

Hong Kong Student Science Project Competition 2022

Template of Extended Abstract (Invention Design Proposal)

(Word Limit: 1,000 words, Pages: 2 pages only)

Team Number: SCPE228

Project Title: Trolley for Better Life (生活的動力)

Project Type: Invention Design Proposal

To our best knowledge and after thorough literature research, as of 28/06/2022, there are no similar works.

I. Background

Visiting the market to buy groceries and food is an essential daily task for everyone, but it can be a difficult task for the elderly. Therefore, we would like to design an electronic self-rechargeable power assist system, the “Assistor” that is easily attachable to existing wheeled carriers, to help elderlies on moving their weighty trolley and thus improving their quality of life.

II. Objective(s)

Our invention is designed to help the older generations or any person in need to carry heavy items with wheeled carriers such as trolleys. The power assist system will attach to the handle and the wheel axle and aid in moving the carrier. The system will only intelligently aid the carrier but not will boost the carrier to exceed the speed of the user. With the aid of our invention, the older generations can easily lift the carriers on the stairs or accelerate them to a faster velocity. This control is merged seamlessly by pulling the handle as usual.

III. Methodology

A prototype will be developed to test the feasibility of the “Assistor”. A **brushed electric motor** will be used to drive the trolley with a safety factor of 2. A 5VDC brushed motor will be used for testing the algorithm as well as the charging circuit. A **pressure sensor** is attached to the trolley handle to detect the amount of force applied. A calibration curve will be generated by varying the mass of the slotted weight placed on the transducer and the corresponding voltage output is measured.

Theory

Case 1 Raising the trolley when it encountered the shoulder of pavement:

When the force applied on the handle of the trolley is roughly equal to the weight of the trolley and the accelerometer indicates that there is an upward acceleration of the force to lift the trolley, the assistor will be triggered.

Assuming that the mass of a fully-loaded trolley is 6 kg. The weight will be equal to 58.86 N. For a typical trolley, the radius of the wheel is 0.08 m. Therefore, the loading torque is $58.86 * 0.08$ which is roughly equal to 4.7 Nm. So, the motor will provide half of this required torque.

Case 2 Moving the trolley across a rough surface:

When the trolley is moving on a rough surface, the trolley will slow down and at the same time, the user will tend to apply a larger force to keep the trolley moving. By detecting the change in speed and the change in force applied on the handle, i.e., a decrease in speed and an increase in force, the assistor will be triggered.

Assuming that the user is moving with the trolley on a level road at a constant speed of about 1 m/s while the mass of a fully-loaded trolley is 6 kg and has a wheel with a radius of 0.08 m. When the trolley speed is lowered due to the roughness of the road, e.g., decreased to 0.5 m/s, then the motor should provide a torque to accelerate the trolley back to around 1 m/s in a reasonable time, e.g., 1 second. The required force for providing this acceleration will be 3 N and the corresponding torque will be $3 * 0.08 = 0.24$ Nm.

IV. Design of Invention

In our design, pressure sensors and accelerometers are used to detect the need for assistance. A geared electric motor is attached to the wheel axle to drive the wheels. Upon obstacles, the geared motor will help drive the wheels and therefore help the users to move the trolley against the obstacles.

On the other hand, if the trolley is moving without triggering the motor, the geared motor will work as a generator to recharge the battery.

The “Assistor” is designed to be lightweight and widely applicable to different carriers. Hence, the footprint of the whole system is targeted to be small, compact, and lightweight.

V. Application / Market Need

The main audience for our product is the elderly.

In a typical family (e.g., 421 families) in Hong Kong, married couples have to take care of their children and even their parents. Given the fast pace and hectic schedules, most of the working generations keep, they may not have time to take care of the older generations.

Nevertheless, people of older age suffer from cataracts and refractive errors, back and neck pain and osteoarthritis as well as chronic obstructive pulmonary disease. Moving the ponderous shopping trolley can be a real challenge for them especially when they have to pull the trolley over obstacles.

In addition, especially due to the pandemic situation, juniors who are tested positive may be forced to be confined to their homes. Despite their infection, transportation is also affected by the pandemic. It is harder for the younger generations to travel to their own parents’ living place and take care of them. Seniors may be stipulated to buy more groceries at one time than before for saving or against unexpected needs. Since the elderly may buy a lot of groceries from the street market or supermarket to prepare for the pandemic, the weight of the groceries is very heavy for them to lift. Therefore, the trolley can prevent them to get hurt from lifting heavy objects.

Most elderlies live in some old buildings like tenement buildings and ancestral buildings. These places usually do not include staircases, it is very exhausting for them to carry such heavy trolleys up and down. But with the “Assistor”, less force is needed in lifting the trolley and less strain will be acted on the weakening body parts such as the knees and shoulders. Elderlies will therefore have less chance of having muscle tears and sprains, back injury, herniated disc and other musculoskeletal problems. The extent of discomfort and disability are decreased, and the elderlies can live a happier and carefree life also they won't be toilsome and feel helpless especially when there is no one around.

The nature of the “Assistor” limits the system to only work on assisting wheeled carriers. It cannot aid the user in other heavy lifting scenarios such as bringing the carrier upon transportation.

VI. Conclusion

To conclude, we believe that with our invention “Assistor”, people especially elderlies not only can avoid getting hurt when moving the heavy shopping trolley and therefore enjoy a better quality of life but also contribute to sustainable development.