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Manipulation machine for a non-moving car

Design, production and test of a device for manual handling of non-moving car

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Abstract: The growing demands for facilitating human work when moving heavy machinery and equipment have become a challenge for research and development of new handling equipment. An example of such difficult-to-control machines are cars that are unable to ensure their own movement for various technical reasons. One of the possibilities of their transfer is the use of a self-propelled device for handling the car, without the manual work of the operating personnel. The proposed solution for saving human energy, preventing mechanical damage to the car body and applying it to all types of passenger cars consists of a complex design of a self-propelled device which is the subject of this article.

Keywords: manipulation machine; non-moving car, car handling

Urządzenie do ręcznego przemieszczania nieruchomego samochodu

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Streszczenie: Rosnące wymagania związane z usprawnieniem pracy ludzkiej przy przemieszczaniu ciężkich maszyn i urządzeń stanowią istotne wyzwanie dla badań i rozwoju nowych systemów transportu i obsługi. Przykładem takich mogą być pojazdy, które z różnych przyczyn technicznych nie są w stanie samodzielnie się poruszać. Jedną z możliwości ich przemieszczania jest zastosowanie samojezdnego urządzenia do ich przemieszczania. Proponowane rozwiązanie minimalizuje ryzyko uszkodzeń mechanicznych karoserii oraz uniwersalne zastosowanie w przypadku wszystkich typów samochodów osobowych.

Słowa kluczowe: maszyna manipulacyjna; samochód nieruchomy, obsługa samochodu

1. Introduction

The requirements of companies that manufacture and service cars are directed towards the development of automatic handling devices. These devices are used in case of non-moving car from different reasons, for example; where it is necessary to handle cars without using their own engine, or where the car's drive is out of function. Handling devices are intended to facilitate and accelerate the work of people in factories and prevent damage of cars during the assembly of the handling device.

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Current devices for manual handling of cars can be divided into two groups. The first group facilitates the handling of vehicles, while the movement of the vehicle itself is carried out by an external force acting on the vehicle, for example: a winch or human power. These include "Dolly" carts or tow trucks [1]. A major disadvantage of this type of device is their applicability on smooth road surfaces, the need for human power (the vehicle may be dented or some parts of the vehicle may be damaged) and the need for a larger number of personnel for handling [2-3]. The second group is characterized by the fact that the external force is supplied from the handling device, usually directly to the car wheel. The movement of the car wheel is ensured by an engine or a set of engines, which also drive the device itself. The disadvantages of this type of device are the need for smooth road surfaces, the possibility of manipulation in only one direction (when changing direction, the device must be repositioned), the need for a larger number of personnel if we want to ensure the steering of the vehicle [4-6].

These limitations reduce the versatility and widespread use of handling devices, therefore the aim of the design of the handling device was defined to bring new improved features and eliminate the disadvantages of current devices.

The aim of the article is to design a handling device for manual manipulation of a car, which will have the task of saving human energy, simplifying car manipulation, ensuring the versatility of the device's use and, above all, preventing damage to the car body. An essential criterion for the device is its applicability to all types of cars with a total weight of up to 3 500 kg and its operation on various road surfaces.

2. Materials and Methods

For design of a proposed manipulation device for handling non-moving cars, it is necessary to define certain parameters, thanks to which this device will have wide application in the short-term movement of vehicles around the company premises, parking or car service. Meeting these requirements should ensure efficient and easy use of the device, facilitate human work, prevent damage to the vehicle and streamline the process of moving the vehicle.
The initial criteria for the prototype were defined as it is shown in Fig. 1:

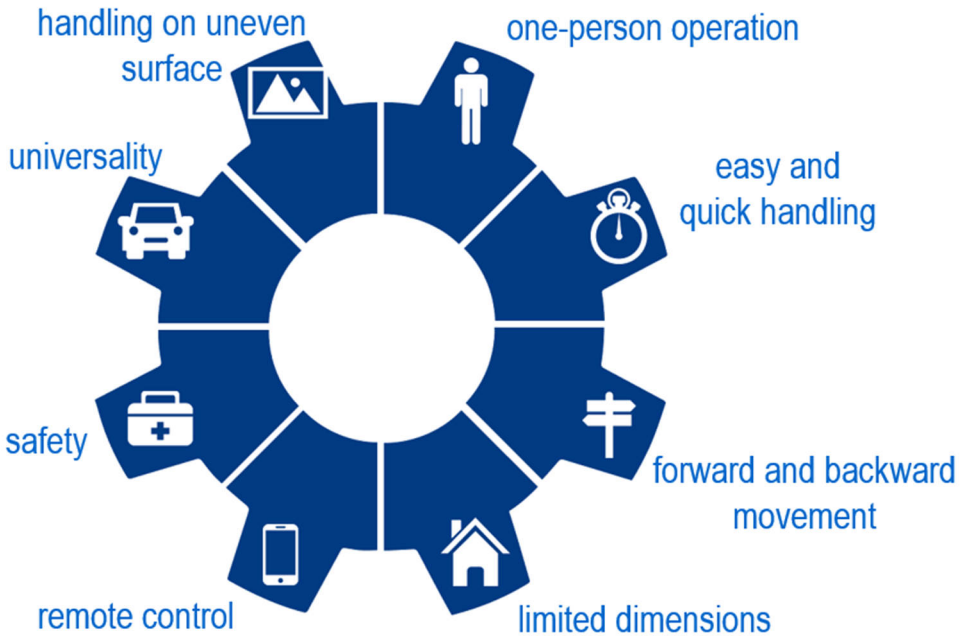

Figure 1. Criteria for manipulation machine

3. Results

The manipulation machine is attached to a car wheel (Fig. 2) so that we can use the front wheels to maneuver the vehicle. It is designed to be attached to the left rear wheel in such a way that the device's swivel wheel faces forward. We chose the left rear wheel because the driver has a better view of it than the right rear wheel and can react more quickly in the event of a malfunction. However, the device can also be used on the right rear wheel if necessary.

During manipulation, only one person is needed, who controls the device using a remote control and maneuvers the vehicle. The great advantage of this device over others is its functionality on unpaved and uneven surfaces. The dimensions of the designed device guarantee its usability in limited spaces - for example, in parking lots and when driving through a garage door.

Figure 2. Example of mounting on a car wheel

The proposed manipulation machine consists of three main parts (Fig. 3):

- mounting disk,
- frame with power unit,
- wheels.

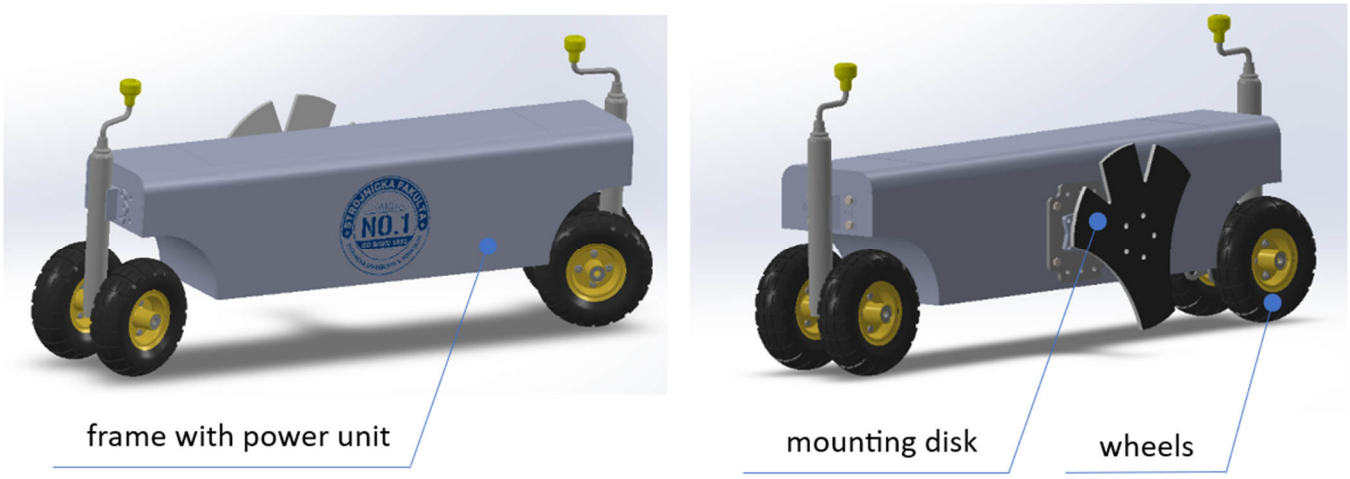

Figure 3. Main parts of manipulation machine

3.1. Mounting disk

The mounting disc is a part of the device that is mounted directly to the car's disc (Fig. 4). It serves to attach and guide the mechanism with the electric motor and the wheel and at the same time to transmit torque from the electric motor to the rear wheel of the car. Thanks to this, the car can move forward or backward. In the center of the disc there is a grooved shaft, which serves to transmit torque and attach to the mechanism. When designing a mounting disc, we have to take into account that there are so-called. sheet metal car discs, which often have a regular shape, and aluminum discs, which, on the contrary, have a different shape and can be in different designs, e.g.: 5-spoke, 6-spoke, etc.

Figure 4. Examples of mounting a disk on car wheel

3.2 Frame with power unit

The frame of the mechanism with the power unit is the part of the device on which the battery packet and the electric motor are located (Fig. 5).

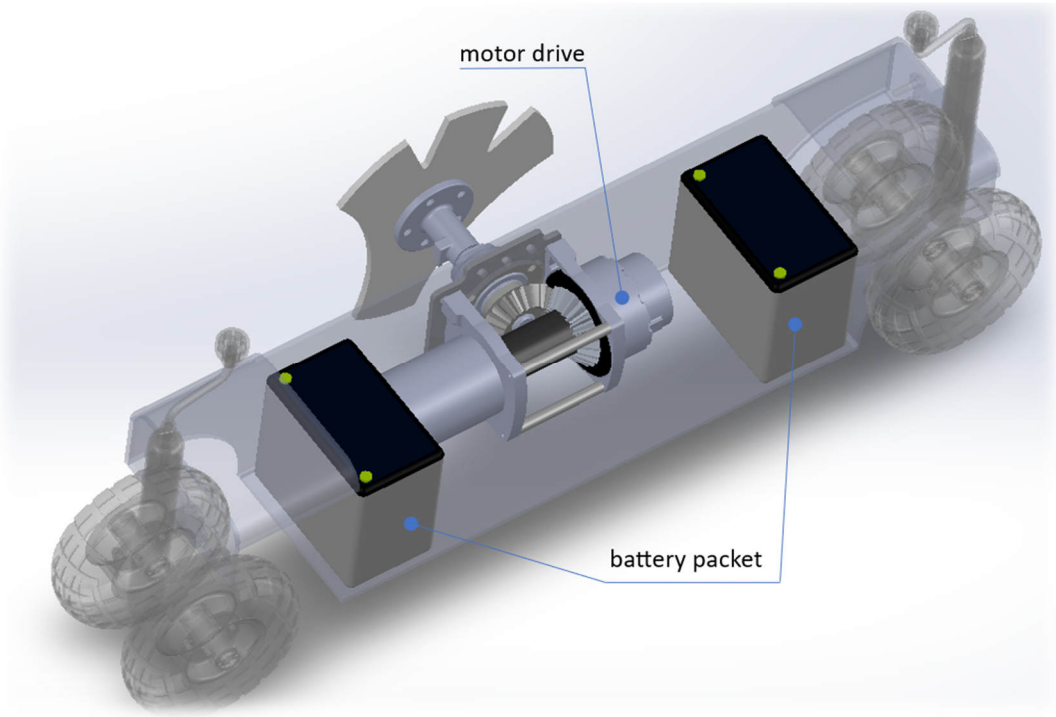

Figure 5. Frame with power unit

We have adapted its shape to meet the set criteria. It consists of several components ensuring the transmission of torque to the mounting disk, describe in Table 1. These components also ensure easy transfer of the device to the vehicle. other parts that belong to the design are cabling, battery capacity status indicators, charger, the control device itself together with the remote control.

Table 1. Description of another parts of manipulation machine

component	*description*	
Motor drive	- drive part of the machine with gearbox, - include a pair of bevel gear wheels (Z22/Z22, Module 5), shaft and bearing house, - attached to the frame with screws	power **4.1 kW** max. speed **0,5 m.s^{-1}**
Battery Packet	- separate source of rechargeable energy	**2x12V 55Ah**
Frame	- from the weight analysis of the device, the material aluminium was chosen for the frame (compared to the weight of the steel frame, it is 3 times lighter), -the frame of the construction is a welded structure	overall dimensions **1450x420x450mm** - total weight: **90 kg**
Wheels	- lifting wheels adjustable according to the height of operating wheel;	dimensions: **260 x 85 mm**

4. Conclusion

The proposed handling device could find wide application in non-moving vehicles in car repair shops, car showrooms, motor sports and in various situations. It could also be used in car factories, where it could be used to move incomplete vehicles on outdoor parking areas. The design of the device can be adjusted in the future research to fulfil following ideas:

- the possibility of weight reduction while maintaining the strength of the structure,
- changing the shape of the frame from the point of view of saving handling dimensions,
- possibilities of use also for vehicles over 3 500 kg.

The next step of future research is the production of the prototype of the handling device and testing in real conditions on various surfaces in order to achieve the required criteria.

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