Needs Assessment & Project Scope

EML 4551C – Senior Design – Fall 2011 Deliverable

Team # 17

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Needs Assessment

The purpose of the project is to design and fabricate a highly stable, semi-omnidirectional robotic walker. The walker will be designed to operate on varying grade and multi-terrain surfaces, while being able to withstand typical environmental hazards. The prototype will maintain current walker demands and standards, while increasing the safety and mobility of the user. The walker will be an active system, responding directly to the actions of the user.

Project Scope

Problem statement

The current market offers limited assistance to the disabled community looking for increased mobility in an outdoor environment. Outdoor terrains as common as gravel can be insurmountable to overcome with the current generation of mobility assistance technology. In addition to environmental hazards, current passive walker systems are limited in their maneuverability and offer only basic support. To empower and enable the disable population, a more versatile and functional design is required.

Justification and Background

With an ever-increasing life expectancy, in both the United States and the world at large, there remains a growing reliance on assistive devices for the elderly and disabled. Out of an estimated 13.1 million users of assistive technology devices (Kraus, Gilmartin 1996), users needing mobility assistance accounted for 61.8% of this population. Mobility assistance has traditionally been accomplished through the use of canes, walking sticks, passive walkers and active/passive wheelchairs. Of these devices, walkers rank as the second most used mobility assistive device only behind walking sticks and canes. An estimated 21% of the mobility disabled users of assistive devices uses a walker. However, these figures can be misleading as there exists a large gap in the requirements necessary to operate the above mentioned assistive devices.

A powered wheel chair offers the most assistance as it requires limited to no dexterity or muscle strength above the waist. An unpowered wheelchair offers less help as it requires both dexterity and strength in the arms of an individual. There exist several commercially available wheelchairs capable of indoor/outdoor use. A passive walker offers comparibly less help as it requires both the strength and balance for an individual to stand upright combined with the strength to operate the walker as well as potentially brace oneself for a fall. Currently there exists no commercially available walker capable of indoor/outdoor use, only models suitable for indoor use. A cane is arguably the hardest to use as there is typically only one contact point with the ground and strength and dexterity is needed in the body as a whole. However, a cane represents arguably the easiest assistive technology to use because of its light weight and small footprint. There exists no product suitable for indoor and outdoor use, for the individual who is able to or simply wants to stand, however, does not necessarily have strength and dexterity to operate a cane or passive walker.

Passive wheels and inadequate suspension lead to several issues in the use of the walkers and wheelchairs. Passive wheels have two main problems. If the wheels are not castered they limit the ease to which the device can move with limited or no slip. If they are castered then the wheels can be unpredictable in the direction they will travel. Inadequate suspension does not allow the wheels or other traction devices to maintain adequate contact. The combination of passive wheels with inadequate suspension can be particularly dangerous on steep grades or low traction surfaces if an individual is not strong enough to fight the additional forces. Tasks such as carrying everyday items such as groceries or even a backpack are quite difficult with limited carrying capacity/space and the added burden to the individual. The use of four casters with adequate suspension could lead to possible solutions.

Objective

The main objective of the project is to design and create a base structure for an outdoor robotic walker. The design will be used in further research to ultimately create a fully functional, highly responsive system. This requires the platform to be highly versatile and robust in addition to being user-friendly and convenient. The walker will be user-driven by a force recognition system and will also be capable of handling various outdoor environmental conditions and terrains. The base dimensions of standard walkers should be preserved within the design.

Methodology

This project will follow a four stage process to successfully meet the demands of the sponsor: design, manufacture, controls, and amend. The design stage entails meeting with the sponsor to determine the design requirements, performing extensive research on the current field of comparable products to determine basic standards and benchmarks, and compiling this information into a single cohesive design that is congruent with the needs of the sponsor. Manufacturing requires taking inventory of the available materials, finding suppliers for the remaining materials, ordering and machining the necessary components, and finally assembling the components into the prototype. The controls stage requires the design and implementation of a user-control system to drive the mechanical system seamlessly and intuitively. The final stage requires the debugging and redesigning of any control failures and the rebuilding and remanufacturing of any subsequent mechanical failures discovered through testing the prototype. These steps will ensure that the design will be completed on time and meet the demands of the sponsor.

Meeting the sponsor's needs is the top priority of this project, so the initial assessment meeting will be the first of many to ensure that the design continues to meet the needs of the sponsor. Research of current passive models of walkers must be completed to determine the standard sizes and dimensions of these models to allow the new design to be as familiar as possible to a transitional user. Additional research into the proper grips, handle height, tire size, and tread will help create the safest and most reliable design possible. The creation of concepts will be completed taking into account this acquired information, and the concept selection will utilize the standard engineering practice of a decision matrix.

Because of the generosity of the sponsor, many of the hardware components will be supplied to the group. Additional hardware and materials will undoubtedly be required to complete the design, so appropriate research must be done to locate a reliable and inexpensive source to supply these materials. The simplest components may be able to be machined in house at a much lower cost. Assembling these components will be the final step in the manufacturing stage of the project.

With the mechanical aspects of the design complete, a control system needs to be added to drive the walker. The control system will be responsive to a user-input force and actuate the necessary components of the design for movement. Various programmable control schemes will allow for a multitude of functions for the user. The control system will need to operate seamlessly with the hardware design and be intuitive to the user.

While designing the control system for the device, tests will begin to determine the functionality of the different control schemes. Throughout this testing process, the previously designed hardware components and control systems will be scrutinized for flaws or failures. This testing procedure will continue for the remainder of the project timeline as more and more complex tasks and controls can be implemented. When a sufficient amount of functionality has been determined from the prototype, a true test involving members of the disabled community will hopefully be possible to provide feedback on possible overlooked system flaws.

Constraints

The walker should be able to maneuver forward and backwards up to 45 degrees from a center axis. The walker should be able to absorb difficult and varying terrain to maintain traction and support for the user. The walker should be lightweight, appropriately sized for indoor/outdoor use, and meet all American Disability Association standards. The walker will operate with minimal dexterity or strength necessary from the user. The walker should support the user as well as a limited number of personal items.

Expected Results

Upon completion of our senior design project, a thorough and precise design and control of an outdoor robotic walker will be produced. Ideally, our walker design will be synthesized into a greater, more dynamically advanced system; requiring additional professional research to ultimately reintroduce the concept of mobility to the motor-disabled population. As discussed in this deliverable, there will be frequent and consistent communication with our sponsors to ensure the quality and success of our project. Similar contact will be made with the team's faculty mentor and staff members to allow a cohesive and achievable senior design project. Clear and harmonious communication both in and outside of the group will also facilitate a fluidly coherent design process while recognizing proper project ethics and standards.

Application deadline for the AbilityOne NISH design competition is April 20th, 2012. By this time, the team will have designed, developed and fabricated a highly user-responsive, fully functional, multi-directional outdoor robotic walker. After the submission of all the applicants, a panel of judges will independently read the projects and collectively select the top 3 best projects. Cash prizes are given to the top 3 qualifiers, so there exists additional incentive to succeed in the project. Finally, our primary focus in the entirety of the project is not only to increase the mobility of the motor-disabled but to improve the overall quality of life of the motor-disabled; in both professional and social atmospheres.

Sources

National Vital Statistics Reports, Vol. 58, No. 21, June 28, 2010

Kraus, L., Stoddard, S., & Gilmartin, D. (1996). *Chartbook on Disability in the United States, 1996.* An InfoUse Report. Washington, DC: U.S. National Institute on Disability and Rehabilitation Research.