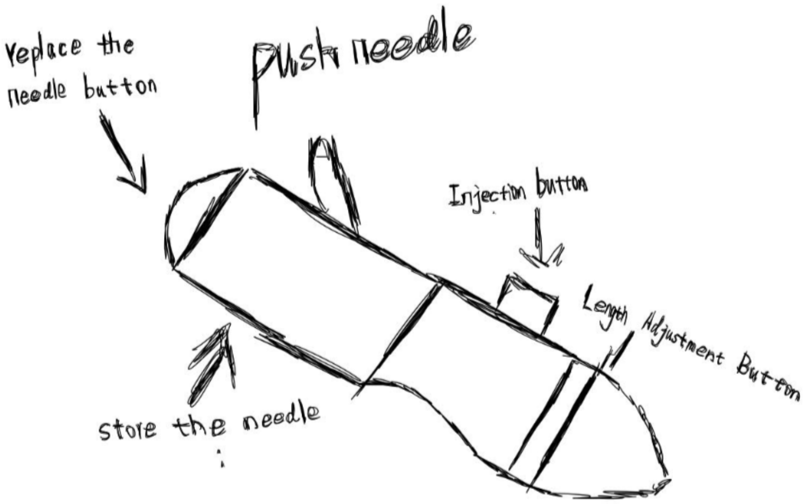


Figure 40: Jerry Wang's Design C (Lancing subsystem)

D.2 Glucometer subsystem

D.2.1 Design A

This screen can have three different modes. The first is simply data presented on a screen. The second way is to shrink the data into a two-screen display of both the measured data and the current data. The third is that the device will send an alert and vibrate to alert the user if the data exceeds the standard value.

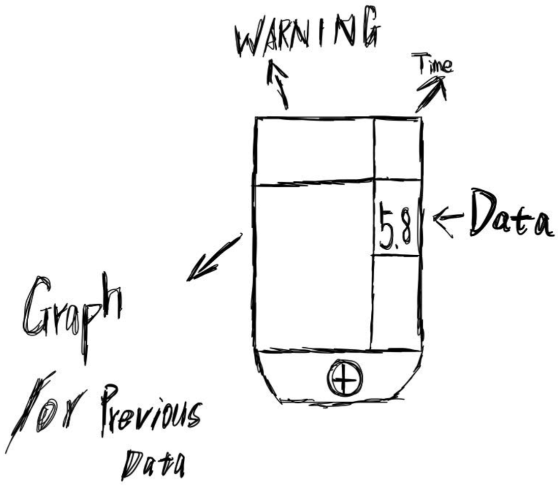


Figure 41: Jerry Wang's Design A (Glucometer subsystem)

D.2.2 Design B

The advantage of such a screen is that it can analyze the predicted response to each change in blood sugar. The benefit of this reaction is that it can determine whether other components of the blood are normal and help the user analyze the blood for potential diseases

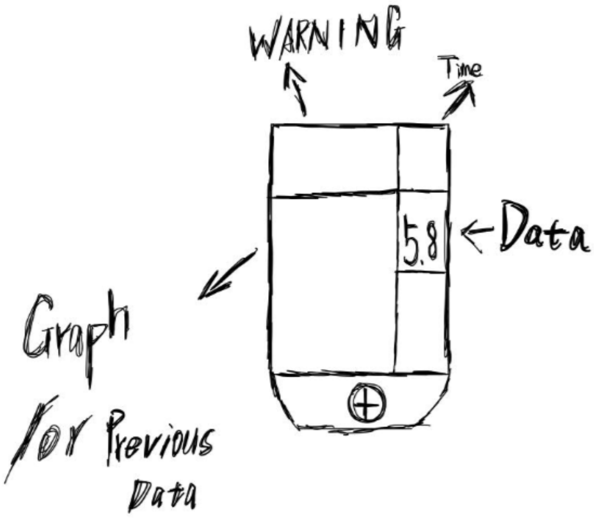


Figure 42: Jerry Wang's Design B (Glucometer subsystem)

D.2.3 Design C

The touch screen type glucose meter has complete functions. It can respectively show the changes of the past data, the harm in blood, the data threat alarm, some use suggestions and the network doctor supervision, so that it is convenient for doctors to remind timely when there is a problem and seek medical treatment as soon as possible.

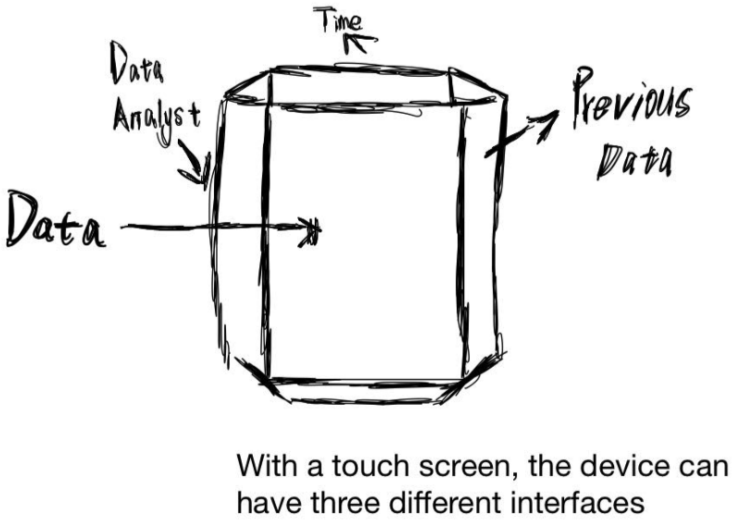


Figure 43: Jerry Wang's Design C (Glucometer subsystem)

E Lucas Hunter

E.1 Lancing subsystem

E.1.1 Design A

The "fully automatic glucometer" uses a custom lancing device controlled by an arduino. When a finger is inserted into the machine and pushes down on the padding (with a hole in it), it presses the buttons (#1 C) and activates the lance via the arduino. The lancets are easily replaceable via the door on the front of the machine (#2 B). The machine will not run with the door open.

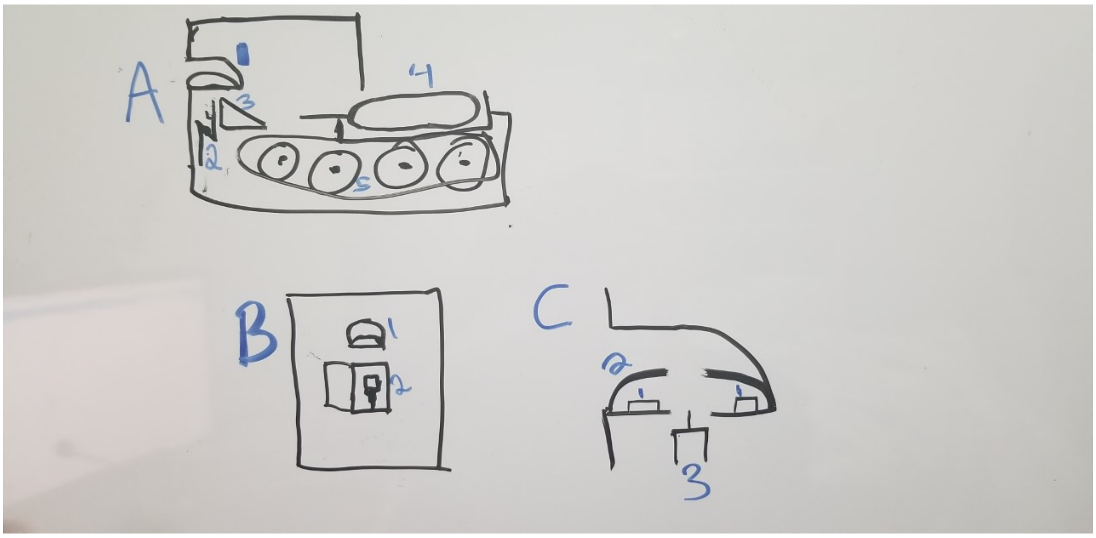


Figure 44: Lucas Hunter's Design A (Lancing subsystem)

E.1.2 Design B

The "mounted vehicle glucometer holder" uses a standard lance device (#1) that is secured to the stiff, movable arm (#3). This secures the lance, so that lancets can be replaced with one hand.

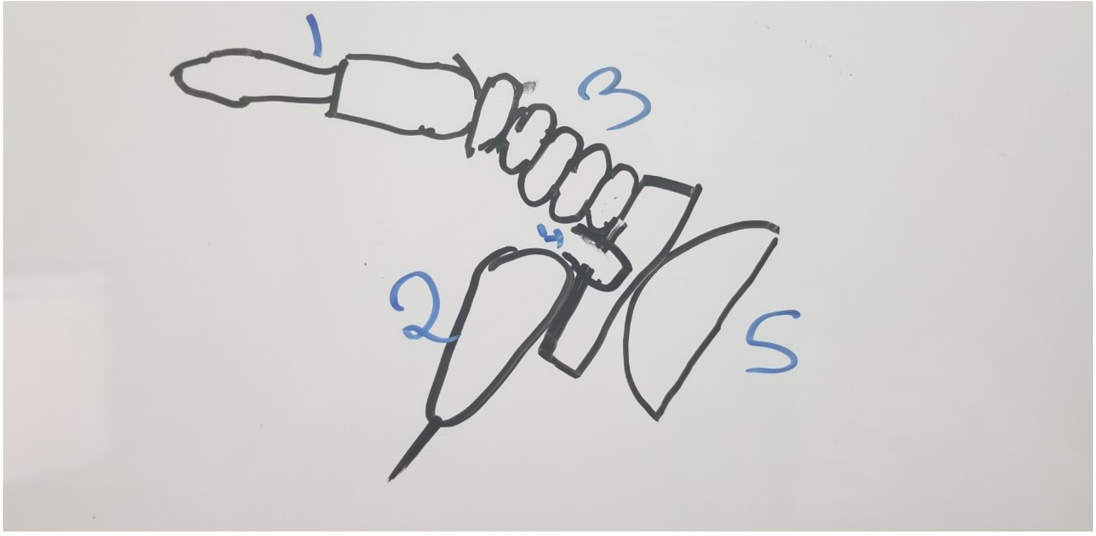


Figure 45: Lucas Hunter's Design B (Lancing subsystem)

E.1.3 Design C

The "blood tap" requires no lance as there is already a place to draw blood from.

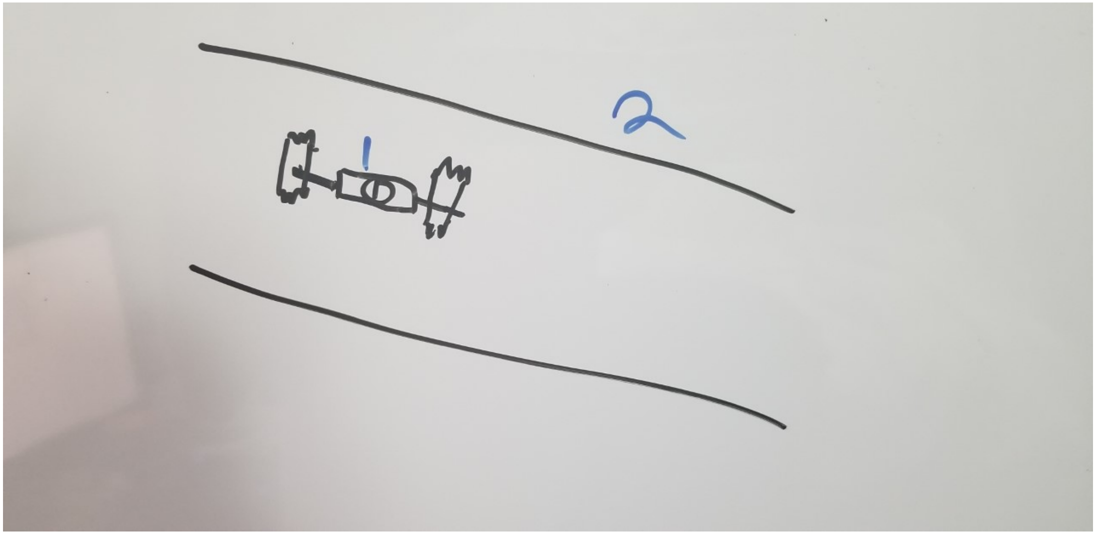


Figure 46: Lucas Hunter's Design C (Lancing subsystem)

E.2 Glucometer subsystem

E.2.1 Design A

The "fully automatic glucometer" uses a standard glucometer (#4 A) that is placed into the back of the machine with a test strip inserted. Once the finger is pricked, the glucometer is moved forward, causing the test strip to hit a ramp, angling the test strip up to contact the pricked finger and getting a blood sample. The glucometer is then moved back out for easy reading.

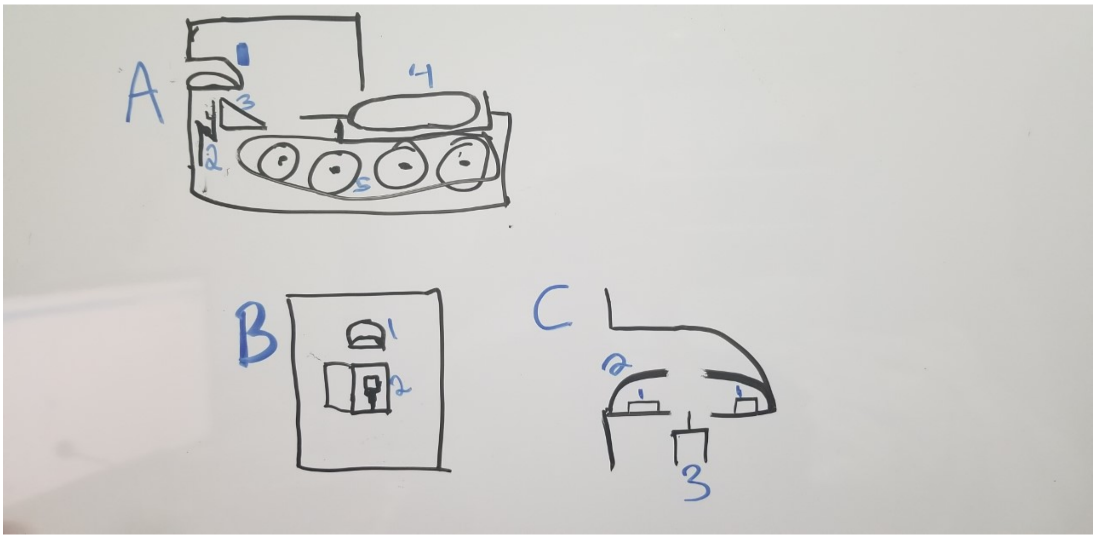


Figure 47: Lucas Hunter's Design A (Glucometer subsystem)

E.2.2 Design B

The "mounted vehicle glucometer holder" uses a standard glucometer (#2) that is mounted to the base. Testing strips for the glucometer are mounted on the side of the base.

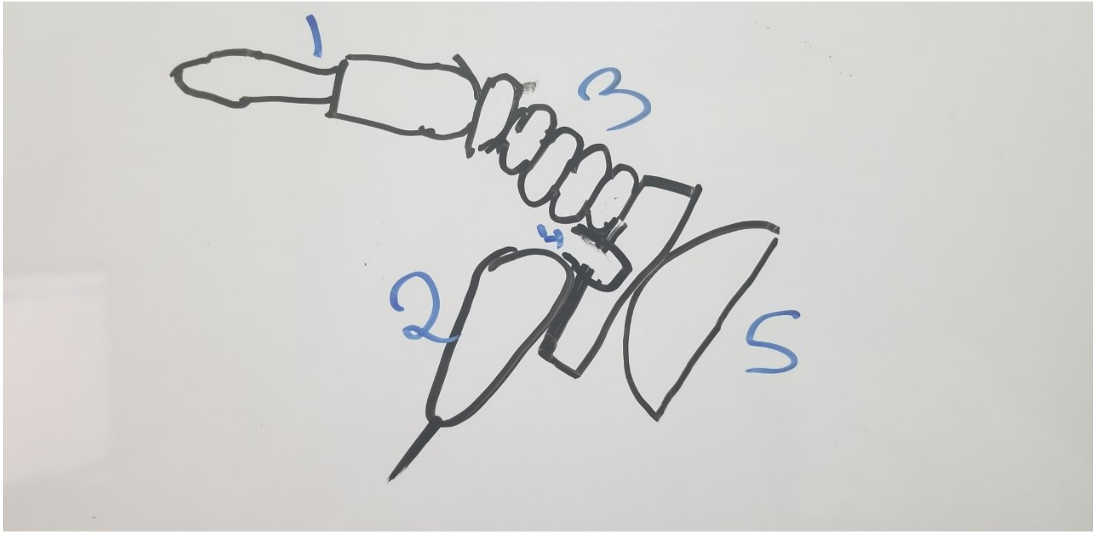


Figure 48: Lucas Hunter's Design B (Glucometer subsystem)

E.2.3 Design C

The "blood tap" is used with a standard glucometer.

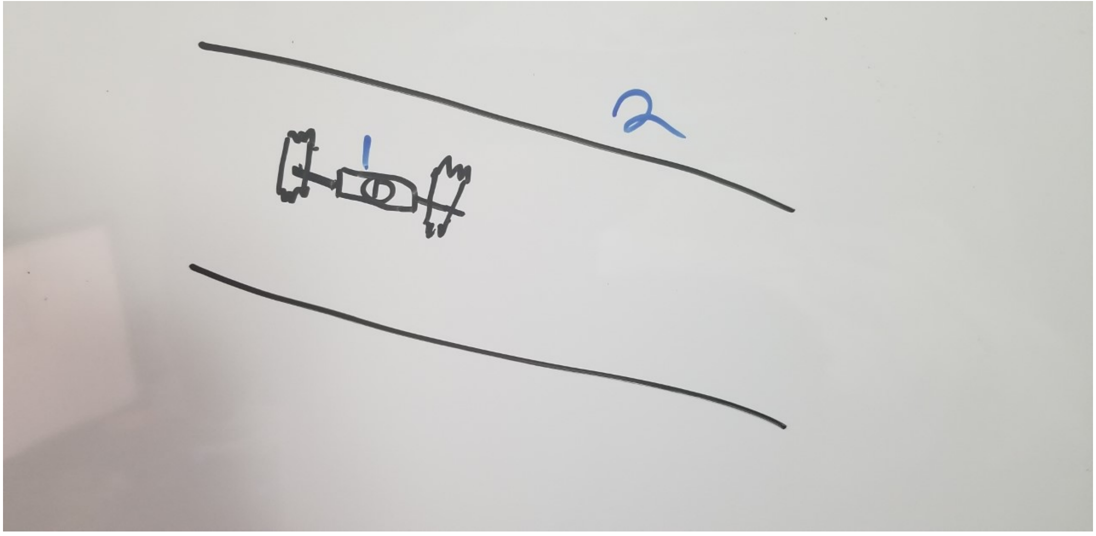


Figure 49: Lucas Hunter's Design C (Glucometer subsystem)

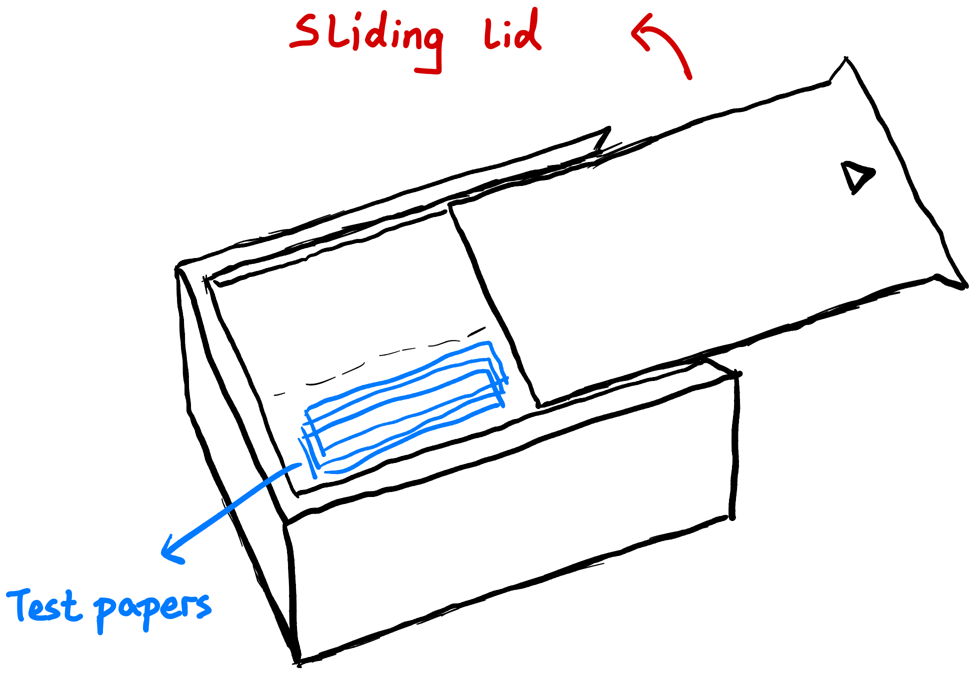
F Bowen Zeng's prototypes

F.1 Prototype [subsystem 1] (design 1)

[Subsystem] Test papers container

Prototype 1 : sliding lid box

Difficulty : ★



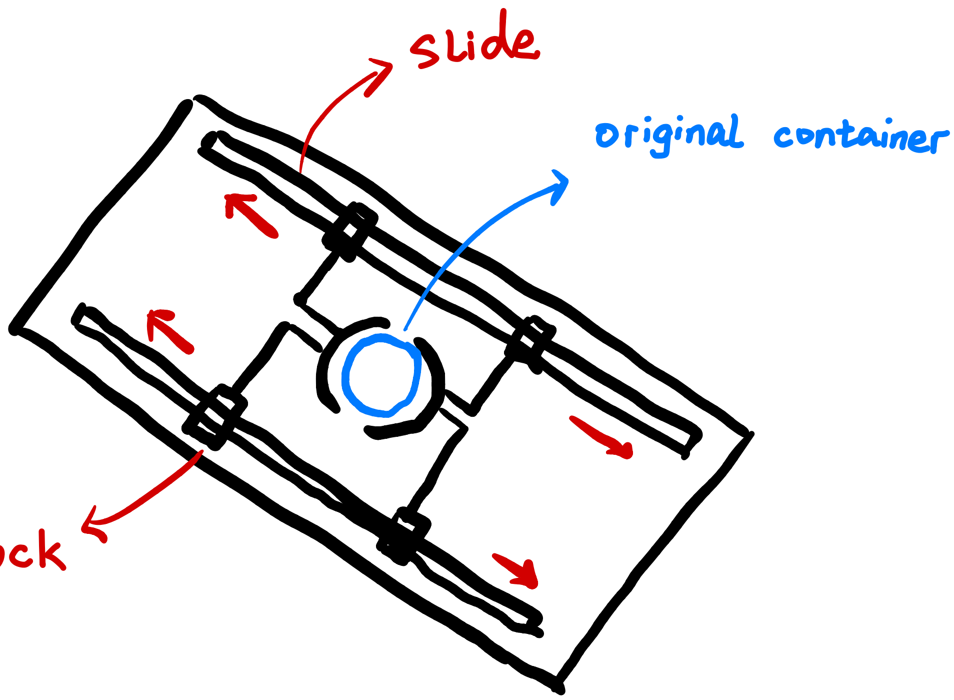
The bottom of the box will be fixed to the product. So the user only need to slide the slide cover with one hand to open the box.

(Simple, relieble . Recommended)

F.2 Prototype [subsystem 1] (design 2)

Prototype 2: Original container adapter

Difficulty: ★★★



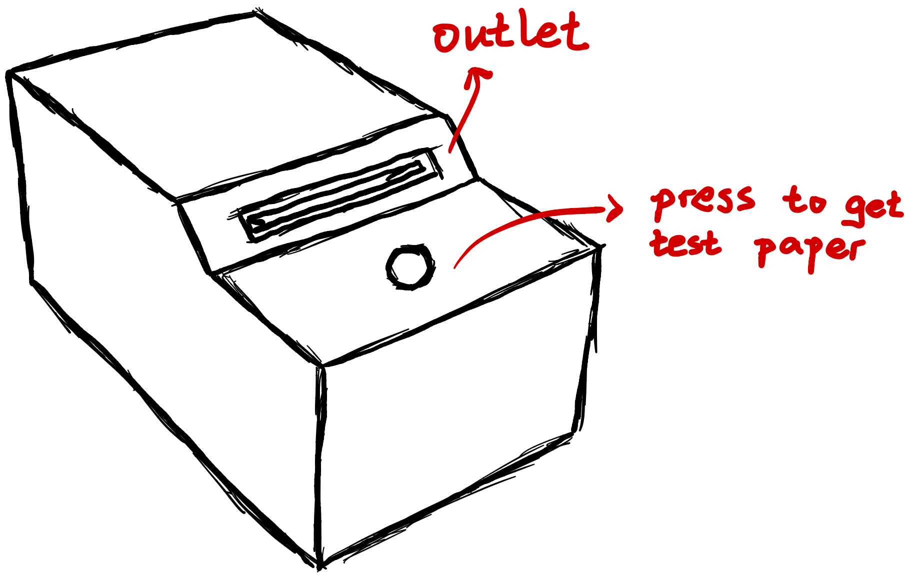
In this prototype, we did not create a new container to store the test paper, but fix the original packaging to our product. So the user can open the lid with one hand and take out the test paper.

(May cause compatibility issues, not recommended)

F.3 Prototype [subsystem 1] (design 3)

Prototype 3: Automatic machine

Difficulty: ★★★★★



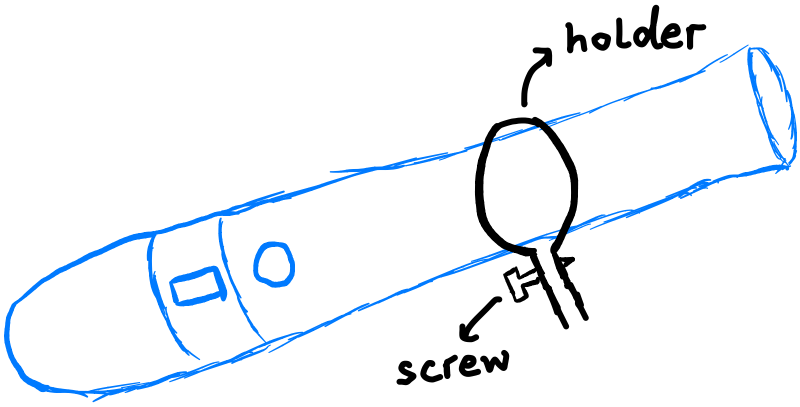
Ultimate solution, based on a complex smart system. User can get the test paper by press the button

(Too complex, not recommended)

F.4 Prototype [subsystem 2] (design 1)

[Subsystem] Lancing device helper

Prototype 1 :

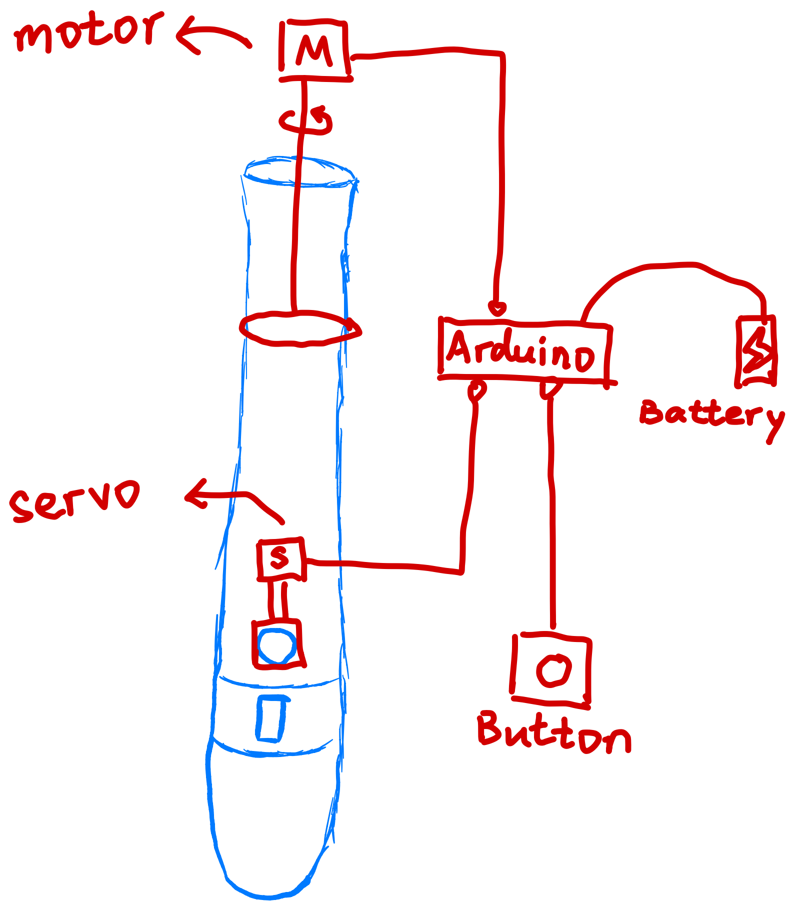


Most lancing device are cylindral. we can make a fixer to fix it on our product, Like mudguard and bicycle. Then user can use the device with one hand.

(Simple and reliеble)

F.5 Prototype [subsystem 2] (design 2)

Prototype 2:



Use mechanical components (motor, servo) instead of manual to rotate the device and puncture the finger. Only need to press the button.

(complex)

F.6 Prototype [subsystem 2] (design 3)

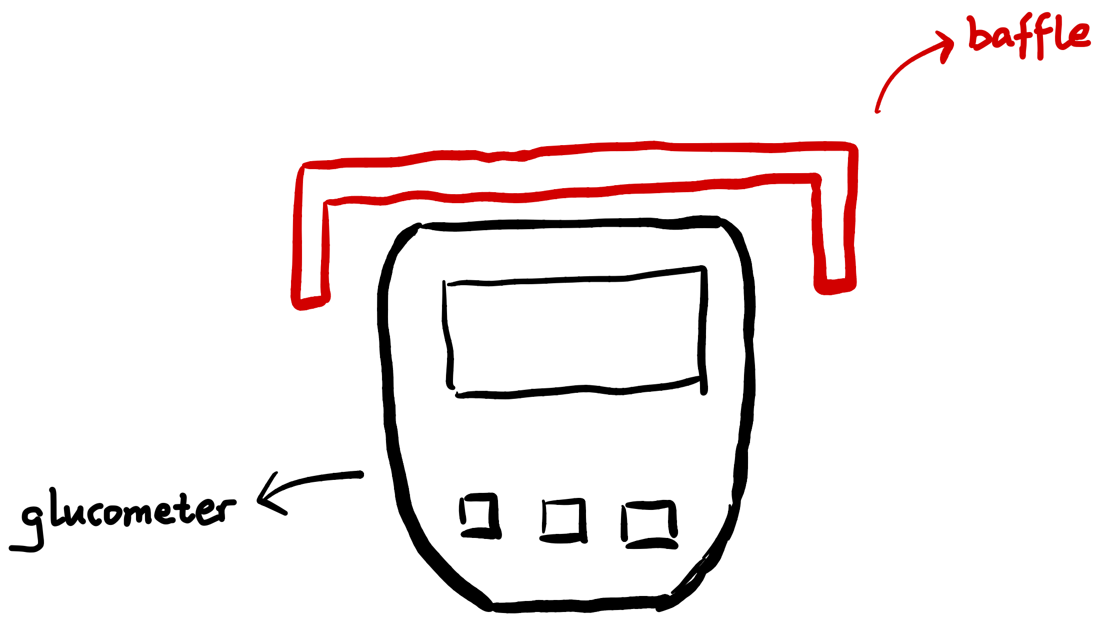
Prototype 3 :

Make a lancing device by ourselve.

(May cause safty problem)

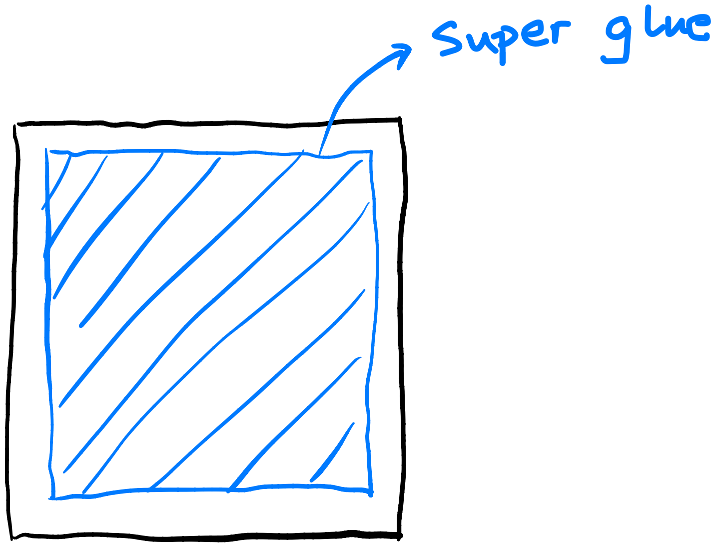
F.7 Prototype [subsystem 2] (design 1)

[Subsystem] glucometer holder
Prototype 1: Baffle

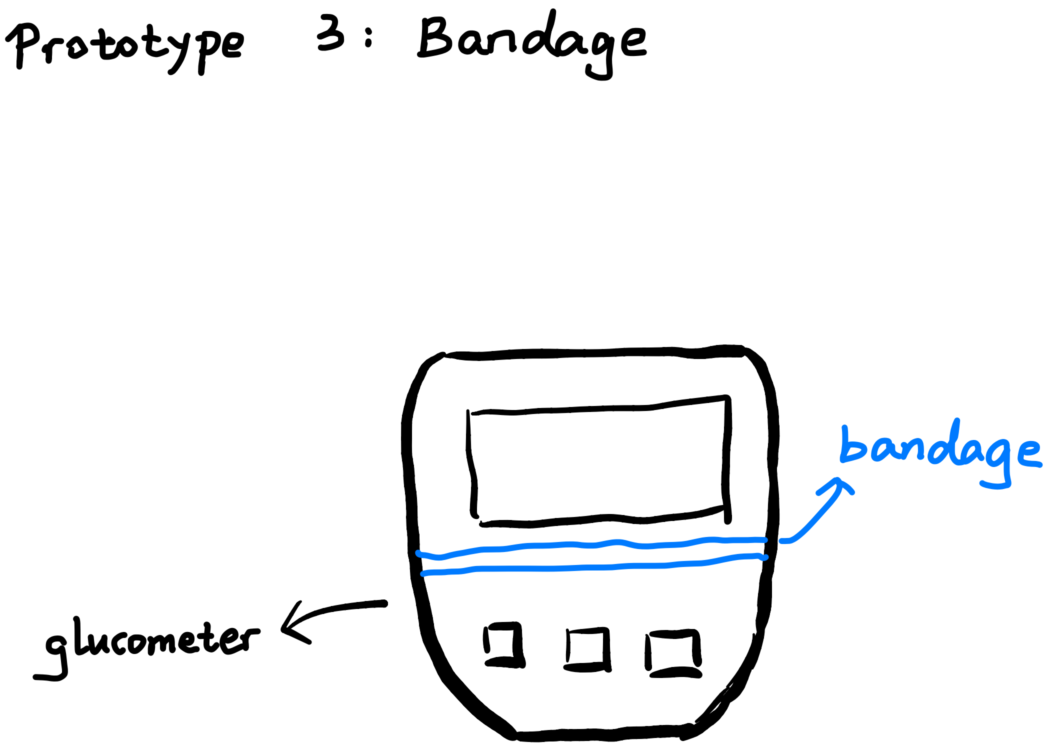


F.8 Prototype [subsystem 3] (design 2)

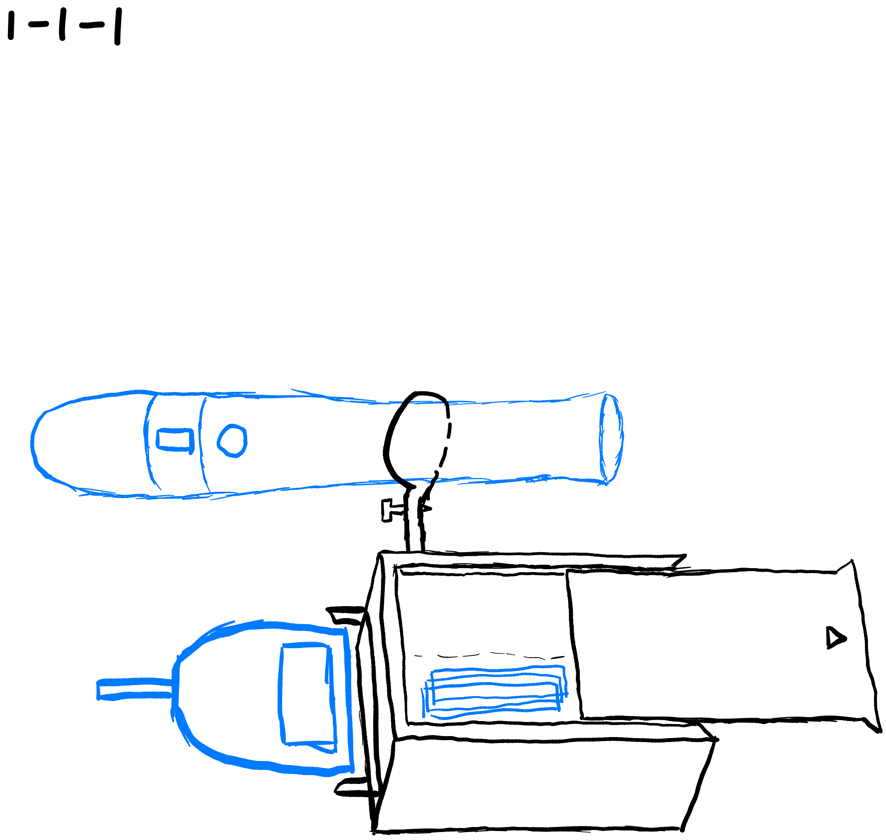
Prototype 2: Super glue



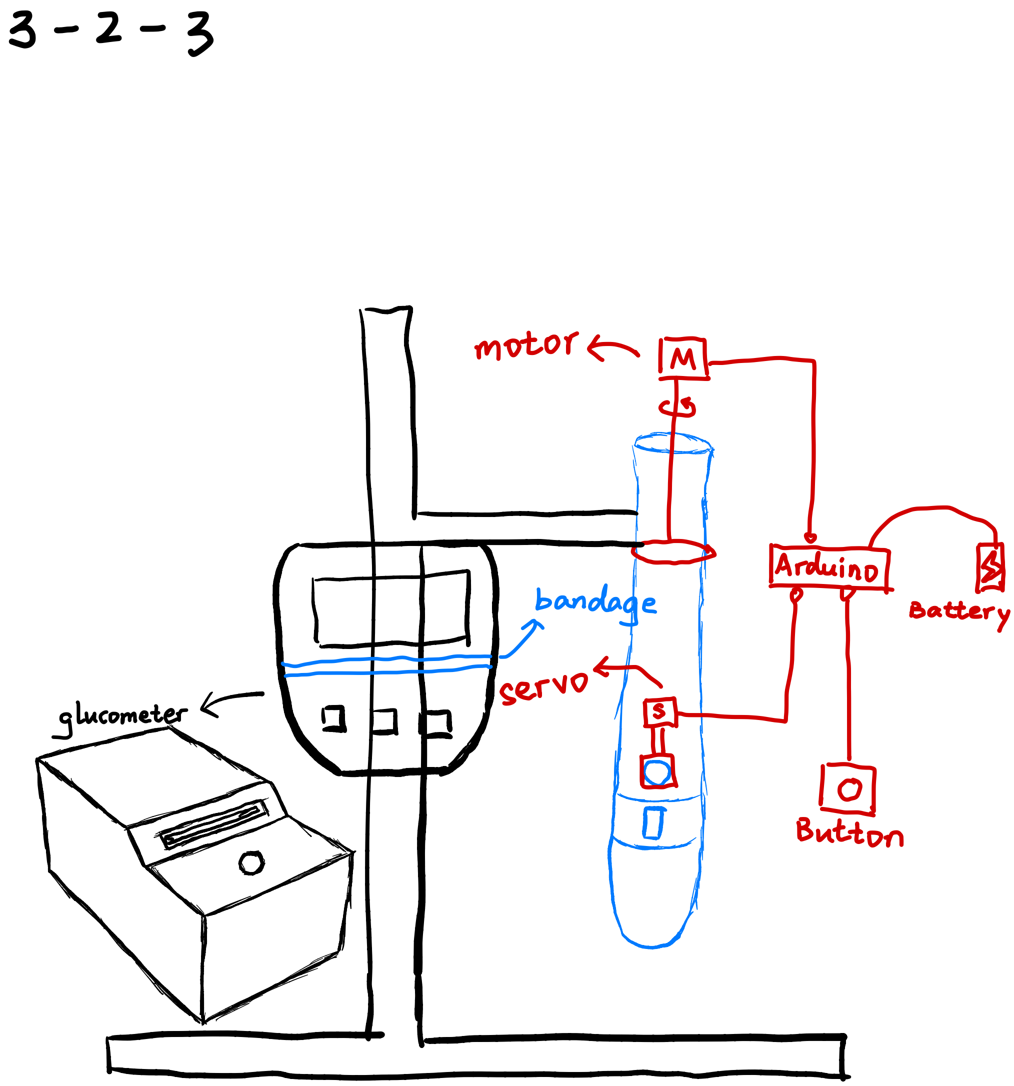
F.9 Prototype [subsystem 3] (design 3)



F.10 Design 1 (combination 1-1-1)



F.11 Design 2 (combination 3-2-3)



F.12 Design 3 (combination 1-2-3)