GNG2101- Intro. to Product Dev. and Mgmt. for Engineers Faculty of Engineering – University of Ottawa

Project Deliverable F: Prototype 2

Submitted by

A1-Seat Belt Guide

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Introduction

This deliverable focuses on the human part of all design processes. The client meeting allowed for face-to-face introductions to the components of our design, receiving key feedback for future iterations. Prototype two has shown the designs potential and the testing allows improvements to be made.

Client Feedback

In this meeting we showed our client our current progress. For the part fixed to the seat belt plug, we showed the 3D printed prototype and explained how this prototype works. Because the current 3D printed parts have some flaws, we said we would change the CAD drawings in the next prototypes, and the client was happy to see it. He also watched the electronics part made of Arduino and motors, we explained how it works and where it is located, and he liked the concept. We also showed how the prototype worked in the car seat, and he told us they still wanted a device to help plug the male side into the female side, which similar to the previous group.

Product Assumptions

Our group assumes that 3D printers and 3D printing filament are available. We also are assuming that the stepper motor will be able to deliver the force needed to pull the seatbelt, so we are choosing a motor that can deliver more than we could possibly need.

Prototype 2

Protype 2 consist of 2 sub-system, an electrical sub-system and the physical sub-system. Both are still early prototype but a were a good start to show and receive feedback from the client. The two sub-systems were unconnected, with the final goal of having them connected.

1.1 Electrical System

The electrical sub-system of the final prototype will feature an Arduino that controls a stepper motor that powers the winch. For this prototype the most basic electrical components were sourced, and the Arduino was set up to control a stepper motor. The system can be seen in Figure 1. The code used was sourced from an online tutorial to use a small stepper motor that a group member already owned (Shojaei, 2022). A pushbutton switch was later added to the breadboard to allow the user to control the motor's operation.

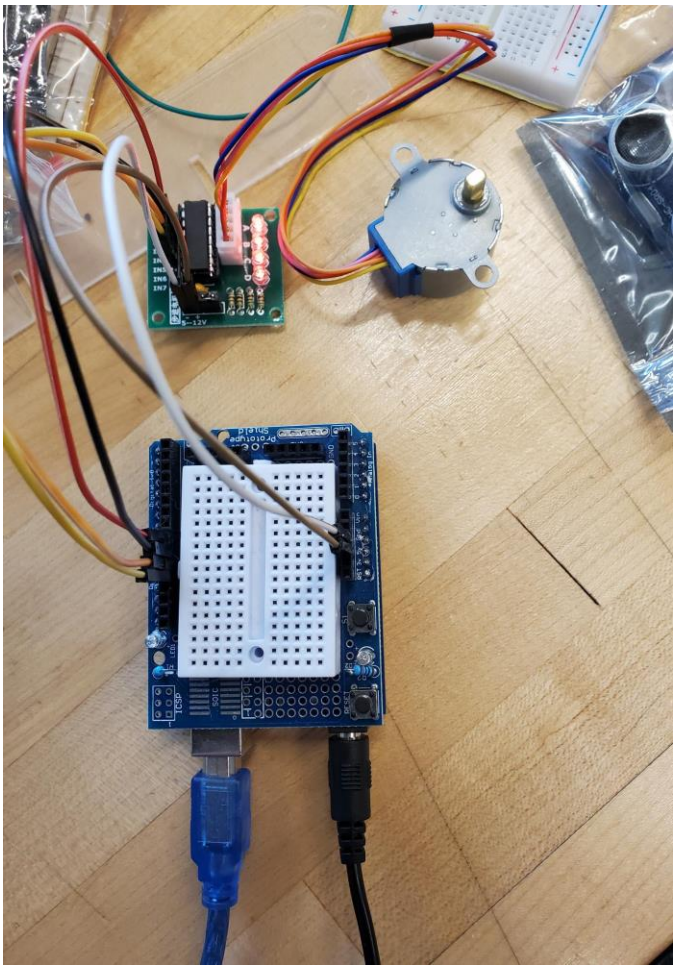

Figure 1 Components of the electrical sub-system

1.2 Physical System

Figure 2 The housing unit for the winch, including the arduino and the motor, and its attaching base to the female end of the seat belt buckle

Figure 3 The top of the housing unit and a failed print of the winch drum

Figure 4 The strap that was used for Prototype 2 to connect with the seat belt webbing

The physical system consists of three 3D printed parts that were drawn up on CAD software and inspired by a previous team's design (Figure 2 and Figure 3), as well as a hooked strap (Figure 4). The main part is the casing which is pictured in Figure 2. The casing will house the electrical system once completed keeping it safe and secured. Next in Figure 3, we have the case lid that simply seals the case once the electrical system is in, along with the winch drum that will be attached to the stepper motor. Finally, in Figure 4 is the hooked strap that will simply be used with the winch to pull the seat belts male end toward the female part.

All together we put together a mid-fidelity prototype that was able to show proof of concept and which we will improve on.

Prototype testing

Table 1 Tested selection criteria for each prototype sub-system

Selection Criteria	Marginal Value	Ideal Value	Electrical System	Physical System
Purchase Price (CAD)	$15-$60	$40	~$30	$0
Ease of Use (1 = easy, 5 = hard)	2-4	2	1 (pushbutton)	2 (same as previous year's)
Able to use on different vehicles	Yes	Yes	Yes	Yes
Ease of installation (1 = easy, 5 = hard)	1-3	1	N/A	4
Size	Small	Small	Small	Small
Durable	Yes	Yes	No	Yes
Aids with mobility issues (1 = helps a lot, 5 = no use)	2-4	2	5	4
Compatibility with a booster seat (1 = designed for booster seat, 5 = not compatible)	1-3	1	N/A	2
Reduces the amount of force needed to unbuckle (1 = Requires almost no force, 5 = Does not reduce the amount of force)	3-5	4	N/A	N/A

Reduces the amount of force needed to pull (1 = Requires almost no force, 5 = Does not reduce the amount of force)	3-4	3	5	5
Reduction in the amount of distance the client's arm must travel	5%-25%	20%	0%	5%
Weight	80-200 g	100 g	~50 g	~50 g

1.3 Electrical System

Because the client will only interface with the physical system, not the electrical system, the target specifications lined out in Prototype B do not generally apply to the electrical components. The electrical subsystem exists to complement the physical system, which is what the user interacts with. That being said, some criteria were tested, as seen in Table 1. The pushbutton system was easy to use and could be scaled up with future prototypes. The stepper motor that was chosen was only chosen because of its simplicity of use and it could stand in for the final stepper while different components were being created.

1.4 Physical System

The casing and webbing were brought to a van with a car seat to test. It was found that while the webbing was installed fine, the casing was too small to attach to the buckle. The sliding webbing attachment did not work very well so we are changing to a fixed webbing attachment.

Conclusion

We need to continue to update our prototype for the next client meeting (design day). Client meeting 3 went very well and got a lot of information from the client, which helped us to work on the later. We currently have the prototype in development, the physical part needs some design changes and 3d printing again, and the electronic part needs a larger motor replacement. We continue to make progress, and in client meeting we got some key data that members are using as a basis for the next step. As soon as the new parts completed, they will be tested to see if they work well.

Bibliography

Shojaei, A. M. (2022). *Interfacing ULN2003 Stepper Motor Driver with Arduino*. Retrieved from Electro peak!: https://electropeak.com/learn/interfacing-uln2003-stepper-motor-driver-with-arduino/