SSC052 Assisted Robotics

ASSISTED ROBOTIC ARM FOR PATIENT WITH CEREBRAL PALSY

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Introduction

Many diseases can affect the motility of an individual, such as Parkinson's disease and cerebral palsy (CP). This project focuses on creating a prototype for a wearable assistive device which aims to provide support to patients who have been affected by a chronic illness influencing their mobility. We will be focusing on the medical, mechanical, and biopsychosocial aspects in designing our wearable assistive device to cater to the patients' needs.

Background

The prevalence of (CP is approximately 2.5 - 3.4 in 1000 live births in the UK (Carter *et al.*, 2019). CP is a nonprogressive neurological disorder of the white matter and grey matter of the cerebrum and the nuclei of the brainstem (Hanssen *et al.*, 2021). Children are usually diagnosed at an early age and CP can continuously limit their mobility. The most common type that affects children is spastic CP and they typically present with muscle weakness and spasticity (Hanssen *et al.*, 2021), especially when making brisk movements, which reduces the range of movements that can be carried out.

Dimensions

The size of the device is based on a study conducted by Edmond, *et al.* (2020) regarding pediatric arm length. The equation is as follows:

Arm length = 0.14(height)+0.28(age)+0.41(sex) (male=0, female=1)
(Edmond *et al.*, 2020)

This has allowed us to estimate the minimal dimensions needed for the device.

Method

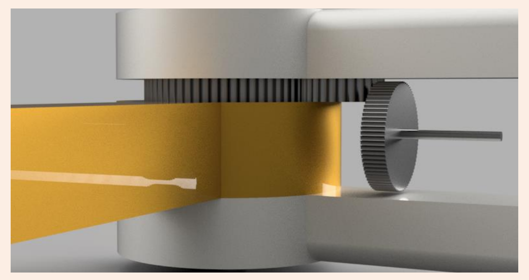

Figure 1 -Close up of gears used in Prorotype 2.

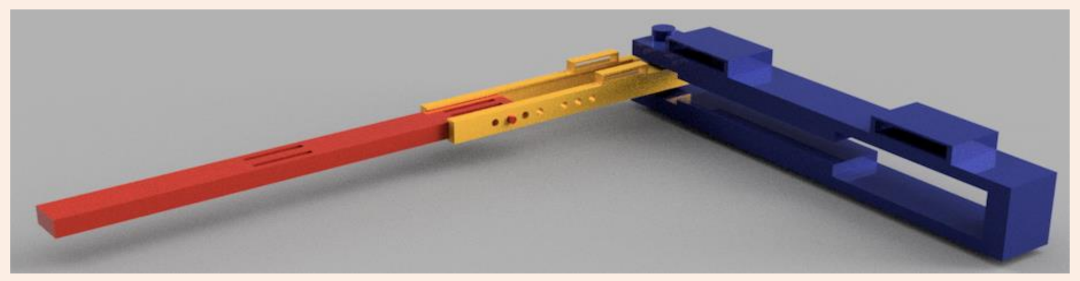

Figure 2 - Prototype 1.

Figure 3 – Prototype 2.

The images above are prototypes that were the basis of the final prototype. There are slight modifications made since these models. For example, the size was changed to fit a child using the equation discussed in the background. Also, some structural modifications were made to increase the stability of the assisted joint.

Our Final Product

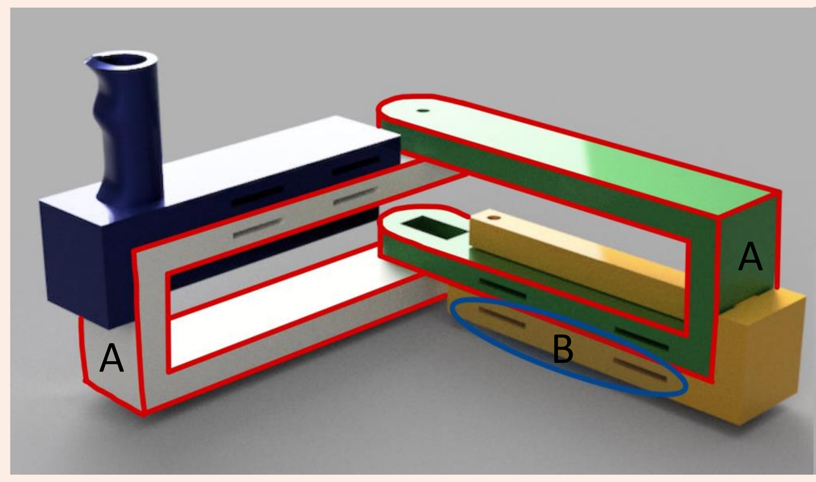

Figure 4 – Final prototype; un-extended with highlighted features

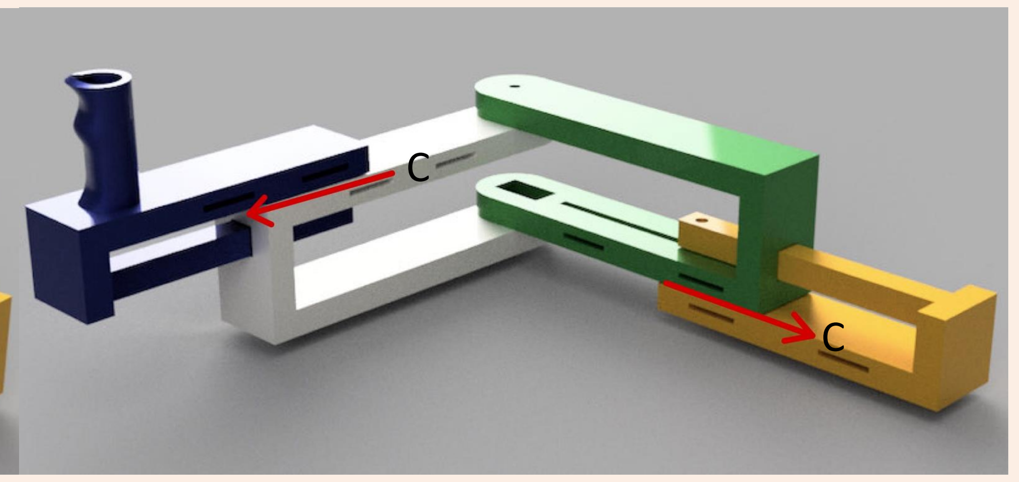

Figure 5 – Final prototype; showing upper and lower component extensions

A – Features of Main Body

The design incorporates 2 parallel parts to the upper and lower arm components joint via an electric rotary actuation system. It compensate for the weight of the arm while providing sufficient torque to mobilize the elbow joint and to lift arms of various mass and size without losing structural integrity.

B – Velcro Attachment

The device features Velcro to attach to a patient's arm to fit different arm circumstances while providing comfort during long term use.

C – Extendable forearm and upper arm

Another important attribute is the linear sliding joint, as seen in Figure 5. The purpose of this is to minimize costs and to create a device that has one size for all. The ability to lengthen and shorten the arm allows for long term use, especially in children who continue to grow. This provides a more sustainable option for patients and alleviates the financial burden of purchasing multiple assisted devices over a lifetime. Moreover, this modification can fit a wider range of people of varied sizes and ages.

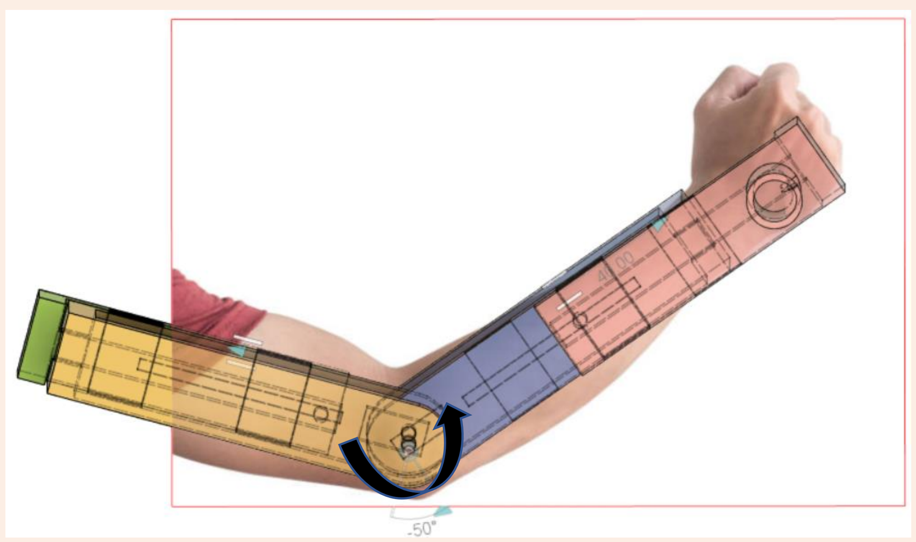

Figure 6 – Image of assisted device fitted onto arm.

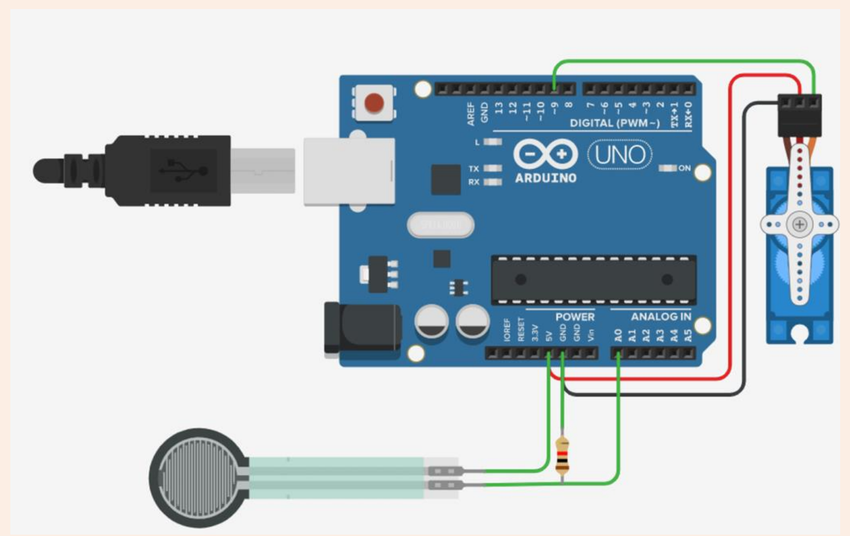

Figure 7– Programming board connection to motor and pressure sensor.

Electromechanics

The arm utilizes a servomotor which is a rotary electric motor and an active actuation system. It can rotate 210 degrees in both directions according to analogue inputs. Since the servomotor uses analogue values, a force-sensitive resistor is used as the user-system interface. This allows for activation of the device even with minimal force and can be quantified as a variable to be utilized in programming.

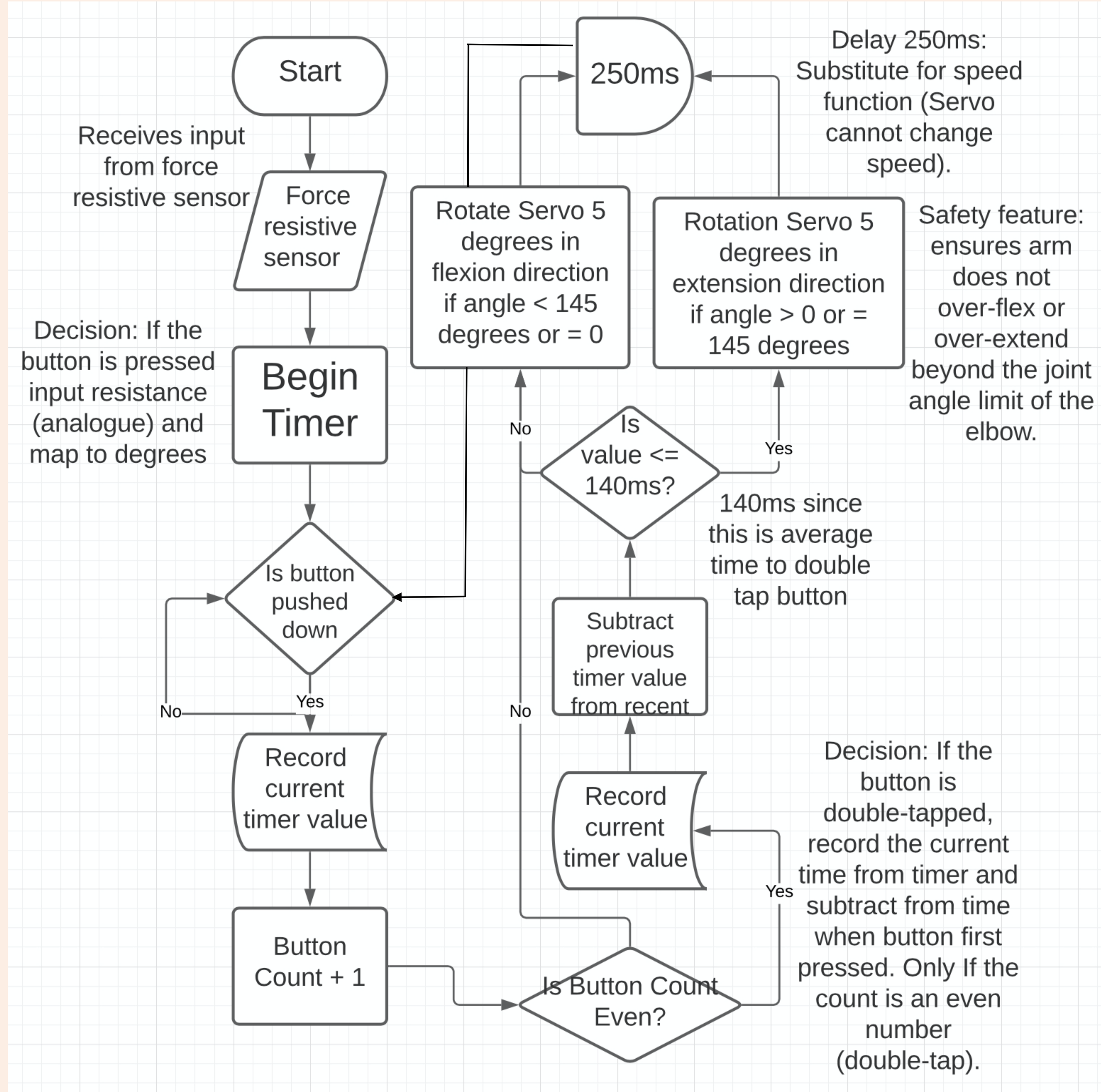

Figure 8 – Flow chart showing program controls of Arduino Uno unit.

Improvements

The areas of improvement are listed below:

- Additional safety features: changing speed and feature to control speed, off-button, etc
- Increasing torque
- Adding a portable battery attachment
- Run-trials / physical testing

Conclusion

The idea of personalized medicine is becoming a reality. By integrating the biopsychosocial aspects with the medical and mechanical components, we have designed a wearable device that may help patients with cerebral palsy or any other illnesses that cause limb weakness. Moreover, by making medicine and treatment options more accessible to a wider range of people it can reduce disability and improve quality of life in patients who are chronically affected by these diseases.

References

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