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Short Communication

THE PROTOTYPE OF AN "OFF-ROAD" WHEELCHAIR BUILD BY STUDENTS USING ROBOTICS KNOWLEDGE

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ABSTRACT

The issue of wheelchair users is still relevant. In our school are also students with physical disabilities. Currently, they are two classmates from neighbouring classes. Obviously, with a lower limb disability they are constrained to use wheelchairs. Sometimes it is difficult for them to get to the places, where other usually get easily. This has led us to create a wheelchair as an aid for these people with a handicap. We have decided to facilitate functioning in the outdoor environment for students with difficulties to move, because where tough paved paths end, tough reality begins. With help of project RUSOS, our students are more capable of solving this complexed task that requires knowledge from robotics.

KEYWORDS: wheelchair, disability, secondary vocational school, students

1. Introduction

By using Internet, we began to explore the offer of outdoor wheelchairs at home and also abroad [1]. We have found that this topic is very up to date and significant. We have noticed that there are various traveling chairs, scooters, buggies, quadrupeds, see Figure 1. In all these types, the wheelchair moves from its trolley to another machine and its trolley remains outside, this can be considered as a major disadvantage. This problem has led us to resolving of this disadvantage. Our design solution offers this option. The purpose is to prevent the vehicle from slipping on the seat of another device. It moves to inaccessible places with its trolley [2]. The main purpose of our work was to make a functional prototype of a wheelchair that would allow a separate movement for immobile people in this field. We have verified the suitability of materials and working methods used for making construction. Our focus was aimed on the protective function of wheelchair and the construction of a barrier-free lifting platform for safe entry and exit and gradually improving ergonomics of the wheelchair.

Fig. 1. Example of outdoor wheelchairs

The knowledge of field trials has been put into practical form, and we have then proceeded to gradually improve the design of the wheelchair. Machine tools for turning, milling, manual metalworking, welding and surface finishing have been used as they are available to us. The entire construction should not exceed 250 kg. Conventional wheelchairs, on which many disabled people are dependent, can usually move only on a good and solid surface [3]. Such wheelchairs are characterised by narrow tires and therefore difficult to ride, for example, on the lawn or other less cohesive surface, the heavy terrain is inaccessible [4]. Greater freedom of movement allows the physically challenged prototype of our new wheelchair. This so-called "off-road" wheelchair enables trouble-free ride on lawns and other unpaved surfaces [5].

2. Methodology

We have started creating the wheelchair construction in the school year 2015/2016. We were interested in the offer of our teacher and later as consultant, Eng. Lukáš Roguľa, so we decided to build a functional off-road wheelchair. The first background for our work was an inspirational video from the Internet. Gradually, we designed various sketches of the future design for technical drawing. There were two variants in the shortlist. One was based on the belt drive, where belt was in the form of a triangle and the other one was with front and rear tires of same dimensions [6]. After that, followed searching of inspiration at websites, searching of relevant materials, procedures and consultations with the master of training in our school workshops. Finally, we decided to make a simplified version.

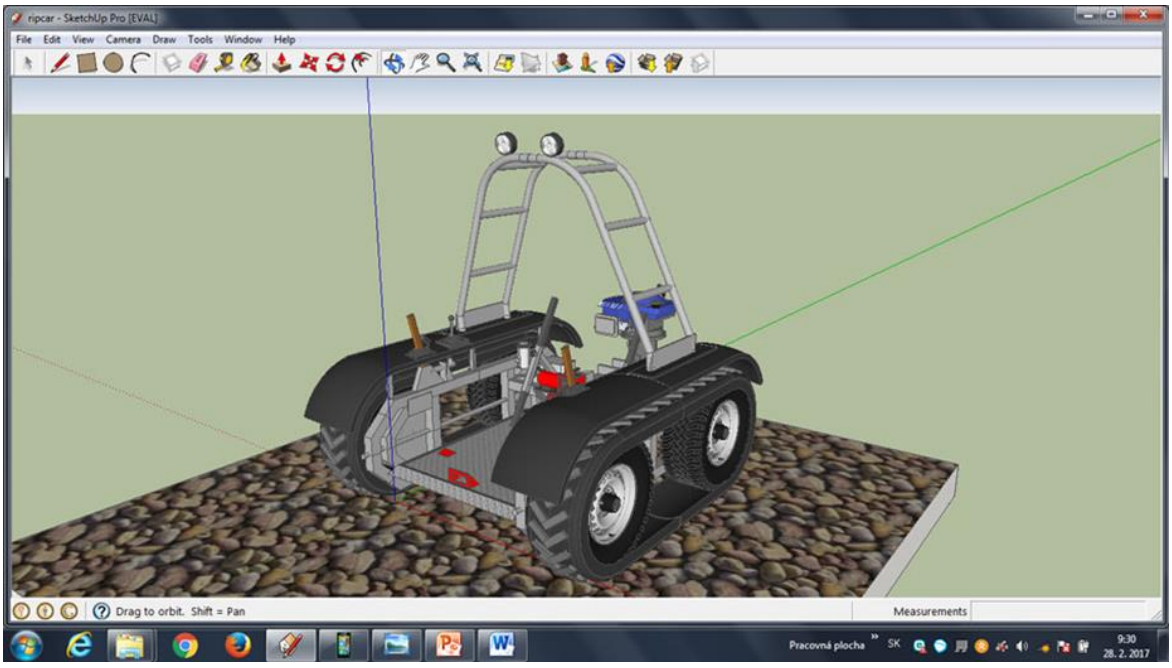

Fig. 2. CAD drawing off designed off-road wheelchair

We have started working on first 3D drawings of the off-road wheelchair. Our school conditions were in line with the sketch shown in Fig. 2. At the beginning we have noticed that our construction must not exceed dimensions L x W x H - 1800 mm x 1350 mm x 1900 mm. That made us sit on a trailer. It was important to select the type of material as well as to determine the overall design [7]. For main materials, we chose the following: on steel frame - square profile (this dense material was provided by our secondary vocational school), the front axle was used from Skoda Felicia car.

The rear axle was taken from the Lada passenger car. For welding materials, we used welding in a protective atmosphere of CO_2. Models have been surface-treated by grinding and protective zinc spraying [8]. As a drive, we used a combustion engine and a factory gearbox. We have certified the transmission from the VARI garden technician. It provided three gears for forward and one reverse gear [9]. We have used a brand new four-stroke engine from the American manufacturer BRIGGS - STRATTON. Invalid off-road wheelchair was produced at school workshops of Juraj Henisch School at Bardejov with the help of professional trainers with professional training, see Fig. 3.

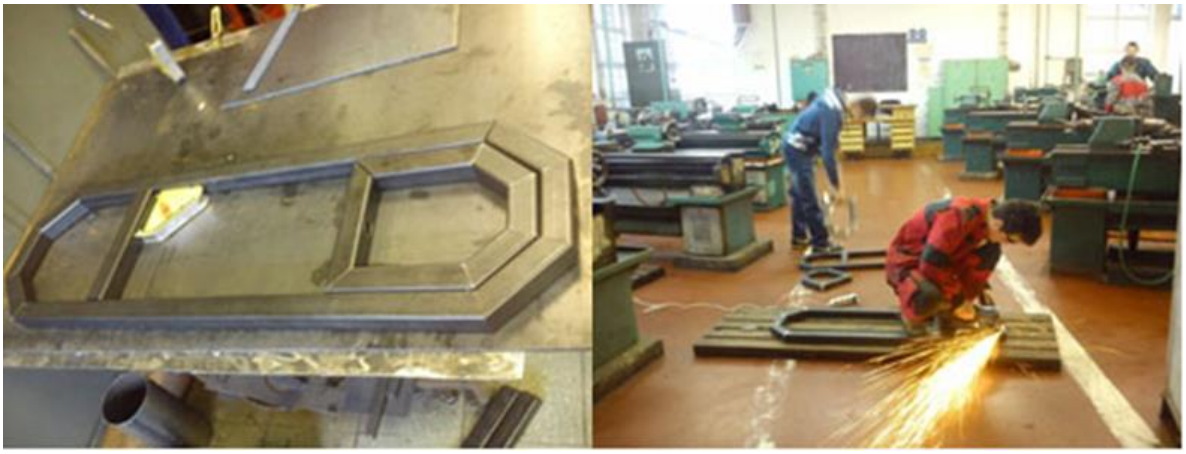

Fig. 3. Building of off-road wheelchair construction

Based on requirements and comments from students, as well as teachers and professionals from companies, we suggested the following improvements:

- increasing the light height of the forklift to 250 mm,
- reinforcing the sides of the belts with steel wire Ø 4 mm,
- manufacturing a protective frame for the safety and overturning of the wheelchair,
- verifying the suitability of using a four-stroke combustion engine.

With the first prototype, we took part in the Pilot Training - RoboReha organised under the Leonardo da Vinci - Robotics in Rehabilitation project, which was realised by the Technical University of Kosice, Faculty of Mechanical Engineering, and Department of Robotics. We also attended the Open Doors Day at J. Henisch at Bardejov. We have gained some knowledge and contacts for rehabilitation physicians, nurses and therapists.

3. Realisation

At our first test of thee off-road wheelchair, the engine twisted the gearbox and over the differential turned the rubber tires on which the belts were slid. By successively releasing one or the other wheel, the differential redirected the force of the engine to the opposite wheel, thus driving the wheelchair [10]. Last year, we were unable to perform further examinations due to time spell. This school year was focused on practical field exams - conditions if the terrain was wet and sometimes if it was frozen. After these tests, we found that the material and the structure itself was very well chosen. Minor problems were caused to the lower centre of gravity of platform [11].

When crossing in a very uneven terrain, it was placed too low [12]. Rubber belts have proven to be both dry and wet, see Figure 4. We also communicated directly with the disability students. Both, we put them inside the tested vehicle. We asked them: "What is your opinion on our off-road wheelchair? Have you ever seen anything similar to this? What should be improved?" We were surprised by their reactions and responses. “Finally, someone is creating something like this”.

Fig. 4. The prototype of off-road wheelchair

4. Conclusion

As part of our capabilities, we have built a functional prototype of a wheelchair into the field, which belongs to outdoor sports vehicles with a rigid frame. We have expanded the prototype last year based on comments and field trials. Depending on the type of drive, it can be said that this is a new type of wheelchair, namely a cart with a combustion engine. The vehicle is not limited by the capacity of the battery. Competitive wheelchairs have a maximum speed of 7 km/h. In our case, the speed is higher, 10 to 15 km/h. The dimensions of our design were adjusted to the size of the mechanical trolley for transportation.

To fit on a trailer, we had to narrow it down. We have also created space for a co-driver who can interfere with the wheelchair management. The passenger seat does not interfere with the trucker. As the basic materials we used a steel yoke profile 50x50x3 and a black sheet of 5 mm thickness. We've used material with old discarded cars. Some parts were made by ourselves or by ourselves adapted according to their own ideas. Using the self-priming zinc spraying, we saved both the time to dry the base and the top colour, as well as the funds.

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