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Intelligent Walking Aid (IWA) for Elderly

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Abstract: Walking frame (WF) is one of the walking aids that the elderly use to move from one place to another place. When using a WF on a rough surface, the WF is hard to move because of the smaller width of the wheels. The main objective of this project is to develop hardware for the elderly to move using intelligent walking aid (IWA) on a rough and smooth surface. This project introduces the steel, WF, chair and hoverboard as hardware parts that will attach together while 3D SOLIDWORK software is in the designing stage. The result shows that IWA is functioning well on both surfaces and it shows that on the smooth surface, IWA is more stable and more speed which only takes 10.94s on the smooth surface while on the rough surface it takes 50.93s to finish 15-meter length. By upgrading the standard WF to technology, it can help the elderly to move without tiring and users can be more stable than using a standard WF.

Keywords: Walking Frame, Elderly, 3D SOLIDWORK, Hoverboard And Standard Walking Frame.

1. Introduction

Nowadays, the population of the year of 1960s all around the world is stepping into an aging society. According to the Malaysian population estimates in 2020, there was 32.7 million population and for citizens, 29.7 million compared to the year 2019 which was 29.4 million [1]. In Malaysia, elderly people are considered from the ages of 65 and beyond. It has increased from 6.7% which was 2.2 million in 2019 to 7.0% which was 2.3 million in 2020 [1]. Elderly people or senior citizen have difficulties walking like normal person which lead them to use a walking aid such as a stick, wheelchair or any supported device to walk. Sometimes when the elderly use walking aid, it also can make them lose their stability which can lead to severe injuries and can make them more tired when walking long distances.

This project was developed by upgrading an existing walking aid that can help the elderly to move easily without tired and injured using a technology of balancing system. In the previous related study, Pandey et. al studied about self-balancing robot on two wheels with line-following capability [2]. This study develops a robot with two wheels balancing device with the additional feature of line following capability and it used ATMEGA32 as the main board while for Gonzalez et .al, they study on the low-cost two wheels self-balancing robot for controlling education which focused on electronic,

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computer programming, modeling, control and signal processing in control and construction of the robot [3] and used an Arduino as a controller to control the movement of the robot. IWA project implements a concept of a hoverboard that will be attached to the walking frame so that it can make the elderly move easily. With the combination of a chair, hoverboard and walking frame, the elderly can move easily because they only need to sit and move their foot to make a movement in short or long distances. Developing this project also can introduce our elderly to the importance of new technology in this era.

The elderly with weakness in walking are required to wear a walking aid to minimize the risk of falling and maintain the quality of their life. The main objective of this project is to develop the hardware for elderly people to move using an IWA device, to design a self-balancing device that can be used on both rough and smooth surfaces and to evaluate the effectiveness of the developed system.

This project was developed by upgrading the current walking frame to an intelligent device that can perform a movement by using a self-balancing concept attached to the current walking frame. For the main component of the circuit, it uses a control board that has a microcontroller (uC) and using 6 MOSFET transistors at the Double-sided 2 Printed Board Circuit (PBC) control board, a pair of gyroscopes, a pair of wheels and a pair of an infrared sensor that were located at the self-balancing device. Next, the algorithm for the embedded system that was used in the self-balancing device is C programming. This project only focuses on a walking frame and self-balancing concept system that were attached together for elderly uses and the maximum load for external use is 120kg.

2. Methodology

This chapter focused on the circuit, designation and component that was used to complete the project. This project proposes a self-balancing device system that will be attached to the walking frame which will make elderly users easy to move without the risk of falling.

2.1 Development of IWA device

The circuit project block diagram of the self-balancing system was described as shown in Figure 1. Firstly, there is a seating chair that can accommodate users when using an IWA device. While there is a battery to support the circuit of IWA to move. In the circuit, it has a main board which is called a control board that controls all the systems of the self-balancing device and it also has two gyroscopes and two infrared sensors. Then the circuit will be connected to both wheels. Each wheel has an electrical motor that is accompanied by a tilt sensor and speed sensor. Both sensors will detect the motion of revolution per minute (RPM) and send data to the gyroscope and the motherboard to control the speed. This self-balancing concept will be attached to the walking frame to make it more efficient when a user using it.

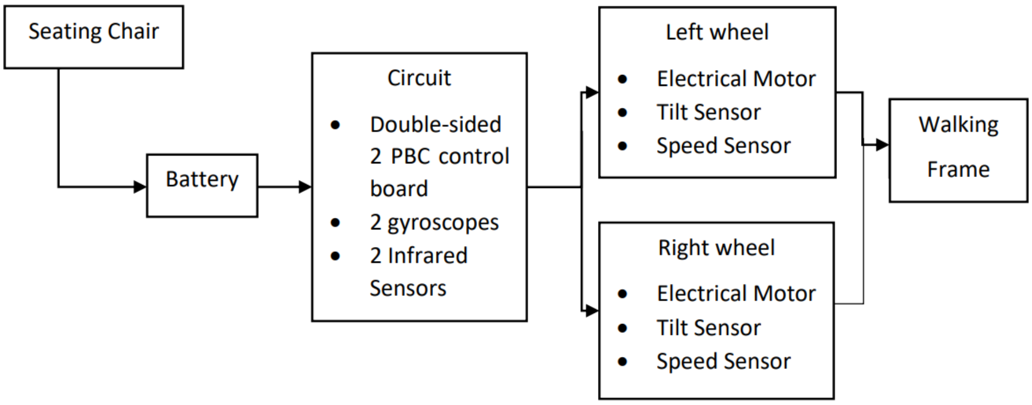

Figure 1: Block diagram of IWA device

• Seating chair

The chair was used in this project to make the user more comfortable when using the IWA device. The width of the seat highly emphasized because when the width seat is smaller, the user might be fall when using this IWA device. The width of this chair is 31 cm and the length of this chair is 33 cm.

• Battery

The battery in the self-balancing device is the lithium-ion power battery pack. The standard voltage of this battery is 36V. The dimension of the battery is 135mm (length) x 90mm (width) x 60mm (high).

• Double-sided 2 Printed Board Circuit (PBC) board.

It is the brain of the self-balancing device that controls speed, wheels, tilts, the direction of wheel spin and LED indicators. This board is used a GD32F microcontroller (uC) as the main controller.

•2 wheels

The self-balancing device uses two wheels which have an electric motor and two sensors inside the wheels. The sensors are a tilt sensor and a speed sensor.

•Walking frame

The walking aid chosen for this project is a walking frame which has a design of rectangular because it is more stable when attached to the IWA devices. It also has wheels at the bottom of the walking aid.

2.2 Processing of the hardware

The hardware of the IWA device was built based on the SOLIDWORK design. To build this hardware, it went through several processes which are a measurement of the design process, cutting steel process, welding process and smooth clean steel process.

2.3 Functionality of the device.

Figure 2 shows the flow chart on how the circuit of the balancing system work. When the user's feet are on the board, the pressure pad will detect the pressure of the feet and the switch under the layer of the pressure pad will be pushed down. After that, an infrared (IR) sensor will allow the user to control their movement direction when they user took their feet on the pressure pad. Next, the mainboard of the motherboard used in this project is a Double-sided 2 Printed Board Circuit (PBC) control, board. In the wheels, there are 3 important components to make sure this device is functioning well. The components are an electrical motor, speed sensor and tilt sensor. Both sensors are used to detect the revolution per minute of the wheel which will be sending the information to the gyroscope and motherboard to control the speed. The gyroscope sensor will keep balancing and determine how far the user can tilt forward and backward. Before the end process, both wheels will move depending on the user's tilt either in a forwarding or backward direction.

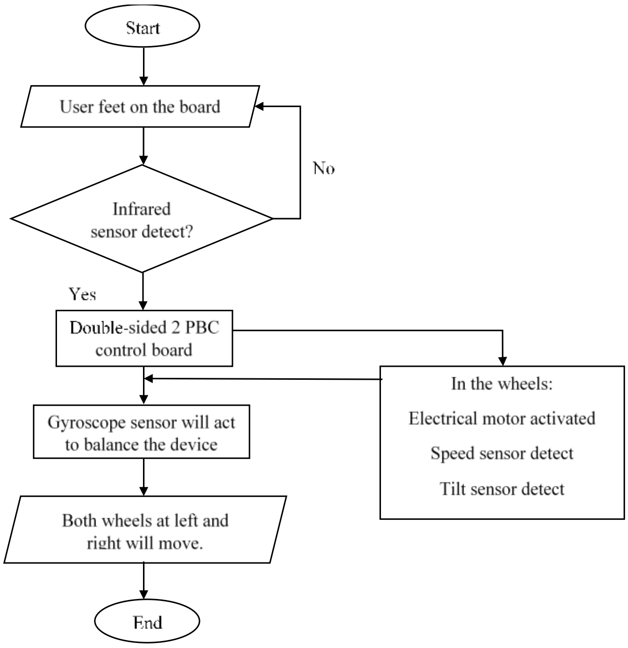

Figure 2: Flowchart on the circuit of balancing system work

Figure 3 shows the flowchart of the Intelligent Walking Aid (IWA) function. For the first step, the user has to turn on the self-balancing device which is work as an input in the device. The user must sit on the chair to make sure they can use self-balancing that attaches to a walking frame without falling while using it. Lastly, the user must attach their feet to the board that has a gyroscope and IR sensor to make a move.

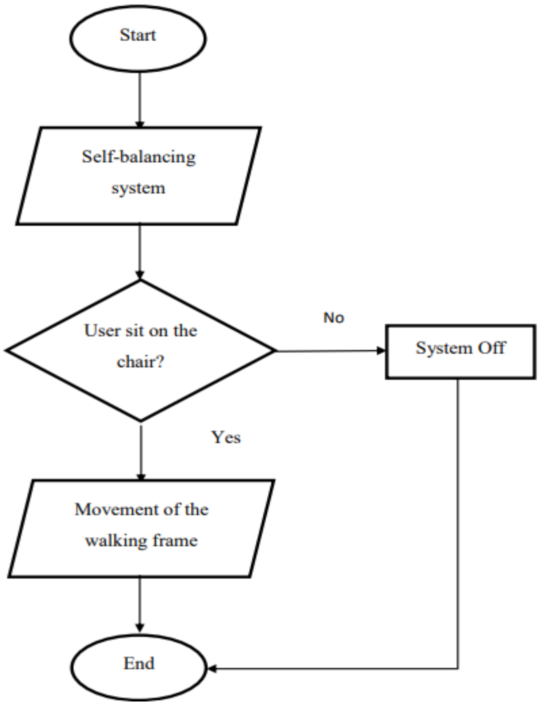

Figure 3: Flowchart of walking aid devices

2.4 Assessment of IWA device

The assessment of Intelligent Walking Aid device will assess in the indoor and outdoor areas. It is because, to know whether the device works well on rough and smooth surfaces, it must assess the indoor area where the surface that involves in the indoor area is a smooth surface (tiles) and rough surface (carpet). While for the outdoor area, it will be assessed on the smooth surface (outdoor tiles) and rough surface (road).

3. Results and Discussion

It will show the result and analysis of the Intelligent Walking Aid (IWA) system device. The proposed system of the IWA is designed to make an easy movement for the elderly to move from one place to another place. It also can help the elderly move outside the home without any helper.

3.1 Design of the device

Figure 4 shows the design of the combination self-balancing device, a walking frame device and steel that had been sketched in SOLIDWORKS software. It is the top plane and right plane of the IWA device

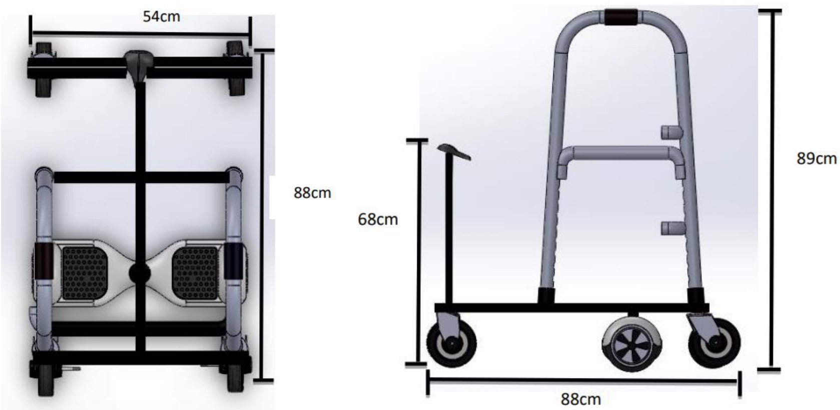

Figure 4: Top plane and the right plane of the IWA device

3.2 Hardware of IWA device

Based on the design in the SOLIDWORKS software, the hardware of the IWA device was built to make sure the elderly can move only using their foot on the self-balancing device that had been attached to the walking frame by using steel. When building this product needs to emphasize the stability of the product when a user uses it. Figure 5 shows the front and top view of the IWA device.

Figure 5: Front and top view of the IWA device

3.3 Testing of IWA device functionality

To make the Intelligent Walking Aid (IWA) device function well, the user needs to put their feet on the balancing system properly to make sure the infrared sensor detects the user's feet and makes a move. To see if the sensor is functioning well in detecting the user's feet, there are LED lights that is connected to the IR sensor where when the user attaches their feet to the board of the self-balancing system, the LED light will be in ON condition. There are several techniques that users can follow to make a move on an IWA device.

•Move forward

To make a forward movement, the hoverboard needs to tilt forward because when a user attaches their feet in a condition of tilt forward this IWA device can easily move forward and an easy to control either want to slow or fast.

•Move backward

When the user wants to move backward. Users must down their heels to make sure it tilts down so that they can move backward easily.

•Moving to the left

The condition of the hoverboard must be pointing to the left. When feet touch the board, the sensor will detect and follow the movement of the feet at the hoverboard so the device will make a move and turn left.

•Move to the right

To turn right, the condition of the hoverboard must be pointing to the right. When the feet touch the board, the sensor will detect and follow the movement of the feet at the hoverboard so the device will make a move and turn right.

3.4 Assessment of IWA device functionality

These devices are suitable for indoor and outdoor activities. This is because Intelligent Walking Aid (IWA) device hardware are using 4 wheels which makes the device more stable when in indoor and outdoor areas. For this project, IWA devices have been tested on smooth and rough surfaces in indoor and outdoor areas to see the capability of speed, stability and battery life. While standard walking frames also have been tested on both surfaces at the indoor and outdoor areas to see the stability and speed of the standard walking frame. Table 1 shows indoor testing of IWA on both surfaces and table 2 shows indoor testing of the standard walking frame. While Tables 3 and 4 show the outdoor testing of IWA and standard walking frame on both surfaces.

Table 1: Indoor testing IWA device in both surface

	Tiles (Smooth surface)	Carpet (Rough surface)
Stability	Stable	Stable
Time taken of the speed in 5 meter	5.72	9.40s
	5.64	8.76s
	5.29	8.00s
Average	5.55s	8.72s
Battery	5 hours 37 minutes	4 hours 15 minutes

Table 2: Indoor testing of a standard walking frame at both surface

	Tiles (Smooth surface)	Carpet (Rough surface)
Stability	Stable	Stable
Time taken of the speed in 5 meter	10.68s	12.08s
	9.70s	11.90s
	9.54s	11.70s
Average	9.97s	11.89s

Table 3: Outdoor testing of IWA device at both surface

	Tiles (Smooth surface)	Road (Rough surface)
Stability	Stable	Stable
Speed	5.40s	19.04s
	5.93s	18.75s
	5.68s	18.83s
Average	5.67s	18.87s
Battery	5 hours	3 hours 30 minute

Table 4: Outdoor testing of standard walking frame at both surface

	Tiles (Smooth surface)	Road (Rough surface)
Stability	Stable	Less Stable
Speed	10.58s	53.72s
	11.30s	50.21s
	10.95s	48.86s
Average	10.94s	50.93s

4. Conclusion

Intelligent Walking Aid (IWA) is a device that helps the elderly to move from one direction to another direction by using their feet. The combination of a self-balancing system, steel and a walking frame can make users easily control the device using their own feet without any falling. This device can be used in indoor and outdoor areas where IWA devices can function well on a smooth and rough surface. To use this device, the weight the device can accommodate is 120kg. The development of the IWA device is one of the efforts to introduce elderly people to the technology. When the elderly lose hope to walk and cannot make a move from one place to another place, the IWA device with the technology of self-balancing can help them to move without feeling tired in their leg. By developing this device, the objective of this project is successfully achieved where the IWA device can be used for elderly people to move, the IWA device can be used on rough and smooth surfaces and the development of the system effectiveness had been evaluated successfully. The recommendation in the future is to apply a manual brake at the walking frame. By applying this item, users can brake using their hand to make the device stop and this method also can make them safer while stopping the device.

Acknowledgement

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