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Design Construction and Training on Making Electric Wheelchairs for Instructors at SLB-D YPAC Bandung City to Improve the Mobility Orientation Ability of Physically Impaired Students

SUDRAJAT, BUDI SETIADI, TOTO TOHIR, ENDANG HABINUDDIN, SUPRIYANTO

Politeknik Negeri Bandung
Email: budi.setiadi@polban.ac.id

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ABSTRACT

Paralympic students in grades 1 to 12 with permanent disabilities in the movement organs (bones, joints, muscles) in the Special School category D (SLB-D) YPAC Bandung City have been equipped with basic Mobility Orientation (OM) technical skills to be able to carry out activities and mobility. Independent. One of the OM techniques taught to people with quadriplegia in the categories of Paraplegia (abnormalities in both legs and feet) and Diplegia (abnormalities in both hands or paralyzed legs) is the use of a manual wheelchair. Even though all quadriplegic students already have OM abilities. However, many students are reluctant to use manual wheelchairs independently. The problem is because it is considered to drain stamina, difficulty controlling it, and fear of using it on uphill/downhill/sloping/potholed roads. So it was proposed that the mobile electric wheelchair be controlled by the physically disabled via a manual button, and as a safety measure, it is equipped with an anti-crash sensor. Anti-crash sensors help the wheelchair move automatically (slow down, stop) if an object is in the way. In implementing this PKM, the team carried out knowledge and technology transfer to Instructors/Teachers/Parents of Students and testing for the Physically Impaired. The results of this activity are in the form of electric wheelchairs that have been tested.

Keywords: *quadriplegics, electric wheelchairs, sensors*

1. INTRODUCTION

Health standards, and the World Health Organization (WHO) regarding wheelchair assistive devices. A wheelchair is a tool for people who physically cannot walk and support their limbs independently **(Syakura, 2021); (Supadma & Rahmawati, 2022); (Mandagi, 2018); (Iksal & Darmo, 2012)**.

Physically disabled people in the Paraplegia and Diplegia categories can carry out social functions in the form of independent activities and mobility in society without the help of a sighted companion. However, there is a reluctance to use manual wheelchairs by students who are teenagers because of the risk of draining their stamina, difficulty controlling them, and fear of using them on uphill/downhill/sloping/potholed roads. If this condition is not enforced, it will forever make disabled students unable to be independent in their activities and mobility. Pay attention to these problems.

Figure 1. Partner Locations

Figure 1 shows the partners' locations where the learning process for the physically disabled is carried out. All disabled students in the SLB-D YPAC environment (located on Jl. Mustang No. 46, Sukawarna, Sukajadi, Bandung City) are equipped with OM technical skills by the DIKNAS curriculum starting from grades 1 to 12. OM practice with a sighted companion is taught starting in grades 1 to 6 and without a companion for grades 7 to 12. Figure 2 shows the activity of using a manual wheelchair on a particular path with a slope > 10º. Student 1 (left) seems to have difficulty controlling the wheelchair because the path is downhill. Meanwhile, student 2 (right) looks like he is struggling, and his stamina is drained because the route is uphill. Conditions like this are dangerous for both students because there is a risk of collisions.

Figure 2. Possibility of Collisions on Downhill/Uphill Routes Due to Difficulty in Control and Stamina

Figure 3 shows the non-independent activities of people with quadriplegia. Students with physical impairments are reluctant to use manual wheelchairs independently because of concerns about being unable to control them, depleting their stamina, and causing collisions. Some developments with wheelchairs use controls or automation **(Matarru, 2022);(Mustari, 2015);(Setiawan, 2021).**


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Figure 3. Physically Impaired do Activities Using Teacher Companions

Figure 4 shows a person with quadriplegia using a manual wheelchair without mechanical brakes on a particular downhill path. If this condition is forced, it will result in decreased stamina, difficulty controlling, and the possibility of crashing (accidents). Development of an IoT-based wheelchair for use **(Sailana, 2021)(Jatmiko, 2019),(Ashegaf, 2019).**

Figure 4. Physically Disabled Forced to use A Wheelchair Without Mechanical Brakes On The Descent Route

From the problems in Figure 2 to Figure 4, an electric wheelchair is proposed, which can be controlled by the physically disabled via buttons manually and, as a safety measure, is equipped with an anti-crash sensor. Anti-crash sensors help the wheelchair move automatically (slow down, stop) if an object is in the way.

2. METHOD

The method for implementing PKM activities offered from the results of site visits, observation, and analysis of problems faced by SLBD YPAC Bandung City partners is divided into 2: theoretical and practical assistance. The theory of scientific transfer takes the form of training in mechanical design technology (using the FUSION 360 application) and electronics related to sensors and actuators (BLDC, LiDar sensor, and gyroscope). The technological and scientific results that have been received are put into practice to become a prototype of an Adaptive (anti-crash) Electric Wheelchair. The tested prototype results will be used as a blueprint document for development or increasing quantities independently by partners. Figure 5 shows a schematic diagram of the hardware design of the electronic and control systems for an electric wheelchair.

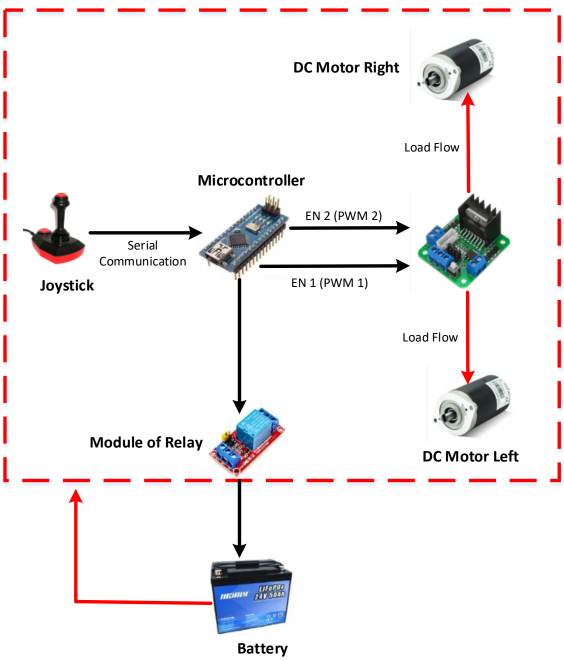

Figure 5. Electric Wheelchair Control Hardware Diagram

Figure 5 is a schematic diagram for controlling an electric wheelchair, where in the wheelchair, a DC motor is used to drive the chair, and motor control is regulated by a microcontroller using an L298D type motor driver by adjusting the amount of pulse width modulation (PWM). Then, the relay module is used as the main power breaker, and the joystick is used to control the rotation direction and speed of the motor. The overall circuit details for the electronic control system can be seen in Figure 6.

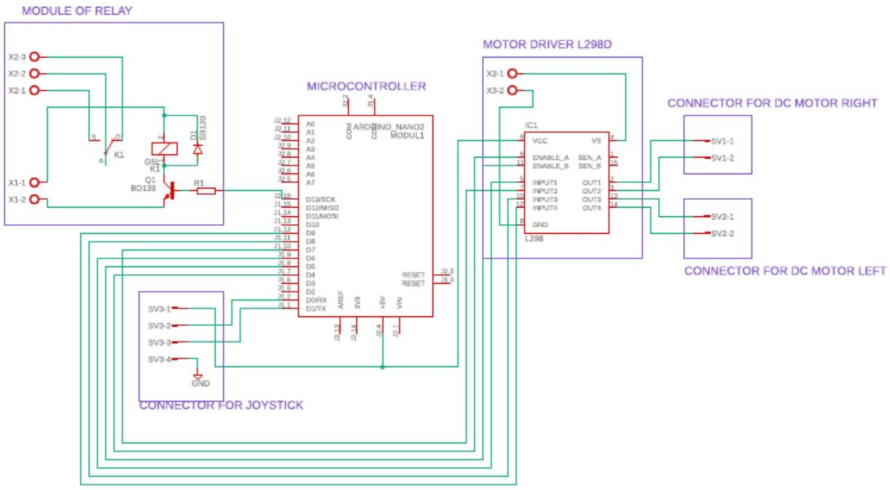

Figure 6. Electric Wheelchair Control Schematic

Figure 6 shows the entire control module system in the form of an Arduino nano microcontroller as the control center, connectors consisting of a connector for the joystick left and suitable DC motor terminal connectors, L298D driver, and relay module. Table 1 explains the use of input and output (I/O) on the microcontroller.

Table 1. Input and Output on Microcontrollers

No.	Pin Arduino NANO	Function	Description
1.	D4 & D5	Output	PWM 1 & 2
2.	D6 & D7	Output	IN1 & IN2
3.	D8 & D9	Output	IN3 & IN4
4.	D1	Output	Module of Relay
5.	D0 & D1	Input	Joystick communication

Table 1 is a table of I/O on the microcontroller from the circuit Figure 6. The DC motor speed setting will be set on the duty cycle size of PWM 1 and PWM 2. For PWM 1 for the suitable motor and PWM 2 for the left motor.

2.1 Training Participant Selection Process and Number of Participants

This process is carried out to anticipate interest that exceeds the capacity of training participants. Apart from that, to more effectively provide material during training and test practical results in the form of prototypes of Electric Wheelchair assistive devices.

The PKM Team management conducted this selection process in collaboration with SLBD partner YPAC Bandung City. The participants who will be selected consist of teacher staff and two parents of physically disabled students. In fact, in the field, the selection process is simple because those who will be trained are those who are used to being tasked with OM learning and maintaining computer equipment. The staff involved will be ten people, including the head, a Productive Teacher, and two physically challenged students simultaneously for testing). The background of the staff to be trained consists of general and technical degrees.

2.2 Creation of Training Materials

This stage involves creating training modules for theoretical and practical training to produce prototypes of Adaptive Electric Wheelchair assistive devices. This includes creating a practical guide to training modules that Partners can utilize. The material that will be created is adapted to the results of site visits, discussions, and interviews regarding the problems faced before making this proposal, namely:

1. Basic robotic and mechanical systems
2. Electric motor VS BLDC
3. Power electronics and power supply systems
4. Analog electronics and interfaces
5. MiniPC programming and interface
6. Programming Sensors
7. PCB design and mechanics
8. Troubleshooting and testing
9. SOP and blueprint

2.3 Implementation of Assistance, Training, Manufacturing, and Testing of Adaptive Electric Wheelchair Prototypes

Assistance in making prototypes of adaptive electric wheelchairs was carried out in conjunction with training in mechanical design, PCB, actuator transducer sensors, electronics, mini PC programming, and operation and maintenance. Before integrating electronic components into the PCB, each training participant is given basic knowledge of sensor actuators and data processing problems through the abovementioned training. After being given the material mentioned above, the training participants will then be given training material about:

1. Identify the problems faced as described above;
2. Then it also explains the analysis of the problem and the solutions provided along with other technical reasons;
3. Jointly carry out mechanical work for BLDC motor mounts and electronic devices, including batteries
4. Carry out work together to integrate electronic components (LiDar, gyroscope, and stick) on the PCB, then store them in a casing and integrate them with the BLDC motor mount mechanics;
5. Carry out joint integration work between electronic mechanics and manual wheelchairs;
6. After completing the integration and becoming an adaptive electric wheelchair, technical testing is carried out by staff and disabled students to determine whether the results will be as expected. If there are still problems, solutions will be sought again based on conditions in the field.
7. Documentation of the SOP for the use and maintenance of the prototype, as well as a blueprint for making the adaptive electric wheelchair prototype, was created.

3. RESULTS AND DISCUSSION

The results of the realization of a tool in the form of an adaptive electric wheelchair are shown in Figure 5. in the form of a (prototype/prototype of the tool) that has been tested/feasibility study document.

Figure 7. Electric Wheelchair Product Prototype

Figure 7 is the results from a prototype product plan for an electric wheelchair equipped with sensors and a stick to control the wheelchair. Figure 8 shows the test results of an electric wheelchair driven by a physically disabled person.

Figure 8. Electric Wheelchair Product Testing

After the product realization and testing phase, training will be held with partners to socialize product use, how it works, and maintenance. Figure 9 is documentation of the product training that has been created.

Figure 9. Training and Assistance to Partners

Figure 9 shows the implementation of training for theoretical and practical class activities carried out at Partner locations. Partners provide training places with samples of standard manual wheelchairs commonly used in classroom buildings. The technology transfer carried out includes design, implementation, and testing. The training given to instructors can broaden their knowledge and in the future, the school can develop it independently with help from third parties. With the development of this electric wheelchair, it is hoped that it can increase user accessibility.

4. CONCLUSIONS

The Design and Construction of Electric Wheelchair Manufacturing for Instructors at SLB-D YPAC Bandung City to Improve the Mobility Orientation Ability of Students with Physical Impairment has been successfully and successfully realized. Students with physical impairments can use electric wheelchairs by controlling them manually using a control stick. Future developments can include making adaptive electric wheelchairs that can automatically move from one room to another and prototypes for other special needs.

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