

GNG 2101  
**Design Project User and Product Manual**

**PROJECT DELIVERABLE I: USER AND VIDEO MANUAL**

Submitted by:

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December 5, 2021

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# List of Acronyms

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**Table 1. Acronyms**

<b>Acronym</b>	<b>Definition</b>
BOM	Bill of Materials
UPM	User and Product Manual
9V	9-Volt

# 1 Introduction

This is the User and Product Manual (UPM) document for the course GNG 2101 from Team B22. Within this document are necessary information for our clients to effectively use our large-font pedometer. It also offers information about the prototype documentation of our product. The document is divided into seven parts: this introduction, an overview of the project and conventions, system setup and organization, the usage of the system, troubleshooting the system, product documentation, and a conclusion. The purpose of this document is to familiarize users with the setup, infrastructure, use, and maintenance of the large font pedometer product, while also providing adequate technical information for possible reproductions. This document is aimed for the users of the pedometer as well as other individuals like family members who may want to understand, construct, or improve our product.

## 2 Overview

According to StatsCan, roughly 5.6 million Canadians could potentially lose some level of their eyesight. More specifically, individuals from 40-79 have a 40% chance of suffering from some level of visual impairment. These same individuals can find it hard to find inexpensive products, like pedometers that accommodate their conditions. Pedometers are portable devices that measure the number of steps walked based on detecting vertical/horizontal movements at the hip or wrist. As most on-the-shelf/conventional pedometers can be difficult to see for those with visibility issues, our group worked on a product that would perform similar functionality but provide more accommodation to a larger, targeted audience...

The objective of our project is to develop a large font pedometer to help the client track their daily steps with a visually larger screen. The solution must satisfy the condition that the client can interact with a system normally outside their ability to interact with. The solution must also be inexpensive, high-contrast, simple to use, discrete, and easy to retrieve when misplaced. All the mentioned conditions are essential to the success of the product. Various store-sold solutions were benchmarked as fantastic standard during the brainstorming of our product. 3DFitBud for example, is a conventional pedometer that tracks daily steps when clipped onto one's clothing; however, the size of the screen is 2-inch x 1-inch.





**Figure 1: Final prototype**

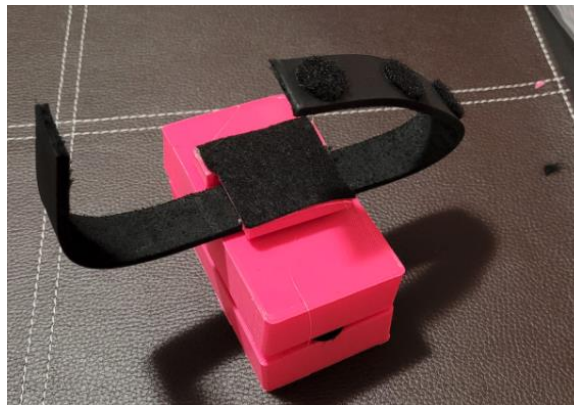
Our solution utilizes Arduino board, seven-segment display board, accelerometer, and open-source software to fulfil the mandate. It is a slick 3-inch x 2-inch device that increments step value upon detection of movements. The solution consists of a USB dock intended for recharging as well as a detachment band that can be swapped with a more preferred one or clipped onto the waist.

## **2.1 Cautions & Warnings**

- **DO NOT** operate this system until THIS document has been **FULLY** read and understood
- **DO NOT** use this product underwater
- **DO NOT** apply downward force on the product
- Prior to use **ALWAYS VISUALLY INSPECT** the product for any revealing internal components or sharp edges
- Prior to use ensure that the battery level is adequate during operation
- **DO NOT** leave the product near children (0-5)

### 3 Getting started

To start, the pedometer is acquired. If the components are not assembled, they are assembled in a sequence described below. If the components are assembled successfully, the pedometer can be worn onto the wrist/waist. The user can now begin walking, and the pedometer will count the steps. To remove the pedometer, the user must unclip/slip off the pedometer. The user can switch off the pedometer by opening the case and unplugging the battery.



**Figure 2: Acquiring the pedometer**



**Figure 3: Wearing the pedometer**

### 3.1 Set-up Considerations

To assemble the pedometer, a list of components is needed: The case, leather strap, Velcro sticky backs, a PC's seven-segment display board, a KeeYees Pro Micro Arduino board, a PC's accelerometer, a 9V battery, and some wires.

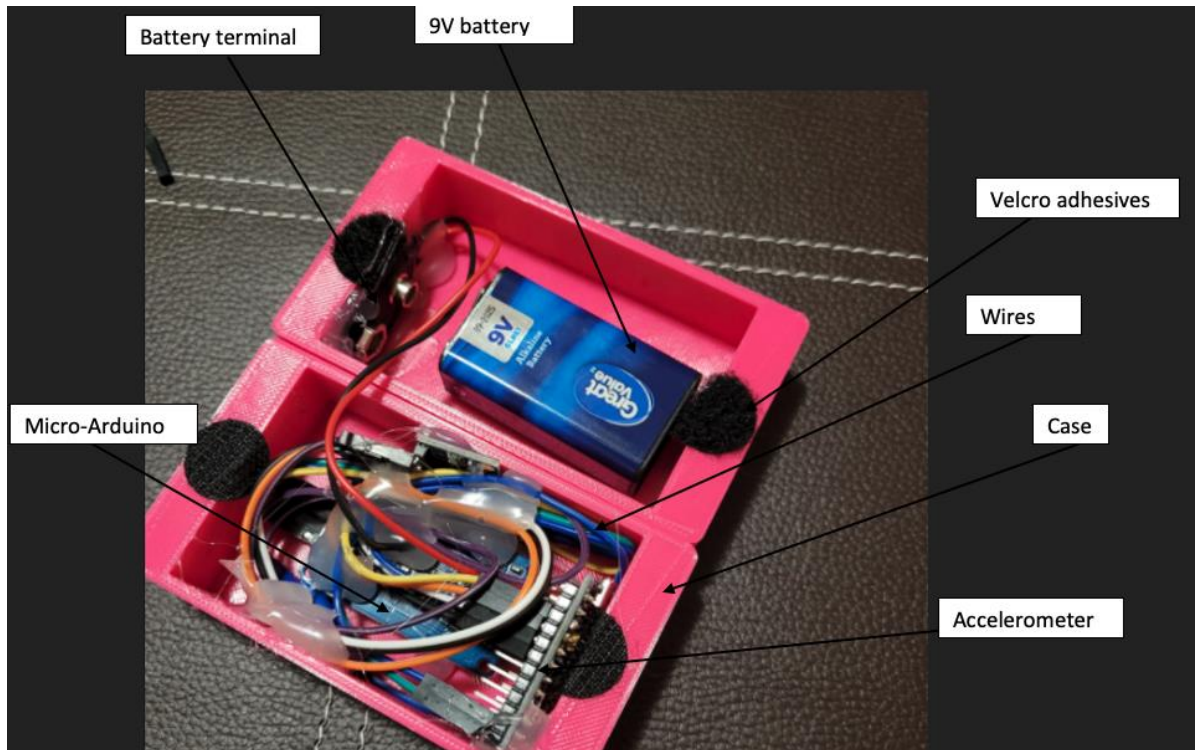


Figure 4: Components of set-up

Input devices: Accelerometer, 9V battery

Output devices: Seven-segment display screen,

## **3.2 User Access Considerations**

The users consist of mainly patients with visual impairments, as the pedometer is meant to visually enhance the size of the steps achieved, hence its overall physical size and low functionality. The main restriction of this prototype would be the large volume and visual appearance of the pedometer, as it stands out easily and can be a physical obstacle. The large volume needed to occur to fit in all components.

## **3.3 Accessing the System**

To setup the pedometer from scratch, the micro-Arduino must have the code installed onto it. The code will be supplied later throughout the document. The wires must be connected to the accelerometer, seven-segment display, battery terminal, and the micro-Arduino board, then they must be soldered onto the micro-Arduino board in a manner that will be discussed later in the document. The battery terminal must be glued to the inner wall of the case, with the 9V battery plugged into it. The screen should light up at this point. The Velcro adhesives must be placed between the two halves of the PLA casing and closed shut to contain the components. The removable leather strap is hooked around the protruding clip. The pedometer is now ready to be worn on the wrist by slipping it on.

If the user wishes to wear the pedometer on the waist, they must remove the leather strap, and attach the clip onto their pocket/waist.

### **3.4 Exiting the System**

To remove the pedometer, the user must simply remove the pedometer from their wrist or unclip it from their pocket/waist. To switch off or reset the screen, the case must be opened, and the battery must be unplugged.

## 4 Using the System

The following sub-section provide detailed, step-by-step instructions on how to use the functions of the large font pedometer.

### 4.1 Counting steps

The main subsystem that the user will interact with is the step-counting subsystem. As the user walks, the gyroscope detects changes in height and momentum and applies an Arduino function which calculates a single step. The gyroscope sends this information to the micro-Arduino, which then sends the information to be displayed on the screen. This is repeated in cycles depending on the user's movement. This function has been tested to prove that the steps increase based off natural walking movement, and not pure horizontal distance. There is no specific input needed from the user apart from walking, in exchange for the output on the screen.



**Figure 5: Display screen before taking a step**



**Figure 6: Display screen after taking a step**

## **5 Troubleshooting & Support**

This section will discuss the different risks of failure that the pedometer can go through and how they can be solved with the help of maintenance and technical support.

### **5.1 Error Messages or Behaviors**

A clear behaviour of error would be that the display isn't working, this could be due to the battery being depleted, or a cut in the wires. To fix this, check that all wires are connected without cuts. If so, then the issue must be the battery being depleted and hence the battery must be recharged.

Another behaviour of error would be if the adhesive Velcro's started to wear off, cause the case to slide apart. If this occurs, the user must replace the adhesive Velcro's.

### **5.2 Maintenance**

The only maintenance required by the pedometer would be to recharge the 9V battery around every 7 hours to ensure the battery doesn't die during usage. It is also advised to check on the Velcro adhesives every week to ensure they don't slip off. If so, they should be replaced as they are cheap and readily available.

### **5.3 Support**

If a certain aspect of the pedometer were to fail, an email should be sent to either of these contacts: Omar Shubair: [oshub055@uottawa.ca](mailto:oshub055@uottawa.ca) or Ben Primeau: [bprim080@uottawa.ca](mailto:bprim080@uottawa.ca). The email title should contain the word "pedometer" to ensure that the receivers know that a failure has occurred. The email should describe what happened, with evidence of the incident using pictures



and/or videos. The recipients will reply as soon as possible to handle the issue with guidance on how to fix the problem.

## **6 Product Documentation**

The final prototype consisted of many different components and can be split into 2 distinct categories: those being the physical components and the software components.

### **6.1 Physical subsystem**

Starting with the physical components, the basis of the case of the pedometer was initially designed on paper using hand sketches. Multiple iterations were designed and finally, all those different iterations were used to develop the product's final design. Refer to figure 7 for a picture of the final design. After that, we then started developing 3D renders of the pedometer's shell on Solidworks. The use of extrusion, cut extrusion, and fillets were mainly used to create the 3D parts. The .SLDPRT files are attached in the appendix to use as guidance. After the creation of the .SLDPRT files, they must be converted to .STL files in order to 3D print them. Similarly, to the design process, we developed many iterations of the pedometer's shell and 3D printed them at the Makerlab. Each iteration would build on the previous one and address design flaws such as parts not being the correct size or not fitting in properly. Refer to Figure 8 for a picture of the final 3D render. The 3D printed case was made of plastic, and we chose plastic for its light weight as well as its availability and low-cost. After obtaining the correct case, the 9V battery, Micro-Arduino, Accelerometer, Gyroscope, and wires were all assembled together. Many wires had to be soldered to the Micro-Arduino. Finally, Velcro adhesives were used to attach both parts of the case together (Figure 4). Initially, we considered using an LED back-lit screen but quickly realized that it was

way out of our budget and that we would need a specialized battery for it, so we settled for the seven-segment display. We also considered a rechargeable system using a USB cable but realized that that also was also out of our budget, so we had to settle for a 9V battery.

## 6.2 Software Subsystem

The software side mainly consisted of an Arduino library (<https://github.com/Perseus14/Pedometer>) used to interpret the shocks the gyroscope felt as steps and a library that sends that output to the seven-segment-display screen (<https://www.instructables.com/Tutorial-How-to-4-Digit-Display-Interface-With-Ard/>). The Arduino IDE was used to write the code that controlled the Arduino Micro-Controller using the C programming language. The reason the Arduino IDE was used specifically is because it is made and tailored specifically for the Arduino Micro-Controller, and since we were using that, using the Arduino IDE made developing the software a much more seamless process. Once all the physical components of the pedometer were assembled and connected, the pedometer's software ran perfectly.

## 6.3 Materials and instructions

Part Number	Part Name	Quantity	Cost(\$CAD)
1	KeeYees Pro Micro Arduino board	1	11.99
2	PC's Seven-segment display board	4/1	17.89/4.47
3	PCs Accelerometer/ Gyroscope for Arduino board	3/1	12.98/4.33
		Total	42.86/20.79

**Table 2: Bill of Materials**

The values with a “/” means that we had to buy that part as a pack but only used the value after the “/” in our pedometer.

### 6.3.1 Equipment list

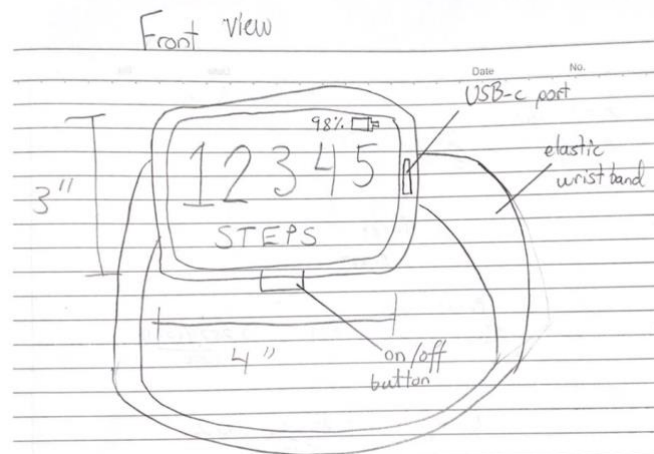
- SolidWorks Software
- 3D Printer
- Wires
- Soldering Station
- 9V Battery
- Velcro Adhesives
- Arduino Micro-Controller
- Accelerometer
- Gyroscope

- Seven-Segment Display
- Wrist Strap

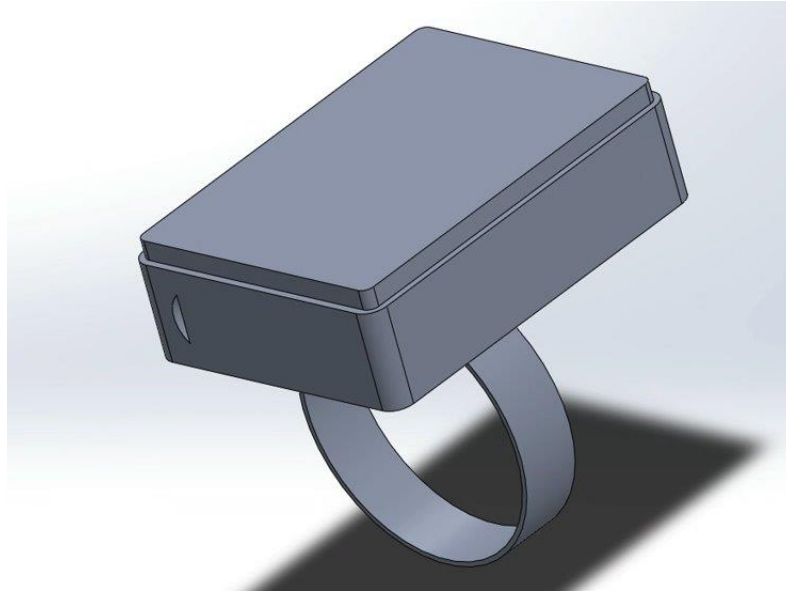
### 6.3.2 Instructions

Begin by designing your model in SolidWorks, you will have to check the integrity of your design in that it can be successfully 3D printed.

1. Your design should look like Figure 4 in section 3.1
2. After that, use a 3D printer to print the design.
3. Use the libraries provided above to encode the Gyroscope.
4. Solder your wires connecting the Arduino Micro-Controller to the 9V battery and the seven-segment display. Make sure to plug the wires into the appropriate pins.
5. Close the casing using the Velcro pieces on both sides of the case.



**Figure 7: Final Pedometer Design**



**Figure 8: Final 3D Render of the Pedometer**

## 6.4 Testing & Validation

Time to navigation comprehension	Opinion on design	Ease of wear	General Feeling
Fast	A little bulky	Easy to wear	Good overall feel
Fast	Very visually visible	Versatile	Good overall feel
Seamless	Simple design	Easy to put on and take off	Blocky, not great overall feel
Fast	Versatile useability	Simple	Good
Fast	Wrist band and clip feature is convenient	Very useable	Good, could add distance
Fast	Good design for budget allowed	Different options for style of wear	Good
Very fast to understand the information	Not very elegant	Easy to put on	Good, would use

**Table 3: Test Results of the Physical aspect of the pedometer**

The Software side of the software was tested by trying out the pedometer and observing if it can accurately count steps, which it did. Refer to Figures 5 and 6 in section 4.1 for the counting steps test.

## **7 Conclusions and Recommendations for Future Work**

The development of our pedometer was nothing short of difficult. Due to the restrictions of COVID-19, the team had to learn how to collaborate efficiently in various remote locations. Thanks to the detailed scheduling and a winning team dynamic, our group was able to successfully exceed the course's requirements. With the help of multiple deliverables that were required weekly, we committed to understanding as a team how crucial it was to stay organized within our respective schedules. To accommodate that, we all agreed to meet up every Tuesday and Thursday to discuss what objectives needed to be completed for the upcoming days. As a team, we focused on working to everyone's strengths and allotted time. By handing out tasks that were better suited for each respective member, the development/document process and the overall productivity within the team were more efficient.

However, the journey was not as smooth as it appeared. Throughout the term, we faced multiple issues with the 3D printer at the campus's MAKERLAB and finding the optimal material to detect steps.

Through all the hardships that we faced as a team, we are proud to present our final prototype which demonstrates the effort in our work. The team learned a great deal about product development and how to develop a pedometer.

Further improvements are needed to create the best user experience and to solve all aspects of the design problem. Given more time to enhance our product, our group would include the following:

- Install permanent connections for the circuits and Arduino controller
- Paint and seal the pedometer
- Provide a power button
- Provide a button to increase the daily step goal
- Reduce the overall size of the pedometer
- Install a water resistance enclosure
- Extend battery life
- Display 5 digits as opposed to 4 digits

## 8 Bibliography

<https://cnib.ca/en/sight-loss-info/blindness/blindness->

[canada#:~:text=Today%2C%20an%20estimated%201.5%20Million,that%20could%20cause%20sight%20](#)

[loss](#)



## 9 APPENDIX I: Design Files

All design files, videos and links are on MakerRepo:

<https://makerepo.com/OmarShubair/998.gng2101b22large-font-pedometer>