TECHAUTO

January 26, 2015

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC V5A 1S6

Re: ENSC 440 Capstone Project Proposal for the Cart-Follow-X1

Dear Dr. Rawicz,

The enclosed document is a proposal for our engineering capstone project, the Cart-Follow-X1. The motivation for this project is to create an autonomous motorized cart that can be customized to assist with carrying different types of cargo. This product will have three operating modes, notably the follow mode, which uses sensor based technology to follow its user. Our goal is to improve quality of life by minimize the need for people to exert any work when using the Cart-Follow-X1.

In our proposal, we provide an overview of our product and discuss design considerations, potential markets, costs, project milestones and planning as well as further information about our company and team members. We will also discuss the risks and benefits of our product and compare the Cart-Follow-X1 to alternatives currently available.

TechAuto Corporation was founded by five senior computer and electronics engineering students from Simon Fraser University. The members include Evan Chen, Jeffrey Wang, Samin Semsarilar, Tom Weng, and James Zeng. If there are any questions or concerns, feel free to contact us at jawang@sfu.ca.

Sincerely,

Jeffrey Wang
TechAuto Corporation

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TECHAUTO

Executive Summary

Have you ever imagined what it would be like if your cargo just followed you? Ever wish that hauling cargo up a hill could be easier? Today we're in an era of technology and automation. Our product, the Cart-Follow-X1 introduces a hands-free experience of cargo transfer. Have too many items to carry for your hands? Wherever you go, the Cart-Follow-X1 will follow and take cargo load off your body from travel, work, school, etc. The Cart-Follow-X1 will take care of it all.

Cart-Follow-X1 will be a cargo carrier that resembles a four-wheel platform truck. It will have the option to mount add-ons to suit your needs. This makes it so that the cart is multi-purpose, thus making it usable for all kinds of scenarios. For example, if you are going to do garden work, you can mount an add-on which turns the Cart-Follow-X1 into a garden cart and have it follow you around with your tools while you work.

At TechAuto we design the Cart-Follow-X1 to have three operating modes, "follow", "assist", and "manual". The "follow" mode uses its sensor technologies to follow its user. The "assist" mode turns off the sensor technology and hands back the control of the cart back to the user, but retains the motor power to help carry the load. Finally, the "manual" mode turns off all electrical components, and the user will operate the cart as any normal cart.

Design goals for our project are automation, safety, practicality, and convenience. The estimated cost would be around $900 which is cheaper comparing with the competing products.

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Introduction

Many everyday tasks comprise of having to carry some type of cargo, whether it be backpacks, books, gardening tools, or groceries. At TechAuto, our goal is to not only provide relief from everyday physical effort, but to also improve quality of life by introducing a hands free experience while transporting cargo.

At TechAuto, we aim to develop an automated, multi-purpose carrier which can assist with carrying cargo. The design will be a four-wheeled platform truck, which can be pushed and pulled normally, but will also include an automated system which will assist the user moving across varying slopes. The main feature that will separate us from other products on the market is a unique “follow mode” function. To enable “follow mode” the user simply detaches the handle of the Cart-Follow-X1, which is used as a tracking device. The Cart-Follow-X1 will then follow its user and will be completely hands free. With the convenience of Cart-Follow-X1, we intend to improve the quality of life and to reduce the chance of lifting related injuries.

Our product will be customizable for different uses through different add-on options. We are designing and building the base of a cart which will be complimented with add-ons based on the type of cargo being carried. For example, Cart-Follow-X1 may be customized into a book-cart for use in a library or a lab-cart to be used in classrooms and labs. With these add-ons, our product can be marketed to a much wider audience.

There are other alternatives to the Cart-Follow-X1 on the market, but they are either too expensive or they are cheap but don’t have the functionalities of our product. We believe that there is a need for the Cart-Follow-X1 because the current products do not provide the same convenience at an affordable price range, nor the flexibility of using them for different purposes.

Our proposal provides an overall scope of our product, which will include a system overview, the risks and benefits that will stem from our project. We will also discuss the current market, competing products, and explain why our product is worth having. Finally, we will review our budget, estimated schedule of the project timeline and briefly discuss our team organization.

System Overview

The Cart-Follow-X1 has three operating modes:

- Follow - The cart combines it's dynamic and tracking system to follows its user automatically
- Assist - Motor is on, and assists the user using the cart's dynamic system
- Manual - All electronic components are off, user manually maneuvers the cart

Our system consists three major parts: a wireless tracking system, microcontroller and a mechanical system.

The wireless tracking system allows the cart to follow whoever is carrying the remote. The microcontroller receives how far the distance is between the remote and the cart and controls the speed of following. The movement of the cart is powered by scooter motors. The following flow chart shows the preliminary idea behind this project more clearly.

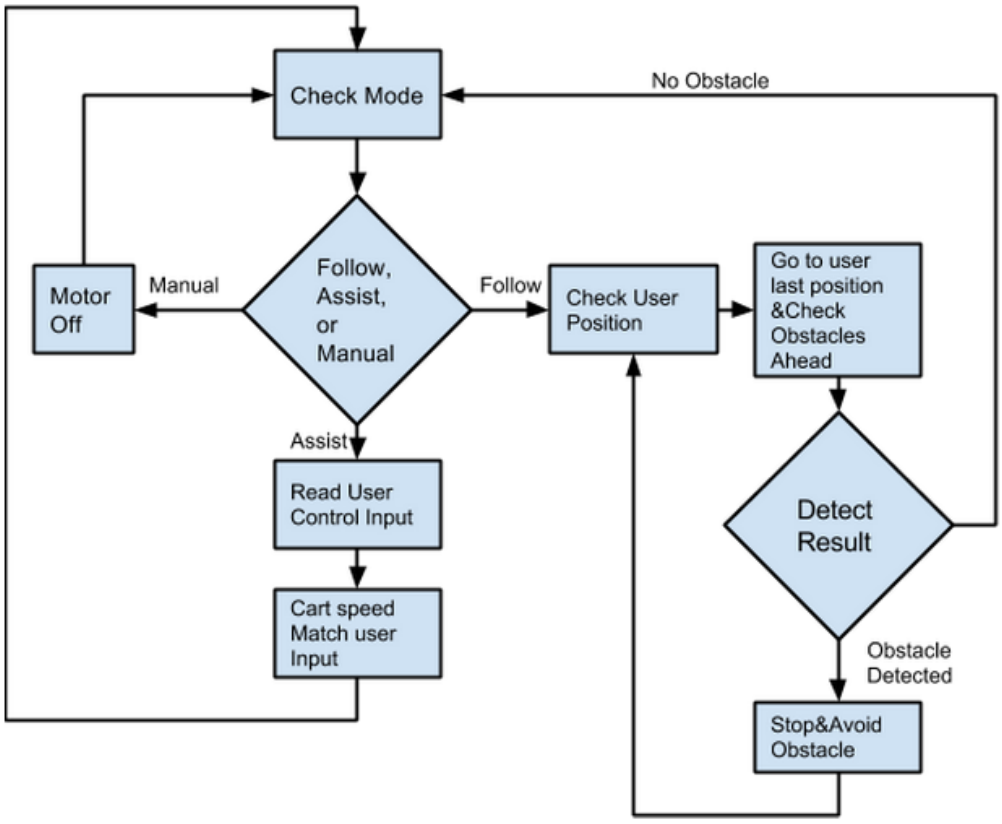

FIGURE 1: Flow Chart of The Three Operating Modes

Risks & Benefits

Risks

There are a few risks associated with using the Cart-Follow-X1. Being a product which is intended to be used inside and outside, there is naturally an exposure to weather and terrain interference. To overcome this problem, we must be wary of the way we protect the electronic components of our product. When using Cart-Follow-X1 outdoors, damage to the wheels is also a possibility. Lastly, since our product has the hands free option, component failures may lead to collisions. Although the Cart-Follow-X1 is designed to be user-friendly and safe, we at TechAuto recommend this product to be used with care.

Benefits

Our product has several benefits which can improve the way that people move their cargo in everyday situations. With the introduction of the "follow mode", Cart-Follow-X1 is a hands free carrier, so people no longer need to exert any physical work when moving cargo. This could be especially convenient for the handicapped or the elderly. Jobs that were previously impossible due to their physical limitations could now be made available with simple training on how to operate the cart.

Cart-Follow-X1's "assist mode" can be very beneficial for people looking to move heavy objects. Long term accumulation of physical effort, which includes heavy lifting, pushing, pulling, or carrying can lead to serious injuries, such as low back pains [1, p. 23]. According to a study done in 2014, low back pain is the leading cause of disability worldwide and nearly 1 in 10 people across the globe suffer from an aching lower back [2]. Another one of our goals is to provide relief from everyday physical effort. With the "assist mode", the load is significantly decreased, so when the user has a heavy load, or is going uphill, the amount of work required to move the cart will be a lot easier.

Essentially, Cart-Follow-X1 is beneficial for anyone for its convenience and customizability.

Market & Competition

Market

Our marketing research suggests that there is interest for a product similar to the Cart-Follow-X1 on the market. We interviewed the Head of Access Services at W.A.C. Bennett Library (SFU Burnaby) who has shown great interest in the product and its potential benefit over the library carts which are currently being used [3]. We believe labs and stores will have similar interest in our product. We also want to target the elderly and people with physical limitations who have trouble with heavy lifting.

The follow mode can also allow one user to operate multiple carts simultaneously which can be beneficial for workers in a warehouse, or other industrial environments. Since the Cart-Follow-X1 is customizable, it is intended for customers to use in a variety of tasks. From moving groceries to gardening tools, the Cart-Follow-X1 will be very versatile in its application. It gives user the ability to multi-task. Ultimately we want to provide our customers with the most convenient experience in cargo carrying.

Competition

We consider our main competition to be other platform carts and platform trucks. The key feature that separates us from the current competition is that Cart-Follow-X1 can follow its user automatically and provide a hands free experience. There are several products on the market that we found which are comparable to Cart-Follow-X1, however there are trade-offs in each design.

Lift Products Moto-Cart Jr. Platform Truck

"The Moto-Cart Jr. has roller grip controls on the handle and has the function to move forward and reverse using an electrical system. This product weighs 395 pounds and can carry up to 1100 pounds of cargo. This system runs on a 24-volt electrical system on 2 rechargeable 33-amp maintenance free batteries [4]."

The Cart-Follow-X1 is very similar to the Moto-Cart Jr. in regards to it's' functionality, but our product has the "follow" feature, is much more affordable and weighs much less.

FIGURE 2: Moto-Cart Jr.

Global Industrial Folding Platform Truck

FIGURE 3: Folding Platform Truck

"This product is a standard platform truck with no electrical components. It weighs 25 pounds and can carry up to 400 pounds of cargo. This platform truck is compact and portable because it can fold its' handle down. It is made of steel and has bumpers along the frame to protect from doorways and walls [5]."

Although this product is much cheaper compared to Cart-Follow-X1, it does not have any electrical components, so it lacks any motorized assistance. As a result, with our "follow" feature, our product provides more convenience for its user.

The following table shows a rough comparison of the competition with the Cart-Follow-X1:

TABLE 1: Product Comparisons

PRODUCT	DETAILS	COST
Lift Products Moto-Cart Jr. Platform Truck	• Motorized • High cargo load (1100 lbs.) • Heavy • Expensive	$3,324.99 CAD
Global Industrial Folding Platform Truck	• No automation • Moderate cargo load (400 lbs.) • Lightweight • Affordable	$48.95 CAD
Cart-Follow-X1	• Motorized (Follow & Assist features) • Low-Moderate cargo load • Expensive • Customizable	$915.00 CAD (estimate)

Cost Considerations

Table 2 outlines the speculated cost of constructing the Cart-Follow-X1. To account for tax and shipping costs, the values in Table 2 have been overestimated by 10 to 15 percent. We anticipate that this prototype will require significant time and money commitment in order for this project to be completed successfully. Parts and components are subject to change throughout the semester in order to build the most cost effective product.

TABLE 2: Component and Costs Considerations [5]

Product	Amount	Cost
24 Volt 250 Watt 2650RPM Electric Scooter Motor x2 # MOT-24250X2650	2	$140.00
DC 24V 40W 3800RPM Permanent Magnet Reduction Speed DC Motor for DIY Accessories	1	$20.00
Rear Wheel for Razor® PR200 Pocket Rocket Electric Pocket Bike Version 1-2	4	$120.00
24V 250W Electric Scooter Speed Controller	1	$40.00
12 Volt 5 Ah Electric Scooter Battery	3	$60.00
10 Amp GMA Glass Fuse & GMA Fuse Holder Cap	5 & 2	$35.00
Tracking System: Bluetooth Package (sender and receiver) + Microcontroller Boards (Arduino Uno?) + Extra sensors (Ultrasonic, infrareds, proximity, etc)	1	$300.00
Cart Frame/Casing/Wires (Misc)	1	$200.00
Total		**$915.00**

Team Organization

TechAuto Corporation was formed in December 2014 by five talented senior engineering students. Our team has a wide range of industry and technical experience, such as hardware and telecommunication protocols, embedded systems development, web and app development and various hardware and software testing methodologies. As such, all team members will be involved in the design and testing of the product. Tasks that are more software oriented will be delegated to the team members who have the most industrial experience with software.

Meetings will be hosted two to three times a week to ensure efficiency while working on this product. The team will be in frequent communication outside of the meetings through spontaneous or non-scheduled meetings, Skype meetings, and E-mail. For further efficiency, we have also set up Google Docs for the different documents of our product as well as Cloud storage to easily share critical information.

Company Profile

Evan Chen - Chief Executive Officer (CEO)
As a fourth year electronics engineering student , I have completed many courses relating to embedded system design, communication systems, and software development which have been applied during my previous co-op, working as assistant engineer in China Mobile Group Design Institute. I have also gained extensive knowledge on electrical power system from my co-op in Amec as an Electrical Substation Protection and Control System designer. I believe that my experience and knowledge can be a great help for my team to achieve our goals.

Jeffrey Wang - Chief Operation Officer (COO)
As a fourth year Electronics Engineering student, I have experience working with electrical circuits and various programming languages. As a co-op at BlackBerry, I developed skills in software testing and debugging cellular devices while I was part of the System Integration team. During my time at SFU, I learned to program in C/C++, VHDL, and use simulation tools such as MATLAB. I have also learned to work with electrical circuits in some of my electric circuits courses. I hope to bring my experience and knowledge to help build the best possible project for our group.

James Zeng - Chief Technology Officer (CTO)
As a senior Electronics Engineering student, I have done my first co-op at Lenovo as a hardware engineer in their tesktop R&D team. During my time there, I have developed my soldering, hardware debugging and testing skills. In addition to my academic and technical skills that I learned at SFU, I have advanced understanding of hardware, including VHDL/FPGA and embedded systems. I have also developed skills in software tools: C/C++, SolidWorks, and other simulation tools. I wish my skills would be beneficial in supporting our team to design the perfect project.

Tom Weng - Chief Financial Officer (CFO)
As a 4th year Electronics Engineering student, I am familiar with C++ and VHDL. My interests and my experience with assembling machine models, as well as my good understanding of computer software may prove to be advantageous for our team. I have co-op experience at Texas Instruments as a test engineer, as a result I have lots of experience in testing automation, running wafers, testing reliability and hardware/software debugging. My goal for this project is to use the knowledge I have to finish it this project perfectly.

Samin Semsarilar - Chief Information Officer (CIO)
I am currently a 4th year Computer Engineering student. Thanks to the courses at SFU, I have picked up both hardware and software skills. I'm familiar with C/C++ programming, VHDL coding, as well as data analysis using MATLAB. I am also experienced with electronics equipments such as function generators, oscilloscopes and spectrum analyzers. I have a strong passion for technology and enjoy working as part of a group on projects. To this project I hope to bring good work ethic, energy and a strong performance.

Project Planning

The following figure is an estimation of what we believe to be the ideal schedule. The specific timings are subject to change. This Gantt chart will be beneficial for staying on schedule and gauging our progress. In the early stages of designing, we anticipate that the integration of the software, hardware, and electrical components will be the most time consuming task.

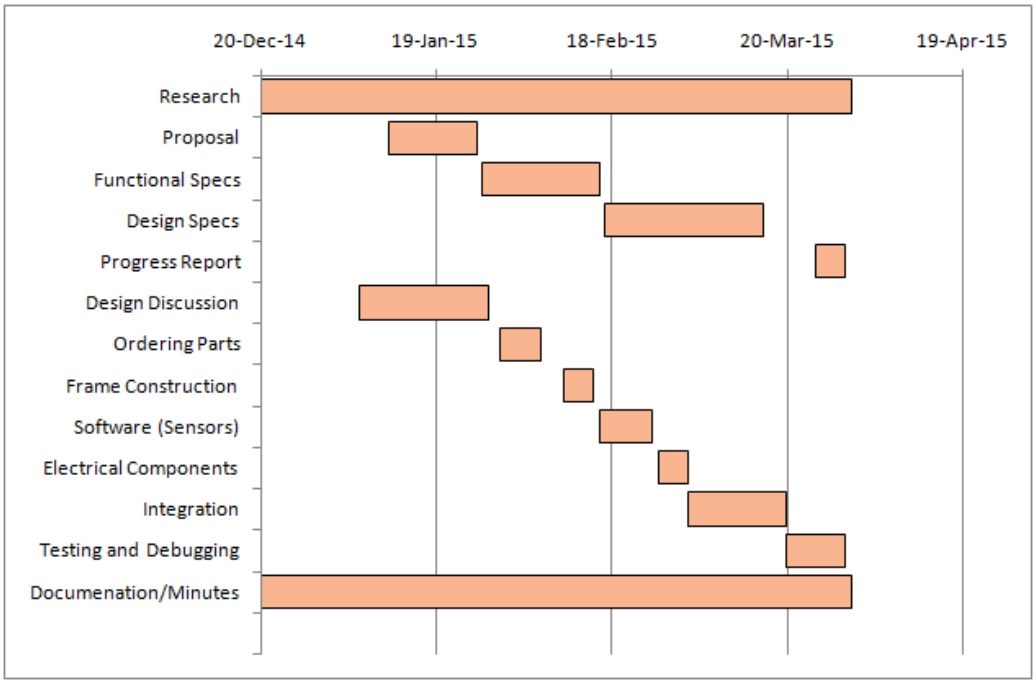

FIGURE 4: Gantt Chart

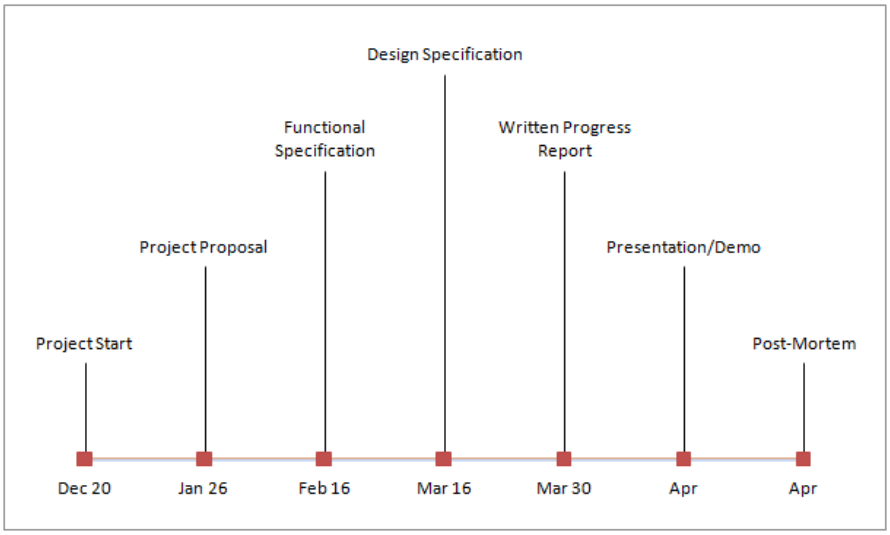

FIGURE 5: Milestone Chart

Conclusion

TechAuto is aiming to integrate automation into human daily activities in order to improve quality of life. Our product's market widely covers from individual to industrial. Cart-Follow-X series brings a whole new dimension to how cargo can be transferred, giving an easy, safe and convenient experience to the user.

Cart-Follow-X1 is a whole new product on the market. The biggest difference between our product and the carts that exist on the market today is that it will follow the user automatically and will be capable of handling loads as heavy as the motor can handle. This will allow people to carry and transport cargo hands-free. For those who carry heavy cargo frequently, our product will greatly reduce the stress to the human body and in term, will reduce the risk of occupational injury, something that is of interest to both employees and employers.

By the end of this term, we believe that we will able to bring a whole new dimension to the human daily experience.

References

[1] WorkSafeBC. (2012). WorkSafeBC Statistics 2012. [Online]. Available: http://worksafebc.com/publications/reports/statistics_reports/assets/pdf/stats2012.pdf [January 20, 2015].

[2] HealthDay. (March 25, 2014). Low Back Pain Leading Cause of Disability Worldwide: Study. [Online]. Available: http://consumer.healthday.com/bone-and-joint-information-4/backache-news-53/low-back-pain-leading-cause-of-disability-worldwide-study-686113.html [January 20, 2015].

[3] Scott Mackenzie. (2015, Jan. 22). "Re: Intelligent Book Cart". Available e-mail: smackena@sfu.ca.

[4] Amazon. (2015). Moto-Cart Jr. Motorized Platform Truck - 24"Lx45-1/2"W Deck [Online]. Available: http://www.amazon.com/Moto-Cart-Jr-Motorized-Platform-Truck/dp/B004XL33RO [January 18, 2015].

[5] Global Industrial. (2015). Folding Platform Truck with 28 x 18 Solid Steel Deck 400 Lb. Capacity [Online]. Available: http://www.globalindustrial.ca/p/material-handling/platform-trucks/folding/folding-platform-truck-with-solid-steel-deck-400-lb-capacity [January 18, 2015].

[6] Electric Scooter Parts. (2002). Parts and Components. [Online]. Available: http://www.electricscooterparts.com/index.html [January 18, 2015].