

Element B

Introduction

This report will discuss existing solutions to the loss of driving independence of spinal cord injury patients. The contents below will also briefly describe patents that relate to vehicle modifications and add-ons.

Problem Statement

A spinal cord injury damages nerves which can cause long-term or permanent loss of function below the waist. Driving with this injury is impossible without special equipment and modifications. As of 2011, 36.5% of people with a spinal cord injury (SCI) in the US are reported to drive a modified vehicle. Studies show that this low number can be attributed to the high price of around \$20,000 to \$80,000 for modifications. Most patients feel a decrease in quality of life because of their lack of transportation and fear of driving without another person's help.

Patents

Operation Device for Vehicles for Disabled and Healthy People¹

Patent Number: JP6219736B2

Author: 益幸 鳴瀬 益幸 鳴瀬

Date: 2014-02-03

Key Features:

This device allows for disabled drivers to operate a vehicle using hand controls for the brake and acceleration mechanism. The patented item consists of a sub pedal plate with an accelerator pad, an accelerator lever used to accelerate the vehicle, and an operation lever used to brake the vehicle. The pedal is attached to a shaft and coil spring so that the brake returns to its original position when you let go. The device uses a push button to drive, as shown in the first image.

¹ US20060082090A1 - Steering wheel sensitivity brake control. (n.d.). Retrieved from <https://patents.google.com/patent/US20060082090A1/en?q=%28hand%2Bcontrols%2Bfor%2Bbraking%2Band%2Bsteering%29&oq=hand%2Bcontrols%2Bfor%2Bbraking%2Band%2Bsteering>

Pros:

The patented item presents an operating device for a vehicle that allows a person with disabilities to manually operate the braking and accelerating mechanisms. The device can be used by both healthy people and those with disabilities. The accelerator lock and brake mechanism can be switched depending on the driver. This item is a low-cost solution because it is not a modification to the vehicle.

Cons:

Using this item requires some training, as it is difficult to operate with only the user's hands while having awareness and recognition of the device. The installation is not a direct modification of the vehicle and is installed onto the brake and accelerator pedals. This will take up more space and decrease the comfort of the driver. \

Analysis:

This patented item introduces the idea of a device that allows for healthy and people with disabilities to operate the same vehicle while having the item installed in both situations. Compared to other solutions, this device includes two operating levers for each pedal. This may be difficult for a driver to use and decrease its efficiency.

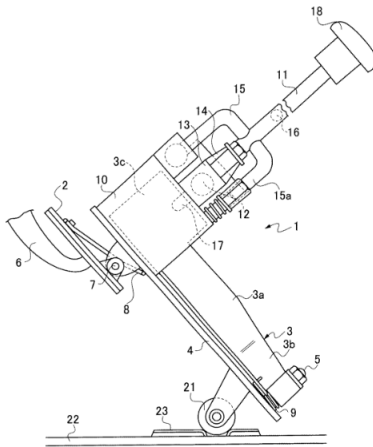


Figure 1: Illustration of Operation Device for Vehicles for Disabled and Healthy People consisting of the brake pedal, accelerator pad, and the sub pedal plate

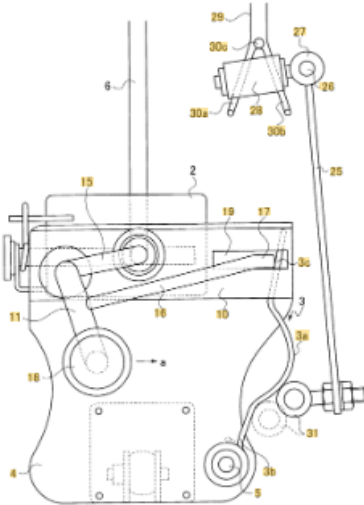


Figure 2: Illustration of Operation Device for Vehicles for Disabled and Healthy People consisting of the whole device and its components

Clickable Hand Control Device in a Vehicle²

Patent Number: US9969401B2

Author: Max Birkelund

Date: 2014-08-15

Key Features:

The hand-operated device is specifically for people with disabilities. The device consists of a brake bar and handle bar. The inferior end of the device attaches to the brake and gas pedal by a locking mechanism which allows the handlebar to be attached to the steering column without the use of tools.

The superior end of the driving control device that is managed by the user is a handlebar that electronically regulates the speed of the vehicle. All parts of the device are cylindrical. The rod is provided with protrusions that can be manually locked holding the rod in place.

Pros:

The patented item is a device that allows people without the function of their lower body to operate a vehicle independently by giving them control over the brake and accelerator pedals with their hand. The way the locking mechanism works allows for the handlebar of the device to be attached directly to the steering column or attached nearby. This feature provides a more comfortable driving experience as the user can position the handlebar in the vehicle according to

² US9969401B2 - Clickable hand control device in a vehicle. (n.d.). Retrieved from <https://patents.google.com/patent/US9969401B2/en?q=%28hand%2Bbrake%2Bhandicap%2Bautomobile%29&oq=hand%2Bbrake%2Bhandicap%2Bautomobile>

their preferences. The connection of the rod and mounting piece have a quick-locking feature allowing for easy and quick installation and adjustment. This device is not a direct modification to the vehicle and provides an idea of a less costly solution of a hand control driving aid for SCI patients.

Cons:

This patent does not clearly explain how the acceleration function of the device works. The patent claims that a disabled driver can accelerate the vehicle using the speed handle that is electronically connected to the acceleration mechanism of the vehicle. However, there is no image or illustration that shows the functions of the claims. This patent focuses on the braking mechanism of the brake bar and the quick-lock feature of the device.

Analysis: This patent is most similar to an ideal solution to hand-controlled driving aids for SCI patients. It does not include any modifications to the vehicle which means the device is less costly. It is a simpler design that solves the problem of usual driving aids that require tools and a longer time to complete its installation.

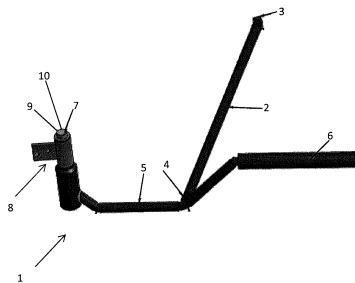


Figure 3: Illustration of Clickable Hand Control Device in a Vehicle consisting of a brake bar that is to be attached to the brake pedal

Steering Wheel Sensitivity Brake Control³

Patent Number: US20060082090A1

Author: Alain Constans

Date: 2005-12-07

Key Features:

³ US20060082090A1 - Steering wheel sensitivity brake control. (n.d.). Retrieved from <https://patents.google.com/patent/US20060082090A1/en?q=%28hand%2Bcontrols%2Bfor%2Bbraking%2Band%2Bsteering%29&oq=hand%2Bcontrols%2Bfor%2Bbraking%2Band%2Bsteering>

The patented item includes a lever installed behind the steering wheel within hand reach. In order to brake regularly, the driver must release the gas, switch over to the brake and press down; which may not be quick enough in the case of an emergency. In order to solve this, a brake can be added to behind the steering wheel. A strain sensor gauge is attached to the brake which can then be controlled by the driver's hand.

Pros:

A brake has a large range of motion based on how quickly the driver needs to brake. With this design, the pull of a lever from a finger has far less range of motion, making it more sensitive and likely causing a jerking motion when braking.

Cons:

This design also makes it difficult to adjust to a different method of braking when it is only used in an emergency. However, it prioritizes safety and is constructed very securely. Overall, it would be beneficial to add if the driver has difficulty switching pedals quickly.

Analysis:

The patented item is a simple and direct solution to creating a hand controlled driving aid that allows drivers to park with only their hand. It does not require direct modifications to the vehicle and can be used for research when creating driving aids that are mounted on to the interior. However, this device only allows the driver to control the vehicle's braking mechanisms and does not account for the acceleration pedal.

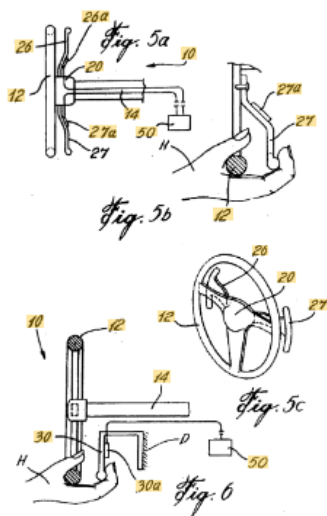


Figure 4: Illustration of Steering Wheel Sensitivity Brake Control showing the patented item and how it is installed onto the vehicle

Double-Wheel Automotive Hand Control System⁴

Patent Number: US4078628A

Author: Anton J. Reichenberger

Date: 1976-08-16

Figure 5: Illustration of Double-Wheel Automotive Hand Control System

Key Features:

The invention provides a brake system that can be utilized with one hand, suited for disabled drivers. It is a modification installed inside the vehicle involving a second wheel mounted in the steering wheel. The positions of the planes of each wheel controls the position of the linear actuator. The actuator activates the brake system of the vehicle and decreases the throttle. This invention is beneficial for drivers who have lost control over their lower body. The driver can move the wheel in or out with only one finger to control the braking system of the automobile.

Pros:

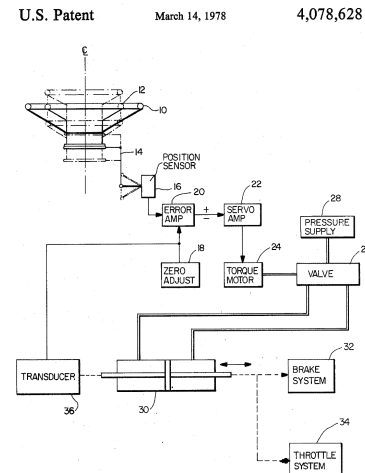
The item allows disabled drivers without control of their lower body to drive independently. This group includes patients with spinal cord injury. The braking system requires low effort and force to control because of the amplified position command through servo motors.

Cons:

However, this solution is a direct modification to the vehicle and requires larger amounts of money to be installed. This patented item shows how the modification affects the internal system of the vehicle and provides an idea of how the braking system functions.

Analysis:

The patented item is a system that is installed within the vehicle. The device allows for drivers without full function of their lower bodies to operate both the brake and accelerator with one hand. It is a solution that provides much user comfortability and efficiency but also one of the more costly solutions.



⁴ US4078628A - Double-wheel automotive hand control system. (n.d.). Retrieved from <https://patents.google.com/patent/US4078628A/en?q=%28hand%2Bcontrol%2Bsteering%2Band%2Bbraking%29&oq=hand%2Bcontrol%2Bfor%2Bsteering%2Band%2Bbraking>

Multi-purpose speed control apparatus⁵

Patent Number: US5282522A

Author: George R. Grindle

Date: 1992-10-22

Figure 6: Illustration of Multi-purpose Speed Control Apparatus

Key Features:

The patented item is a device that can be attached to a vehicle that allows those who are paralyzed or have disabilities to use the brake and accelerator pedals using their hands. The handle is installed near the right knee of the driver and the right hand is used to operate the apparatus. The device consists of a hand operated bell crank connecting to a protruding tab to the accelerator pedal and a projecting tab to the brake pedal. It is a mounting bracket that is installed onto the vehicle.

Pros:

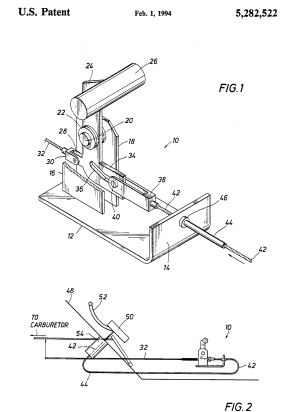
This position of this device allows the user to rest their arm, which makes it easy to drive for long hours with comfort. There are no rods interfering with the leg space, drivers can ignore the device and use the foot pedals if desired, such as instances of switching drivers. It can also be adjusted to fit any automatic vehicle. By targeting accessibility, this patented item is an effective solution to assist handicapped individuals drive.

Cons:

There are few negative aspects about this patent and the device. However, the patent only provides one image yet refers to multiple figures when describing the operation of the device. Multiple illustrations of the device from different views or focusing on certain components would greatly increase the usability of this patent for research.

Analysis:

The patented item is mountable onto any vehicle and therefore, an inexpensive solution. This patent can be used for research on mountable hand control driving aids, as it allows for drivers with disabilities to operate both braking and accelerating mechanisms using one hand. It comes with many benefits such as being used by both healthy and disabled drivers and providing comfortability with the placement.



⁵ US5282522A - Multi-purpose speed control apparatus. (n.d.). Retrieved from <https://patents.google.com/patent/US5282522A/en?q=%28hand%2Bbrake%2Bhandicap%2Bautomobile%29&oq=hand%2Bbrake%2Bhandicap%2Bautomobile>

Current Solutions From Competitors

Vehicle Modification

The most prominent competitors to consider are MPD, MPS, SureGrip, and Viegall. Since the majority of the competitors share the same categories, this section will focus on SureGrip's specific designs for each category.

Push/Pull

This is a mechanical system that is used by pushing the lever towards the floor to brake and pulling the lever toward the steering wheel to accelerate. This is commonly installed to the right of the steering wheel, but some companies can install on the left depending on comfort.



Figure 7: SureGrip's Push/pull hand controls. This particular one is installed on the left of the steering wheel, which is a very seamless addition to the vehicle.

Pros: It is also most suitable for individuals with limited finger dexterity.

Cons: May be awkward to adjust to or feel unnatural.

Push/Rock

To operate these mechanical hand controls, the driver must push the handlebar forward to brake and pull the handle toward themselves to accelerate.



Figure 8: SureGrip's Push/Rock hand controls. This one uses a vertical handlebar, however it can also come horizontally depending on the company.

Pros: it is easy to use and does not require a lot of space. With this design, the driver is also able to have part of their hand on the steering wheel while also controlling the brake and gas pedals.

Cons: May not be as comfortable to use since it is typically installed on the left and there is nowhere to rest the elbow.

Push/Right Angle

With this style, the driver pushes a handlebar down towards their lap to accelerate and move it forward to brake.



Figure 9: SureGrip's Push/Right Angle. This product only comes as a horizontal bar, whereas the other categories have the option of a vertical bar too.

Pros: It is well suited for compact vehicles. This product is easier to install than the rest.

Cons: This may feel more unnatural for users since accelerating and braking are two separate motions--pushing forward vs pushing down--while the rest are parallel to each other.

Conclusion

There is no one design superior to the rest. The quality and reliability is consistent throughout all of the options. It is more a matter of preference and ease of use when choosing a modification to install.

Products without Vehicle Modification

Modifying a vehicle requires a lot of money and is also more permanent. In the case of temporary injury or multiple drivers sharing a car, solutions that can be added onto the vehicle would be a better fit.

QuicStick Portable Hand Controls for Disabled Drivers

Manufacturer: QuicStick Hand Controls

Retail Price: \$179.99

Where to buy: Amazon

Key Features:

This product comes fully assembled. In order to install, the driver clamps it to each pedal using screws. The QuicStick Portable Hand Control weighs 2 pounds and its dimensions are 20 x 6 x 3 inches. It is made out of three pounds of aluminum.

Pros:

This product is one of the simplest products on the market. It uses a button for gas and is easy to use. The QuicStick Portable Hand Control is durable and easy to transport as it will fit in any luggage or carry on. The product is lightweight as it weighs two pounds. This product is suitable for both left and right handed drivers as the placement of the device is adjustable.

Cons:

The product requiring continuous holding down of the button for the gas is not ideal as it can cause discomfort for the driver.

Images:



Figure 10: Picture demonstrates the use of the QuicStick Portable Hand Control on the driver's left side.



Figure 11: Image displays the function of the push button on the brake.



Figure 12: Image shows the entire product not installed in the vehicle.

Analysis:

Overall, the QuicStick is a solid driving aid. This product considers the comfort of any driver, no matter which one of their hands is dominant. The portability of the product also allows for ease of installation and of transportation of the device from vehicle to vehicle.

Loveso Hand Controls for Disabled Drivers

Manufacturer: Loveso

Retail Price: \$1,070.00

Where to buy: Amazon

Key Features:

This solution is far more complex in its structure, using a mechanical system to create a push/rock design. The Loveso Hand Control requires drawing back for the accelerator and pushing forward to brake. The button of the handle will lock the brake. The brake pedal also has an extension rod to reach over the gas pedal, with two brackets that slide over the extension rod.

Pros:

The brake lock feature works like a gear shifter release button, and allows for rest at a stoplight and for ease when parking on a hill and needing to use the parking brake.

Cons:

It is more difficult to install as it doesn't simply clamp to the pedals, but it ensures sturdiness by screwing to the car floor.

Images:

Figure 13: Figure 13 displays the product installation process. It does not require drilling. It can be directly fixed to the driver's seat rail.



Figure 14: Figure 14 displays the installation of the floor accelerator pedal.

Analysis:

This is by far the most similar to vehicle modifications in the way it operates and also in its reliability. This product sacrifices an easy installation process in order to ensure the sturdiness of the device in the vehicle.

Freedom Staff Hand Tools SYL-940

Manufacturer: Freedom Staff

Retail Price: \$260.00

Where to buy: DevineMedical; Amazon

Key Features:

The Freedom Staff Hand Tools SYL-940 weighs 3.26 pounds. There are no tools required to install this product into the vehicle.

Pros:

A unique feature of this product is that it comes with a strap to the steering wheel, which allows it to not slip or lose grip. It also comes with a steering wheel spinner, which makes it easier to steer with one hand.

Cons:

This product operates differently from the rest, using a rocking side-to-side for the brake and acceleration. Because of this, it may be a little more difficult to drive with in comparison to the other product.

Images:

Figure 15: Image of Freedom Staff Hand Tools SYL-940 and a driver resting his hand on the handle



Figure 16: Image of all separate parts of the product disassembled and not installed in the vehicle.

Analysis:

While the Freedom Staff Hand Tool makes it easier to steer with one hand using the steering wheel spinner, the overall driving experience may be difficult as the product uses a rocking side-to-side motion.

YANGG Hand Controls

Manufacturer: YANGG

Retail Price: \$1,266.80

Where to buy: Amazon

Key Features:

This solution is very similar to the Loveso Hand Controls in its mechanical system. However, this one is more simple to install but it is also not adjustable.

Pros:

This product comes with a steering wheel spinner and a brake lock, hitting on both ease of driving and safety. It is suitable for most automatic transmission vehicles and can switch between two modes, allowing a healthy driver and a driver with disabilities to operate the vehicle.

Cons: Similarly to LoveSo hand control products, the driving aid may be hard to install and will take up more leg room, decreasing the user's comfortability.

Images:

Figure 17: Image of the installation and placement of YANGG Hand Control product



Figure 18: Image of the all components of the product disassembled.

Analysis: This product is similar to LoveSo products and contains similar functions. However, this product also includes the feature of two mode switching and includes easier installation, making it more a marketable product.

Peddle Master Vehicle Hand Controls

Manufacturer: Peddle Master

Retail Price: \$320.00

Where to buy: Peddle Master, Inc; Amazon

Key Features:

The gas and braking aids are two separate products. The product runs evenly with the steering wheel and is 26 ½ inches in length. The hand controls attach to the vehicle by clamping on to the pedal with spring loaded jaws. The Peddle Master Vehicle Hand Control does not attach to the steering column.

Pros:

The product allows for more flexibility and comfort for the driver as it does not attach to the steering column.

Cons:

This design lacks a lot of features that the other products use, as it has two separate sticks for brake and acceleration. This makes it difficult to operate and it is also not adjustable.

Images:



Figure 19: Image displays superior and inferior ends of the Peddle Master Vehicle Hand Control.



Figure 20: Image displays product installed in vehicle.

Analysis:

Overall, not a great solution, but it does use a mixture of steel and aluminum which sets it apart from the other products.

DriFeez Hand Controls

Manufacturer: Drifreez

Retail Price: \$169.90

Where to buy: Amazon

Key Features:

The structure of the Drifreez Hand Control is mostly made out of steel, but is entirely made out of metal. The product fixes onto the pedals and is positioned near the steering wheel. It is also compatible with automatic transmission vehicles. The device requires a push to brake and a pull to accelerate.

Pros:

While the Drifreez Hand Control requires a tool for installation, the process only requires using one allen wrench. The set-up of this product allows for one-hand-control with one hand of the device and one hand on the steering wheel.

Cons:

This product requires that the same amount of effort a leg would apply onto the brake to be exerted by the hand. The composition of the product also allows for error with the handle becoming stuck when trying to push for the brake.

Images:

Figure 21: Image displays driver using the Drifreez Hand Control in the vehicle.

Analysis:

This is a really well designed product because it has the same simplicity as QuicStick and Freedom Staff, but it operates as push/rock driving. By having this style of driving, it mimics the most popular vehicle modification for disabled drivers. It also distinguishes it from the other push/rock products because it clamps to the brakes.

Table 1: Similar Solutions Matrix

Similar Solutions Matrix		Features	Push button for gas	adjustable	Lightweight	Push (brake)/rock (gas)	Screws to car floor	Brake lock feature	Rock side-to-side to brake/gas	Clamps to pedal	Comes with steering wheel spinner	Straps to steering wheel	Stainless steel	Aluminum	gas and brake are two separate devices	Comes fully assembled
Solutions & Designs																
	QuicStick portable hand controls	X	X	X					X				X			X
	Loveso		X		X	X	X			X		X				
	Freedom Staff Hand Tools SYL-940		X	X				X	X	X	X					X
	YANGG hand controls				X	X	X		X	X		X				
	Peddle Master Vehicle Hand Controls			X					X			X	X	X	X	X
	DriFreez hand controls		X		X				X			X				X

Previous solutions must be reviewed first before determining a project design. This matrix identifies popular products that already exist and their features.

Conclusion

The most common features among all the designs are clamps to the pedals and adjustable rods. The clamps are the simplest way of attaching the device to the vehicle, and is incredibly easy to create. Having adjustable rods is also important as all cars are different. Each individual has their seat at a different distance and height, which makes it important to be adjustable for comfort and ease. It is more common to be built out of steel as it is more sturdy, but aluminum is a second option because it is lightweight.

A more unique feature, but certainly not necessary, would be a steering wheel spinner. This makes it easier for drivers to steer with one hand. Creating a push/rock design would be more ideal since it emphasizes on ease of driving, looking most towards *DriFreez's* solution.

Conclusion

The patented items and current solutions presented in this document are effective solutions to the problem of patients with spinal cord injury not being able to travel independently. Currently, the most popular solutions are vehicle modifications that often cost thousands of dollars. However, this document outlines both vehicle modifications and mountable hand-controlled driving aids. According to available patents and products on the market, hand-controlled driving aids often

include common features of clamps for easy installation and adjustable rods for user comfort. Some solutions also have other key features that make the product more marketable and appealing to patients with SCI and their caretakers. This research will be compiled and used to create an ideal solution that consists of the common features in all current solutions and minimize the disadvantages.