Project Deliverable F
Large Font Pedometer

Submitted by

Team 10 - The Next Step

Andy Saber, 300166437

Best Osajie, 300163327

Caroline Tippins, 7691410

Eshaan Kunchur, 300176301

Yusuf Hilal, 300202318

November 4, 2021

University of Ottawa

Table of Contents

Table of Figures and Tables

Introduction

DEEN Support Services is a charity service that needs a large font pedometer for an individual with visual disabilities. Through the GNG 2101 course at the University of Ottawa our team was chosen to implement this idea. We already had two initial meetings with DEEN and many brainstormed design ideas to pitch our prototype and collect feedback.

This deliverable aims to cover the main points of the third meeting, as well as any other contact we had with the client. A detailed design will also be presented as an improvement to the design ideas we pitched to the client. This deliverable will also review our first prototype and present our second, more physical prototype. This deliverable has a target of explaining the changes made to our prototype, as well as the improvements and details of our design.

Summary of Client Meeting 3

Throughout the third client meeting, we presented a slideshow summarizing our work done so far. We started off by showing our client the previous prototype designs we had in mind and then presenting our improved design concepts that satisfied their needs. We showed them the integration of buttons we would like to apply. They responded positively to this idea an gave us great feedback to make sure it is an audible clicking button that produces a sound after a mechanical click.

After a discussion with the client on whether to implement the button(s) on the top of the pedometer or the side, they concluded that they would want it on the side of the pedometer, so it is better for their user.

A conversation took place about the colour of the writing and background choice for the pedometer display. We came to a clear agreement that we will be using yellow writing and a black background as we tested it to optimize visibility and reduce glare.
All around the third client meeting was a success as it cleared up any group uncertainties. We are now on track to completing the pedometer. After all the client feedback our group has taken the clients information and used it to improve our current prototypes solution.

Brief Overview of Prototype 1

The first prototype aimed to be a general overview of the way our product would look and function. Its main purpose was to test the feasibility of the design concept, as well as lay out and test some key aspects. The pedometer was initially presented to be a waist pedometer, but the idea was changed into a wrist pedometer after further discussion with the client. Therefore, prototype 1 was designed to reflect the key components of the design. The main goals behind the prototype were to understand if the overall shape of the design would not be too uncomfortable and figure out what would be the best screen colors to optimize visibility. The following images and tables represent an early CAD model, a basic circuit design, and a table with all the tested colors that were included as our first prototype.

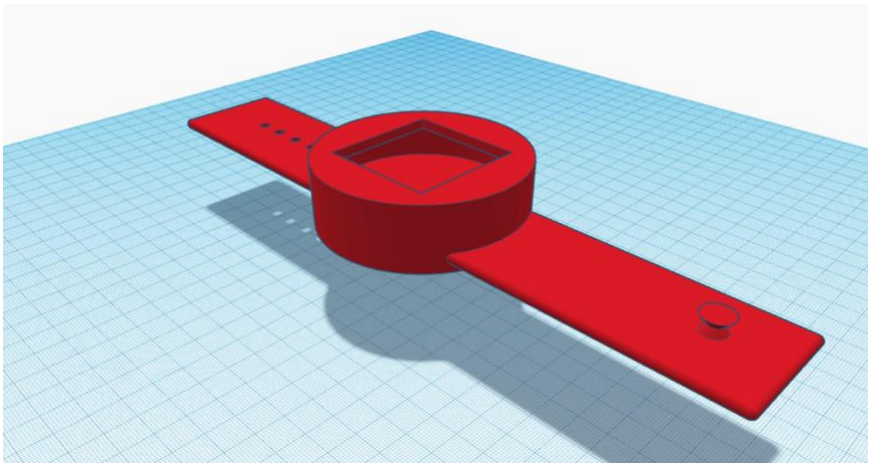

Figure 1. Initial CAD design with wrist straps

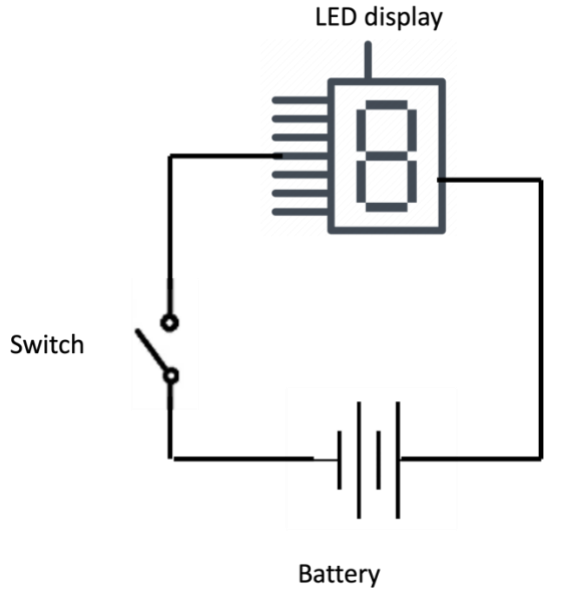

Figure 2. A rough look at the electric connections for our design

Table 1. Testing of different colors to ensure visibility

Text color	Background color	Ranking (out of 5)
Black	Yellow	4
Black	White	4
Pink	Light Grey	4
Blue	Black	2
Yellow	Black	2
White	Dark Blue	5
Bright Red	Black	3
Blood Red	White	1
Neon Green	Dark Grey	2

Critical Product Assumptions (Prototype 1)

These are the early product assumptions, but due to the nature of the first prototype, they could not be completely verified till the production of the second prototype.

The product's main function should be to count steps and display them with clarity. It should also be comfortable to wear as to not hurt the user. The buttons will also be easy to use and accessible, while not making it too easy to break. The case should be big enough to accommodate the parts but not too big that it is not wearable. The display will also have to have high contrast levels to be visible.

Improvements to be Made for Prototype 2

We focused on 3 main improvements for our second prototype. The first was to further develop the CAD model and begin 3D printing. This will enable us to ensure that the case size can accommodate all the electronic components. The wrist strap design also had to be improved so it can be produced in a realistic way. The second aspect that needed further work was the display. After understanding the optimal colors, we need to work with the actual display and motion sensing piece by developing a code that would work. We need to ensure the functionality of all the aspects together, where the screen works with the motion sensor, the buttons, the battery, and it all fits in the case and is secure.

Prototype 2

Our first prototype consisted of an analytical CAD model of the wrist band and pedometer holder. After getting the approval from the client, we purchased the necessary electronic components and refined our CAD design to 3D print the pedometer holder. Thus, we have now developed a physical prototype based on the feedback of our client.

Prototype Objectives and Testing Assumptions

This prototype aims to develop aspects that were missing in our first prototype, as well as provide a more physical design and representation. Another objective is to develop a program that can count steps accurately by utilizing the purchased electronic motion sensor/shake detector. We also attempt to figure out the functionality of the straps and the buttons and how they will be incorporated with the case.

Some testing assumptions were made to ensure that the prototype followed and fulfilled our objectives. The most important of those assumptions was that the case should accommodate the materials that the strap will be made of. Another assumption was that the decided-on color combination might not be the best for our screen, and that it may have to be changed upon further testing with the display.

Description/Documentation of the Prototype
This prototype was broken down into 2 main parts, with some subfunctions for each.

1) The 3D case which will house the pedometer components.
This part of the prototype includes the case design and physical 3D printed model, a theoretical place for the buttons, and an example of the strap. The following image is a representation of the case, with space for the buttons, and a makeshift strap that represents a strap that will be made in the future.

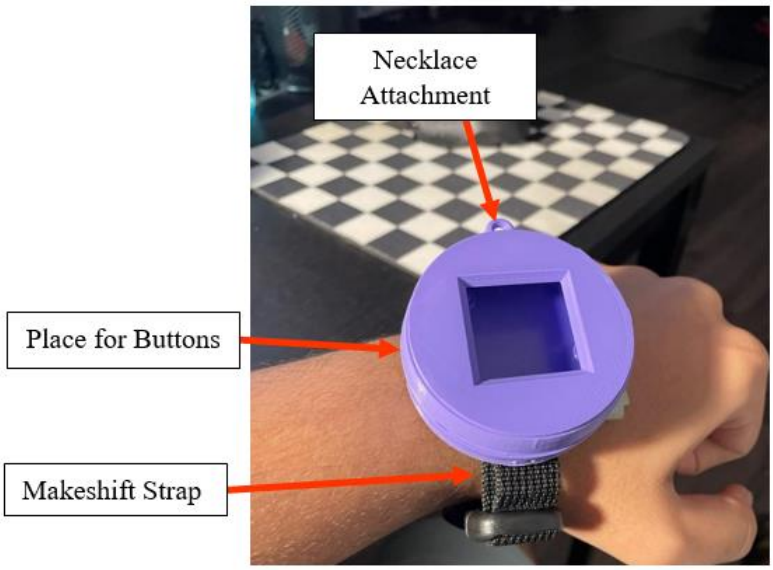

Figure 3. 3D Printed Case with Some Attachments

The case was designed using TinkerCAD and printed at the University of Ottawa's Makerspace. The material used was PLA, because of its rigidity and how cheap it is. The case was also broken down into 3 parts to ease the printing and assembly. As shown in the figure above, the case also included space for the buttons. The wrist strap was made using a spare backpack strap taped to the case. Another image is shown that presents the parts of the case designed in TinkerCAD with the electric components in blue.

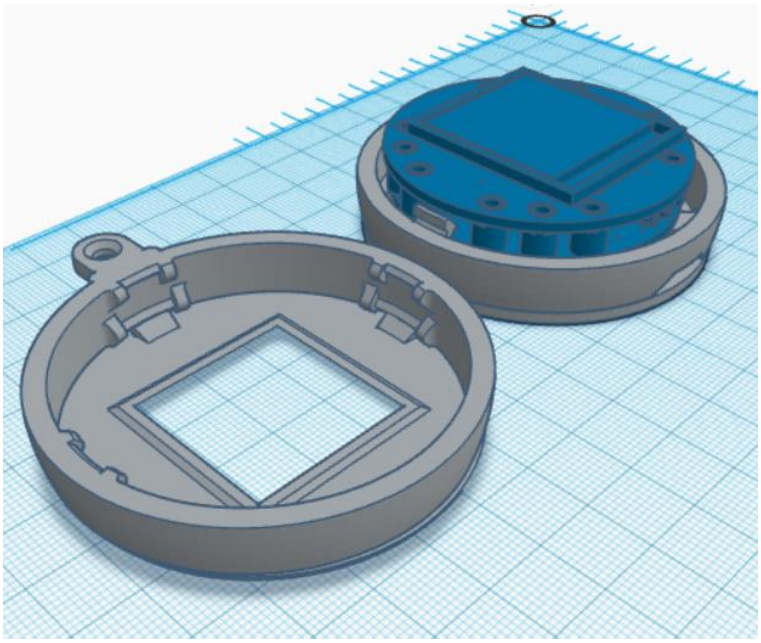

Figure 4. CAD Model of the Case (Blue Parts are the Display and Controller)

2) The display screen of the pedometer.

The electronic prototype was broken down into the display colors, the step detection, and the code to control the display and motion sensor. This was done using the Adafruit Circuit Playground circuit board, which allowed us to easily control the Circuit Playground TFT Gizmo - Bolt-on Display screen. The controller uses motion detection and saves a Circuit Python code that programmed (*see Appendix*) to display the step count on the screen as shown below. The colors were also very roughly tested on the display, but not really focused in since the main objective of the prototype objectives was testing if it could accurately detect a step and display a count on the screen.

Figure 5. Circuit Playground TFT Gizmo - Bolt-on Display on top and Adafruit Circuit Playground controller on the bottom

Prototype Testing

1) Case Design Test

Testing the case design was challenging given the time constraints and the difficulties obtaining highly accurate product dimensions. What we decided to do was to make a basic CAD model of a case that would store the electronic components and leave the buttons to be integrated afterwards by drilling holes through the case. The case was designed as a clip-on of three parts, where every part gets clipped on to make the whole case as shown in the figure below.

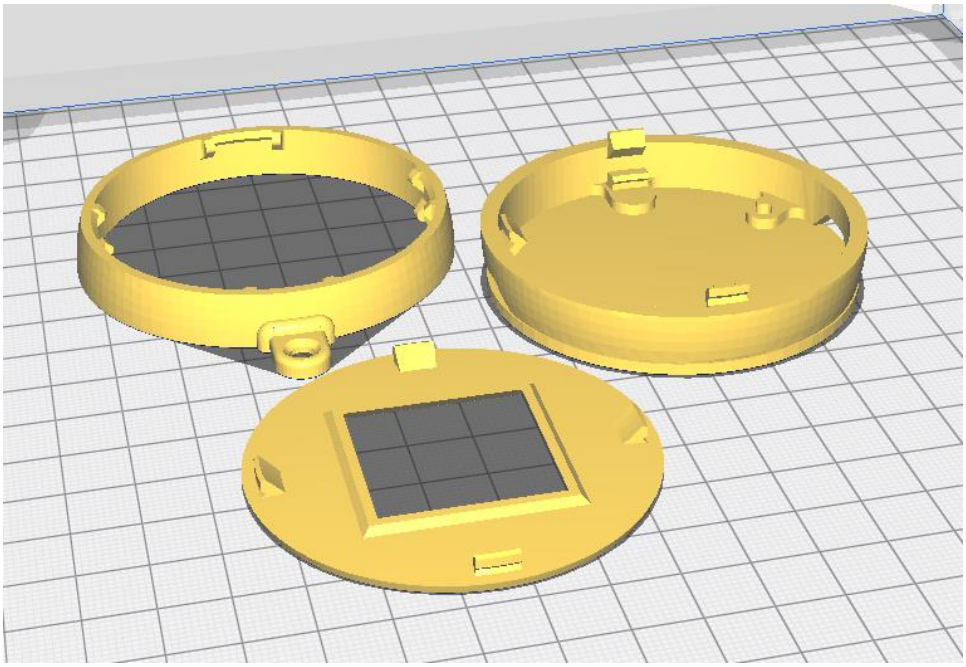

Figure 6. The 3 Pieces of the Case Before Printing

The case was then printed and tested for waterproofing and size, by ensuring that the clips are secure and don't allow for water leakage. We found out that the sizing and clips would have to be exact, and that if done well, the case would be completely waterproof. Also, a part was added to allow for the possibility of a chain-like attachment. Further tests were done with the actual electrical components, and a securing mechanism was added for the pieces. This part of the prototype is great because the testing is continuous. We show the client a design, they give us feedback, and we keep on going in this cycle till we achieve the closest thing to perfection. Here are some pictures of the current model:

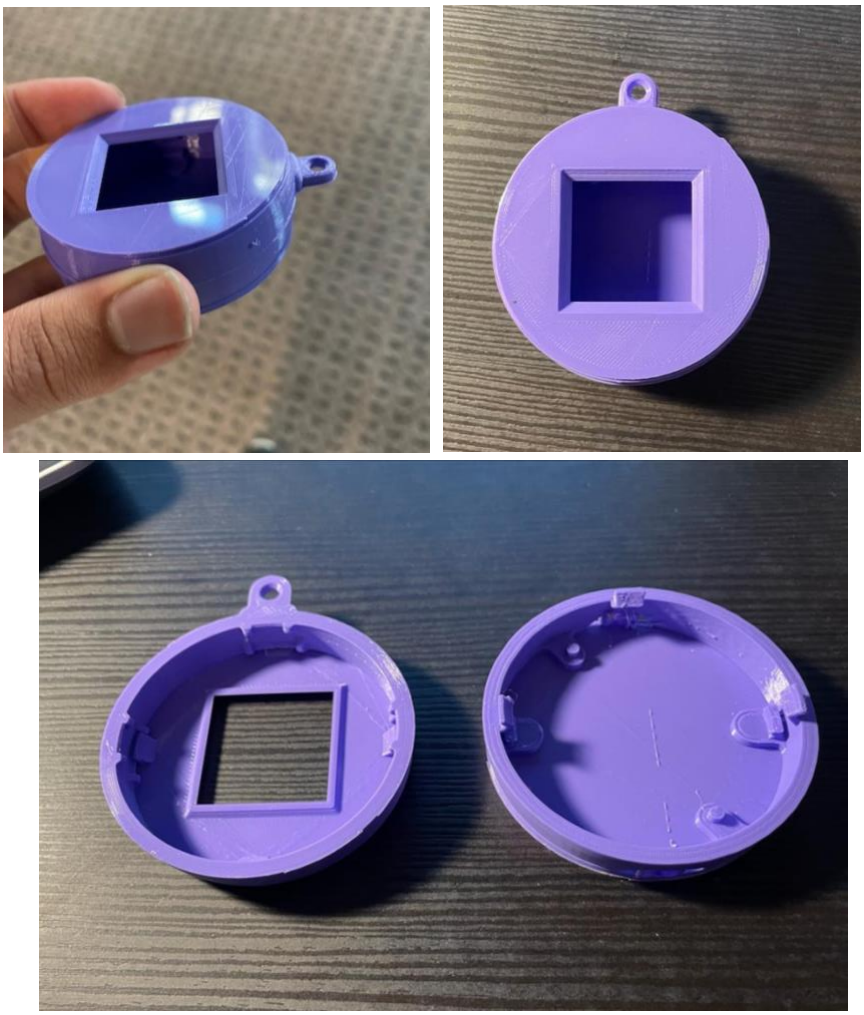

Figure 7. Multiple viewing angles of the 3D printed case (side, top, open)

2) Color Testing

We decided to conduct a few tests with the screen dealing with different color combinations. We tried out a few colors and further strengthened our earlier findings that there were 2 optimal situations: light colors on dark backgrounds and vice versa. This is also an aspect of the project that will be continuously tested. The colors can also be seen in the code (*see Appendix*)

3) Code Testing

This part of testing was to implement a program that would track the steps based off the motion of the user. As the code was constructed, it was tested to see if the program was effective. In the first picture, we can see that the user shows the steps counted which is zero. In the second picture, we can see that the user begins to walk which we assumed the device would pick up the motion. In the third picture, we can see that the device did in fact pick up the motion and the testing for our program does work.

Figure 8. Code and Display During Step Testing (Before, During, After)

All these tests were based on a code that detected motion/shaking. We developed the code to only count a step after a certain threshold of motion was passed. This threshold was optimized and tested depending on the force of arm swinging while walking. Through multiple tests and modifications, we found out that an average walking threshold was 12 and above and anything in the range would count as a step the full code can be found in the appendix.

Reflection

Our second prototype was instrumental in understanding how all the pieces of our pedometer physically work. The prototype was successful in testing our design and verifying our assumptions. The objectives were also met since we were able to print a 3D case and make the pedometer count steps as required. Compared to the first prototype, this second one is a big leap forward and brings us closer to making a complete project. Table 2 represents an updated version of our target specifications compared to the actual values.

Table 2. Overall Prototype Testing with Regards to Target Specifications

#	Design Specification	Relations (=, < or >)	Value	Units	Verification Method	Expected Value	Actual Value
Functional Requirements							
1	Display Size	>	50x 50	mm	Analyze	60x 60	53.3x 53.3
2	Weight	<	100	g	Test	70	59.1

3	Clarity of the display	=	Yes	N/A	Test	Any high contrast colors	Black and Yellow
Constraints							
1	Cost	<	100	$	Experiment	100	93.20
Non-functional requirements							
1	Water-Resistant	=	Yes	N/A	Test	Complete Resistance	Partial Resistance
2	Auditory features	<	80	dB	Test	50	Not yet Implemented

Future Work

Onwards, we look forward to putting all our functions together to construct our full and final prototype. Although, there are still few requirements need to be implemented to produce our final prototype. These requirements include:

- Reworking the dimensions of case to fit exactly with device
- Reconstructing the case to be able to be incorporated with buttons and wires that will be added
- Design a strap that will be easy to fit with the device and case
- Update the program code so that it matches new functions being included such as the buttons and buzzer sounds
- Integrate the buttons in the case and integrate them into the pedometer.

Ideally, our team will be improving our prototype each day to make sure that everything is running smoothly and that there will be no problems in the future. We plan on meeting up at least twice a week as a group to consult what needs to be done for our design.

Updated Project Plan

As illustrated in the Gantt chart, we have a completely updated project plan with a great number of details for the next 2 weeks, and a rough schedule for the next month. It can also be seen that every task has one member responsible for it to ease the understanding of who does what. With that in mind, we also make sure to check in with each other and always ask for help when needed. An important part to note is that we take into consideration our time frame and that we are busy on days like Tuesday, Friday and Saturday. Therefore, we made sure to always have tasks on other days or over multiple days if they include those 3 days. Also, we always have Thursday to check for quality and give us time just in case we're late.

Conclusion

This deliverable summarized the client feedback from our third meeting, displayed our first prototype, developed our second prototype which will help us focus on our final prototype, and indicated our testing results based off our target specifications. It is important that we develop a product with a client-first mentality, thus checking in with our client for the final time helps us refine any details for our final prototype. In the next coming weeks, our goal is to complete our third and final physical prototype with all our key features included. This also includes having a software program that runs at our command based on the instructions we give to the pedometer. Overall, our group is on track to complete our final prototype in the given time we are alluded to.

Appendix

Python Code:

```
# SPDX-FileCopyrightText: 2021 ladyada for Adafruit Industries
# SPDX-License-Identifier: MIT

import time
import displayio
import terminalio
from adafruit_gizmo import tft_gizmo
from adafruit_display_text.label import Label
from adafruit_display_shapes.rect import Rect
from adafruit_bitmap_font import bitmap_font
import adafruit_ble
from adafruit_ble.advertising.standard import SolicitServicesAdvertisement
from adafruit_ble_apple_media import AppleMediaService
from adafruit_ble_apple_media import UnsupportedCommand
from adafruit_circuitplayground import cp


#------------DISPLAY#------------
BACKGROUND_COLOR = 0x49523b  # Gray
TEXT_COLOR = 0xFF0000  # Red
BORDER_COLOR = 0xAAAAAA  # Light Gray
STATUS_COLOR = BORDER_COLOR

def wrap_in_tilegrid(filename:str):
    # CircuitPython 6 & 7 compatible
    odb = displayio.OnDiskBitmap(open(filename, "rb"))
    return displayio.TileGrid(
        odb, pixel_shader=getattr(odb, 'pixel_shader',
displayio.ColorConverter())
    )

def make_background(width, height, color):
    color_bitmap = displayio.Bitmap(width, height, 1)
    color_palette = displayio.Palette(1)
    color_palette[0] = color

    return displayio.TileGrid(color_bitmap,
                              pixel_shader=color_palette,
                              x=0, y=0)

def load_font(fontname, text):
    font = bitmap_font.load_font(fontname)
    font.load_glyphs(text.encode('utf-8'))
    return font

def make_label(text, x, y, color, font=terminalio.FONT):
    if isinstance(font, str):
        font = load_font(font,
"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz.,?()")
    text_area = Label(font, text=text, color=color)
```

```
    text_area.x = x
    text_area.y = y
    return text_area

def set_label(label, value, max_length):
    text = "{}".format(value)
    if len(text) > max_length:
        text = text[:max_length-3] + "..."
    label.text = text

def set_status(label, action_text, player):
    label.text = "{} on {}".format(action_text, player)
    _, _, label_width, _ = label.bounding_box
    label.x = display.width - 10 - label_width

display = tft_gizmo.TFT_Gizmo()
group = displayio.Group()
display.show(group)



while True:
    '''
    if cp.shake(shake_threshold=12):
        print("Shake detected more easily than before!")'''
    print("here")

    # Draw the text fields
    #group.append(wrap_in_tilegrid("/A_black_image.bmp"))
    title_label = make_label("None", 12, 30, TEXT_COLOR, font="/fonts/Arial-
Bold-18.bdf")
    group.pop()
    group.append(make_background(240, 240, BACKGROUND_COLOR))
    border = Rect(4, 4, 232, 200, outline=BORDER_COLOR, stroke=2)
    group.append(title_label)
```