Project Statement
Assistive Robotic Arm

Team #5
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Project for Hampton Elementary School

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Statement of Need

The client is a fifth grade boy with quadriplegic athetoid cerebral palsy. In order to assist him in the classroom a robotic assistive arm device will be designed and mounted on his wheelchair. This device will be used to help him accomplish simple tasks in the classroom without the use of an aide. Athetoid Cerebral Palsy occurs due to damage to the basal ganglia and extrapyramidal motor system. This disorder makes fine motor motions very difficult. It is a great challenge for the client to hold objects stationary or maintain posture. Despite these damages to the nervous system, patients with Cerebral Palsy often have no mental handicap; this can make life very frustrating. The client is an extremely bright young man who enjoys academics. He communicates with a voice box and utilizes an electric wheelchair. He is extremely adept at using a joystick control for maneuvering his wheelchair and a similar control system will be used for the arm.

The assistive robotic arm will act as a third limb for the client, translating his gross motor movements into fine motions. It is hoped that this will reduce some of the frustration in the client’s life and also give him a greater sense of independence. The discrepancies between the client’s mental and physical capacity can cause a great deal of anxiety and stress. He has difficulty typing, eating, and interacting with other students. While he has an aide who helps him in class he feels a lack of independence which affects his self esteem. The robotic assistive device will help bridge this gap between physical and mental abilities for the client. It is crucial that this device reach the client as soon as possible so that he will no longer be handicapped by his disability.

Basic Preliminary Requirements

- Arm must be easy for client to control.
- Arm must be safe for client and peers
- Device should attach to client’s electric wheelchair without interfering with controls or tray.
- Device should provide full range of motion in x, y and z axis
- Device should be capable of flexion, extension, pronation, supination, circumduction, abduction, adduction, opposition, reposition, and rotation.
- Device should translate gross motor actions to fine motion.
- Device should be capable of picking up a variety of objects.
- Device should aid client in controlling a computer.
- The motors and materials used must be both durable and light.
- The robotic arm must withstand wear and tear as well as the possibility of spillage while eating.
- The device must be aesthetically pleasing.
- The robotic arm must provide the client with a sense of independence.
- The power source for the device must be rechargeable, lightweight, and safe.

While other assistive robotic devices are currently on the market they are extremely expensive. One example of such a device is the Assistive Robotic Manipulator (ARM) designed by Exact Dynamics based out of the Netherlands. This device performs many of the same
functions that this project hopes to achieve, but costs more than ten times the allotted budget. A cost efficient design will be utilized to achieve some of the same results.

**Basic Limitations**

The most important limitations to this project are the result of the client’s difficulty in fine motor control. This will make control of the arm a major challenge. The goal of this project will be to translate the client’s gross motor actions into fine motion. The project is limited in this regard by the client’s inability to finely control a joystick or keypad. An additional limitation is the $750 budget allotted to this project. Other systems addressing this same problem cost thousands of dollars and it will be an incredible challenge to achieve success with a fraction of this budget. This project also faces the challenge of materials selection. It is crucial that the materials used in this project be durable but as lightweight as possible. In addition, the assistive device must have safety constraints to ensure that the arm will be unable to harm the client or his peers.

**Other Data**

The client is a fifth grade boy named Sam. He is an extremely bright student at the Hampton Elementary School who suffers from Quadriplegic Athetoid Cerebral Palsy. The Speech Pathologist and Physical Therapist at the Hampton Elementary school are the primary contacts for this project and are very enthusiastic about the device.

The assistive robotic arm will be mounted on the C400 Standard Junior model of a Permobil wheel chair. This wheel chair allows the user the option of driving in either a standing or sitting position. It allows the user to sit, stand or lie down while in the chair. The wheel chair enables the user to maneuver around advanced obstacles, as well as facilitating in uphill strolls. The wheel chair is 44 inches in length and ranges from 24-28.5 inches in width and has a maximum speed of 4 mph.

**Questions**

- What method of control would be least frustrating for the client?
- What are the most important functions for the client?
- How can we ensure the safety of the client and his peers?
- What are the dimensions of the wheelchair?
- How much weight must the arm be capable of lifting?
- What is the optimal power source?
- How often must the battery be charged?
- How can the arm be made to supinate and pronate?
- Should different hand pieces be used for different objects?
- What material will be optimal for durability and weight?
- How can the arm be made fun for a 10 year old client?
- How many motors will the arm require?
- Will the arm need to be waterproof in case of spills?
- Can an additional device be utilized to aid in typing?