MOBILITATE

Progress Report for the R2000 Rehabilitative Exoskeleton

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1.0 Introduction

For patients who have muscle injuries, such as a torn ACL or PCL, studies have shown that constant exercise will prevent muscle shrinkage and decrease recovery time. The R2000 is an attachable rehabilitative exoskeleton which helps users exercise their knee. Its intuitive interface and ease of use allows for users to rehabilitate at home, rather than a clinic. Furthermore, the R2000 is designed to fit many knee braces in the market, so users are encouraged to use their original knee brace rather than buy new ones.

2.0 Schedule

Figure 1 presents the current project schedule in green, and the original project schedule in grey.

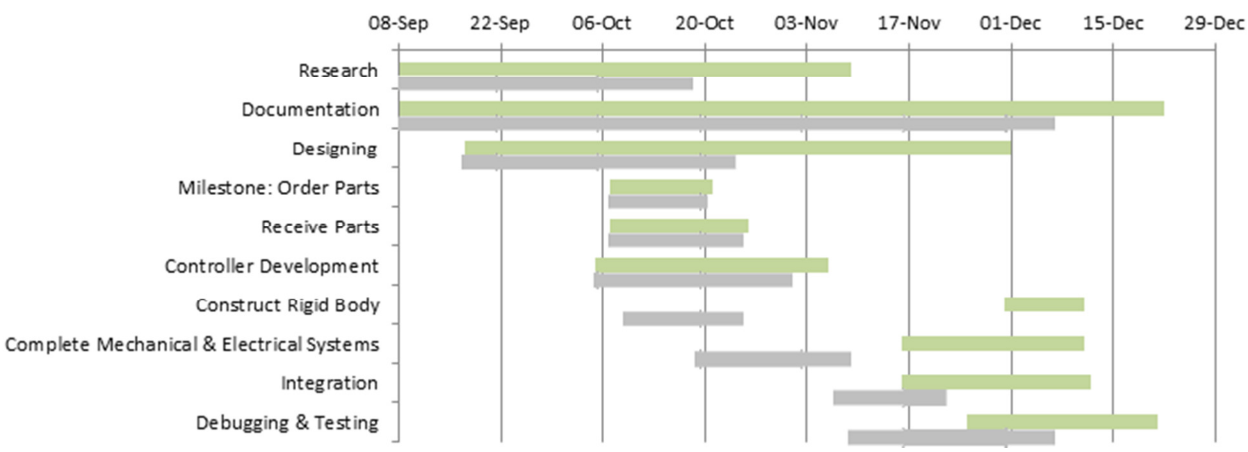

Figure 1: Gantt chart of the original schedule (grey) and the updated schedule (green)

Actual deadlines of the original schedule were subject to change, as we originally estimated our demo to occur around December 8th, when in fact it will be on December 22nd. The major reason for delays was due to an underestimation of how long the design phase would take. A number of advantages and disadvantages for sources of actuation, for example pneumatics or motors, were taken into consideration and tested before ordering more expensive parts and designing the rest of the system.

3.0 Financial

3.1 Funding

The ESSEF has provided $400 in funding. As stated in the proposal, an application will be made to the Wighton fund as well, and personal funds will also be used.

3.2 Costs

Table 1 outlines accumulated and future costs for all components and services required.

Table 1: Accumulated Costs

Component	Cost ($CAD)
i00600 Torxis Servo Motor	481.16
Motor enclosure	25.85
Distance Sensor	11.00
UI components (Arduino Uno, LCD shield, switches, etc.)	76.73
Total:	594.74

Some components, such as batteries, wires, and PCB boards have been donated by team members and are not included in accumulated costs. Future costs for the rigid bar fabrication and 3D printing for the UI enclosure are estimated to be a maximum of $270. After allocating an extra $40 for miscellaneous costs and contingencies, we are slightly under our initial budget. The rigid bar costs more than originally anticipated, as we first thought to make it ourselves. We later opted to have it made at a machine shop to ensure a strong, durable product.

4.0 Progress and Remediation

4.1 Rigid Bar and Motor Enclosure

4.1.1 Progress

The design of the rigid body has been redone several times after consulting numerous external sources, such as the Burnaby campus machine shop. The finalized design will be similar to what was presented in the design specifications with minor changes for additional stability.

4.1.2 Remediation

The motor enclosure is being hand-made to save money. The biggest issue being faced is that the motor is much larger than anticipated, so the initial design of mounting the motor on top of the user's thigh may not work. However, the enclosure for this design will still be implemented and tested once the rigid bar is made. A minimal and aesthetic design would be preferred, however if issues arise and there is not much time to address them, we will default to other designs that, while more clunky, will provide us with a functioning prototype for the demo.

The largest reason for the delay in rigid bar fabrication is because the motor was purchased quite late, and the rigid bar configuration relies on the motor characteristics. The entire system will be tested together once the rigid bar is fabricated. This is because if there are issues with the way the bar is designed, we can address them quickly and have time to test the remade system.

4.2 Motor System

4.2.1 Progress

Motor and motor driver have been successfully integrated with the UI system and can control from the motor from 0 to 90 degrees. Work is still required in fine-tuning the precision of the output angle with the Arduino, however repetition testing has been conducted to ensure precision and repeatability.

4.2.2 Remediation

As the precision of the Arduino (0-256) is not as fine as the motor driver (0-4092), we may need to select and hardcode intervals at which the motor can move, for example 10°, 20°, etc.

4.3 User Interface Unit

4.3.1 Progress

The software of the UI is almost complete. Input from the user can be read via push buttons and a rotary encoder, translated to PWM signals, and used to control the motor. Relevant information, such as all menus and submenus, warnings, and elapsed time are displayed on the 16x2 LCD. A built-in interrupt has also been implemented to handle cases when the PWM signal goes out of range. The hardware for the user interface unit has not yet been integrated onto a single PCB.

4.3.2 Remediation

The PCB will be designed and implemented by two group members using an off-the-shelf prototyping PCB board that can be soldered onto directly. We estimate that this process should take no longer than eight hours, and therefore can be tested and fixed immediately.

5.0 Conclusion

To summarize, major work remains for the rigid bar system and the enclosure for the motor, which is expected to be finished this week. Minor tweaks remains for the motor system and soldering hardware onto a single PCB, which should also be finished by this week, leaving two weeks for integration and testing.