Project Proposal

Team 5- Go-Kart

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Go-Kart for Joey Toce
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Executive Summary

This senior design project is to design and fabricate a specialized go-kart for a child with Cerebral Palsy. The client has limited coordination and limb dexterity therefore cannot properly operate pedals and steering devices found on commercially available recreational go-karts. In order to solve this problem, the client has requested that two alternative methods of operation be implemented. The first method of control is to be a series of directional buttons that will be mounted on the main dashboard. The second method is a remote control that will be operated by the parents. Although it might take the client time to learn the dashboard controls, the remote control will allow use of the go-kart immediately.

In order to ensure the maximum amount of safety, it has been requested by the client that the go-kart be battery powered. Along with that, a multitude of other safety features will be implemented in order to assure maximum comfort and security. The seating area will be designed to be adjustable to account for future growth as well as supportive in order to account for the client’s limited trunk strength. The go-kart will be designed and fabricated to meet the needs and requests of the client. The final product will be a go-kart that is more user-friendly to the client than any commercially made product available.

1. Introduction

1.1 Background

The client, 6 year old Joey Toce, has Mixed type Quadriplegic Cerebral Palsy (CP) with a second diagnosis of Global Apraxia. He has severe motor planning issues and requires many more repetitions to learn simple patterned movements. His CP restricts his movement, balance and proprioception; he cannot walk, stand or sit-up without assistance. Joey is smaller than the typical 6 year old, standing at 42 inches and weighing only 35 pounds. Joey is a happy child and when he gets excited he kicks his legs leading to less body control which has causes him to slip out of his wheelchair. To prevent this leg straps and a groin harness were implemented which will be replicated in the seat design. Another function of his wheelchair which will be replicated is adjustable trunk supports to keep him from slouching side to side. Joey seems to prefer his left hand for coordinated movements so his dashboard controls will be mounted on the left side.

1.2 Purpose of the Project

The purpose of this project is to provide the client with an alternate source of mobility. This will allow him time away from his wheelchair as well as a chance to be
independently mobile. The client cannot operate typical go kart controls, therefore alternative methods of controls need to be designed. The controls need to account for the possibility for the client’s motor control improvement. A traditional go kart seat would not support Joey properly so the seat on this go kart would be modified appropriately. Ultimately, the purpose is to provide the client with a unique form of recreation that is fun and provides optimal safety.

1.3 Previous Work Done by Others

1.3.1 Products

There are several other products and projects that have been designed to meet similar requirements to those in this project. At the University of Connecticut, there have been three past projects in which a go-kart has been built for children with Cerebral Palsy. In 2009, a go-kart was built for a child with limited mobility. It has three different types of controls, a joystick, a remote control, and a steering wheel. It used a gas powered engine, with power steering, power braking and power throttle. The total cost, including the estimated value of free parts was $7,300. In 2008, and 2001 electric go-karts, named the E-racer, were designed so that they could be controlled with a joystick. The 2008 E-racer also used a steering wheel with switch controls, so the go kart could be operated completely by hand. Also, both go karts were electric. Both of these projects cost about $2,500.

In 1994, an NSF project at the State University of New York-Buffalo, designed the Recreational Electra-Scooter. This device allows a wheelchair to be mounted to it, and it can go straight, either forward or backward, or in a designated circle. The driver does not do much controlling of the Electra-Scooter. It uses a plywood ramp to get the wheelchair onto the scooter. Once the wheelchair is on the scooter, it is secured using an aluminum bar, similar to those used on handicap buses. The cost for the Electra-Scooter was about $870.

There are also several commercial go-karts available for children with disabilities. Mobility4Kids makes several different types for children of all sizes and with different physical limitations. They have go karts with joystick controls, steering wheel controls, and switches. The go kart is designed to ride over grass, hard surfaces, gravel and dirt. It is not designed to go on the sand or any rough terrain. They do make a go kart that can be used on the beach with a joystick control. Another product they offer is The Boss. This is a car is operated with a joystick. It was designed to give the feeling of racing on a dirt track. It has a wide base for stability, but can be used in tight spaces as well as open
spaces, such as a yard or driveway. All of the cars a custom built and range in price from $3000 to $7000.

Another commercial go kart available to children with disabilities is the Child’s Vehicle by Tetra Society of North America. This is an electric car that uses a modified joystick control, which allows for slight movement of the forearm and simple palm movement. It was designed for children with poor hand or arm strength and coordination, who cannot use a regular joystick. It does not have a harness, but a harness is recommended for any child who has poor upper body support.

1.3.2 Patent Search Results

There is currently a patent out on the market which relates to go kart controls for handicapped individuals. The Handi-Driver, designed by Keith Alan Roberts in 2002, combines three driving functions of throttle, braking and steering into a single steering column. The Handi-Driver can be used by individuals limited to the use of a single hand. The steering column is designed with a motorcycle-type hand throttle and brake and throttle cables along with a kill switch that can shut down the system if needed.

2. Project Description

2.1 Objective

The design of this project must incorporate the following:

1. There should be two sets of controls, so that the client or a helper would be able to operate the kart.
   a. Dashboard controls for the client operate.
      i. There must be a 3 button system (forward, left, right).
      ii. The controls must be left side oriented.
      iii. The controls must be continuously depressed to function.
   b. Remote control
      i. The remote must control the kart from a reasonable distance and have a kill switch to shut down the go kart.
      ii. The remote must be controlled by dual single-axis thumb sticks (vertical for speed, lateral for steering).

   a. A bucket seat tilted slightly back to keep the client from slipping out.
b. The seat must be adjustable to increase leg room accounting for future growth.
c. The clients knees must stay bent at approximately 90°.
d. The seat must have a headrest to prevent whiplash.
e. The seat must have adjustable trunk supports on the sides.
f. The seat must have a 5-point safety harness.
g. The client’s legs must be strapped in with Velcro.

3. The vehicle must to be battery powered.
   a. The battery must be rechargeable.

4. The chassis size must not exceed 3 feet wide by 5 feet long.
   a. The chassis must be made of steel.
   b. The chassis must comfortably fit all necessary components.
   c. The chassis must be orange.

5. The vehicle must have a roll cage.
   a. The roll cage must be strong enough to withstand the weight of the entire go-kart and client.

6. The vehicle must have a basic suspension to enhance ride comfort.

The following design factors must also be incorporated into the go-kart for the requirements to be fulfilled:

A. A selection switch must be designed to choose the mode of control (dashboard or remote).

B. A RF system must be designed to control battery power delivered and power steering from the remote control utilizing associated software.

C. A small motor must be implemented controlled by electrical software to tilt the wheels for steering.

D. A DC motor controller must be implemented to take inputs from variable resistors to allot the appropriate voltage from the battery to the motor.
E. The DC motor with associated gear transmission must be designed to provide a reasonable top speed with a comfortable acceleration.

F. The basic suspension must be designed to absorb impacts on various terrains.

The components designed exclusively for this go-kart are solely meant to accommodate to our clients needs. Upon fabrication this go-kart will resemble commercially available product but will be equipped and controlled much different. This go –kart for instance will not have a steering wheel, just 3 dashboard buttons to control forward, right and left movement. Due to the physical size and limitations of the client the seat and harnesses will be specifically sized to optimize safety as well as comfort. The client is not expected to immediately be able to control to go-kart from the dashboard controls. The remote control will allow the client’s parents to operate the kart for him providing immediate use and enjoyment of this product for the client.

2.2 Methods

All components of this go-kart will be assembled personally by the team. This includes building a custom chassis to properly fit all necessary components. The parts will be acquired and the frame tailored to not only the client’s size and physical limitations, but also to optimize space and efficiency. Fabricating this project from start to finish will first require mechanical and electrical components, then the use of software to ultimately provide desired mechanical output through the electrical component interface. To simplify explanation each group will be handled separately but ultimately will work as one to provide a finished product to our client.

Mechanical

The mechanical component of the go-kart consist of the chassis, seat, drive train, motor controller, steering as well as all associated hardware. Each component will be described individually as it will be tested individually before assembly. Several mechanical components listed are not available on commercially sold products, and therefore must be tailored to the needs of the client. This kart will also have several features that cannot be found on any other product, such as the dashboard controls. Listed below are the mechanical components which must be implemented into the design.
**Chassis**

The chassis of the kart will be assembled into a single component through welding of independent components. The battery, motor and accompanying mechanical and electrical equipment will be set behind the seat providing torque to the rear axle only. The seat will be permanently fitted to the chassis on a single-axis steel rail sliding track with a locking mechanism. The front of the chassis will be reserved for electrical components to turn the front wheels appropriately. The chassis will be equipped with basic bumpers to protect the electrical components in the event of an impact. The chassis will have a weight distribution providing a low center of gravity greatly decreasing the chance of the vehicle tipping over. Finally, the chassis will be painted orange, the color the client’s mother informed the team the client was often drawn to.

**Roll Cage**

The roll cage incorporated into the chassi s will provide superior protection in the unlikely event of the vehicle tipping or rolling over. The roll cage must be wider than the client’s seat in order to protect a side impact with the ground if the kart tips to one side. It must also be taller than the seated client to safely hold the client’s head off the ground if the kart rolled completely upside down. The roll cage will either be a section of welded metal behind the seat taller and wider than the client, or a system of two bars on either side of the client coming from behind the seat, over the head and connected to the front of the chassis. Regardless of appearance the roll cage will manufactured to be able to sustain forces equivalent to the full weight of the kart plus the client.

**Seat**

The design of the seat will be based on that of the client’s current wheelchair, but with several unique features to optimize safety and comfort. The client’s current wheelchair seat is padded to provide comfort, with a headrest and adjustable trunk supports. The seat also includes a padded groin support, foot rests, as well as leg straps to keep the client seated properly while preventing slipping out. These are the features which will be replicated in the go-kart seat with the following additions and slight alterations. The seat itself will be a bucket-style rather than flat bottom in the wheelchair to keep the client better contained. It will be slightly tilted back to not only ease the task of keeping the knees bent at 90°, but also maintaining a lower center of gravity while doing so. As stated, the seat will be permanently attached to the chassis on single axis steel rail sliding track with adjustable locking mechanism. This will allow for the seat to be quickly adjusted to ease entrance and exit from the kart.
Harness

Attached to the seat will be a 5-point safety harness securely fastening the client into the seat. The anchor will be connected to the groin support with two straps over either shoulder. Two more straps will connect to the anchor from either side of the client securing the waist into the seat.

Suspension

After visiting the client’s house and inspecting the terrain the team concluded the kart will only need basic suspension, most likely mounted on the front axle only. The terrain is predominantly flat with only minor changes in elevation. By refraining from installing unnecessary complex suspension the team hopes to save money and spend more time improving more important components of the kart.

Drive Train

The drive train for the go-kart consists of all the necessary equipment that goes into powering the system. The drive train will consist of the battery power source, DC motor controller, brushless DC motor, an H-Bridge integrated circuit, and the necessary gearing to deliver the power from the motor to the axle. The go-kart is intended to be designed to go anywhere between 7-10 mph upon request from the client’s parents. It has been suggested that potentiometers be used to vary the input voltage between the different control mechanisms. This is a safety feature to be considered because it would allow the go-kart to go slightly faster under the control of the parents than it would under the control of the client. The electric motor proposed in this design is a 36V, 500 watt chain motor that is used for scooters, go karts, and other electric vehicles. The motor has a current rating of 18.3 Amps and a 2500 rpm maximum revolution. In order to save energy, the motor will only run at 60% maximum power, giving the motor an output of about 1500 rpm. In order to reach the desired speed, it has been calculated that a gear reduction ratio of approximately 4.5:1 will be used. Since the go-kart needs to go in forward and reverse, an H-bridge Integrated circuit will be installed in the system in order to achieve this.

Motor Controller

One of the most important features in the drive train of the go-kart is the motor controller. The motor controller is responsible for handling how much power is sent to the motor. The motor controller used for this go kart is a DC motor controller that uses
Pulse Width Modulation (PWM) in order to interact and drive the motor. The PWM motor controller varies the speed by sending voltage to the motor in pulses of variable widths. The wider the pulse, the more voltage is being sent to the motor which ultimately leads to a faster speed. Using a PWM DC motor controller would have the same effect as manually flipping a switch on and off constantly at a certain rate in order to maintain a desired voltage output. PWM motor controllers are also very efficient because they dissipate nearly no heat so almost all of the power from the battery source can be relayed to the motor.

**Steering**

The steering system on the go kart is going to be designed to be extremely responsive with minimal lag time so that it can be executed almost immediately when prompted to. Since the client does not possess the capacity to be able to steer a wheel alternate methods of steering will have to be included which are the remote control for the parents to use and then also a set of dashboard buttons so the client can learn how to control the car even with his limited motor control. The design for the steering system will be inspired by past group’s projects. The 2009 S-90 go kart used a gear motor to power the rack and pinion which in turn, changed the direction of the wheels. Since the go kart in this project also had to be controlled by a remote control, the steering system for this go kart will be closely designed using the same principles. A gear motor along with the proper gear reduction ratio will be used to power the rack and pinion. The rack and pinion will be attached to tie rods which will ultimately help move the wheels left and right. In order for the rack and pinion to be controlled remotely, a linear position encoder will also be attached to the rack and pinion system. The linear position encoder will be programmed to have a set position in space and the magnitude of the degree of turning will be gauged by the position if the linear position encoder with respect to its initial position. Since the dashboard controls are going to be designed using push-buttons, the left and right buttons are going to have to correspond with a turn in the steering system that will ultimately turn the wheel at a constant radius while also powering the rear wheels in order to execute the turn. Remote control steering will be done using a dual-axis thumb-stick remote control that sends signals via PWM

**Electrical**

Most of the systems in the go kart will be controlled by an electrical system. The three main electrical systems that will control other systems will be the remote control, the remote kill switch and the dashboard buttons controls. All of these systems will then have an output that will control other systems within the go kart.
Remote Control

The remote control will use radio frequencies so that it will have a larger area of control. A radio frequency remote control uses radio frequency to transmit the signal and dual tone multi frequency (DTFM) signals for frequency modulation. The transmitter will consist of a FM transmitter and a DTFM generator. The receiver will be put on the go kart and at the receiver the modulation signals will be converted into DTFM tones. These tones will then again be converted and sent to the microcontroller. The microcontroller will then switch on or off the electrically controlled systems.

The remote control will direct the go kart, manage the speed and control the braking system. To direct the go kart and manage the speed, the remote will have two toggle switches. One toggle switch will control speed as well as braking, and the other toggle switch will control the forward, left and right movements.

Remote Kill switch

The remote control will not only control the direction, braking and speed of the go kart, but it will also have kill switch that will be able to shut down the go kart safely. The remote kill switch will use the same radio remote control system; however, the DTFM tones will be converted into a signal which will safely shut off power to the go kart.

Dashboard Control Buttons

The dashboard control buttons will be part of a secondary control circuit. These controls will always be over powered by the remote control killswitch. There will be three buttons, which will control forward, left, and right. The buttons will have to be continuously depressed to continue moving. By using rear wheel drive power can be output by the motor when any of the three buttons are pressed. When the left or right buttons are pressed a lower power will be generated. When all the buttons are released, the output power will decrease and the go kart will come to a stop.

The buttons would be controlled by pressure sensing potentiometers to dictate the degree of turning. For the forward button, there would be only one speed so no matter how much pressure is put on the button the speed would remain constant and the wheels would be positioned straight. For the left and right buttons, the amount the button is depressed would manage the degree of turning.
Software Control

The electrical signals will be sent to the main software control, a Microchip PIC microcontroller. The microcontroller will be controlled by embedded C code. The software will be in charge of taking the input signals from the remote control, or the dashboard buttons, and converting those signals into mechanical output through the electrical interface. The software must also account for control loops to continuously relay signals throughout the system.

There will be two main loops, the primary control loop will control normal function of the go kart and the emergency control loop will shut the go kart down safely when the kill switch is activated.

Primary Control Loop

The primary control loop will control all the functions of the go kart under normal operating conditions. The loop will begin after initialization and continue until the kill switch is activated. The loop will detect which control system is in use. Once detected, the loop will send the information to a secondary loop. The secondary loops will take input from the respective control and move the go kart appropriately.

Emergency Control loop

The emergency control loop will run similarly to the primary control loop. It will take input from the kill switch on the remote control. Once the kill switch signal is detected, the loop will safely shut down the go kart.
3. Budget

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35% of Total 1214.51

It must be stressed that this is a preliminary budget and it is subject to change. This budget accounts for purchasing everything, but the team hopes to acquire as many donations as possible to decrease cost. If this prototype cost the initially expected $3600, the production value, 35% of prototype, would be set near $1200. Through research it was found that modified go-karts for people with disabilities cost substantially more meaning this could become an appealing product for this market.
4. Conclusion

This project will offer the client the enjoyment of a motorized vehicle. This will be a fun, safe way for him to get outside and be like other children. The go kart will allow for two methods of controls, a remote control and dashboard controls. Having multiple control mechanisms allows the client to use the go kart under many different conditions. The vehicle will allow for his growth and have many adjustable parts so that it can fit many sizes of people. The go kart also allows for the chance of motor function improvement.

Above all other functions, the safety of the go kart must be considered. This go kart will have several different safety measures in place. The client will be harnessed in by a five point harness. There will also be leg straps to ensure that he stays in the seat. A roll cage will also be implemented to guarantee that if something happens with the go kart the client will be safe. By designing and fabricating all the go kart parts, the go kart will meet each specific need and request the client has. This go kart is unlike any that are commercially available. A customized go kart that has push button controls and remote control will be truly unique. The design of the go kart will allow the client optimal safety and fun, while meeting all required and wanted specifications.
5. References


