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THE PROJECT OF SHOULDER OF THE SUSPENSION SYSTEM FOR AUTONOMOUS PLATFORM

PROJEKT RAMIENIA UKŁADU ZAWIESZENIA DLA PLATFORMY AUTONOMICZNEJ

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Summary

The paper describe project of shoulder from the suspension system of rescue autonomous platform. The shoulder is designed as part of the suspension system working in modular system allows easy assembly and removal of the suspension with the wheels. The project as described in the article is a continuation of a scientific thesis titled Project of elements of the mode of halt of the self-propelled platform guided remotely written by one of the authors under the supervision of professor Stanisław Radkowski.

Suspension Shoulder is designed in 3D. The article describes the modeled material and determined the weight of the shoulder. Making a simulations of strength under load in computer program SolidWorks and Ansys. In addition, the article presents a proposal for Authors for a modular solution to the problem of rapid assembly and disassembly of the suspension. Taking into account the installation of electrical motors located in the wheel rims autonomous platform. Suspension is a corps designed like the crank of the bicycle, which has the force of gravity to move the whole platform from the load.

Keywords: shoulder, rescue autonomous platform, computer modeling

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Streszczenie

Artykuł opisuje projekt ramienia układu zawieszenia autonomicznej platformy ratunkowej. Ramie jest zaprojektowane jako część całego układu zawieszenia pracującego w systemie modułowym pozwalającym na łatwy montaż i demontaż kół z zawieszenia. Projekt opisany w publikacji jest kontynuacją rozprawy naukowej zatytułowanej Projekt elementów układu zawieszenia platformy samojezdnej sterowanej zdalnie napisanej przez jednego z autorów pod nadzorem profesora Stanisława Radkowskiego.

Ramie zawieszenia zostało zaprojektowane w programie 3D. W artykule opisano dobór materiału oraz ustalono masę ramienia. Dokonano symulacji wytrzymałościowych pod obciążeniem w programie SolidWorks i Ansys. Ponadto w artykule przedstawiono propozycję modułowego rozwiązania szybkiego montażu i demontażu zawieszenia. Dobrano zainstalowane silniki elektryczne w obręczach koła platformy autonomicznej. Element zawieszenia jest zaprojektowany na wzór korby rowerowej, który przenosi siły ciężkości w trakcie przemieszczania się platformy wraz z obciążeniem.

Słowa kluczowe: Ramię, autonomiczna platforma ratunkowa, modelowanie komputerowe

Introduction

The idea of this publication is presenting the project of a suspension component of an autonomous self-propelled platform. A platform with such a suspension can enable detection and localisation of the injured, especially in the area inaccessible to rescuers, etc. The arm, that is the suspension component of the platform should ensure sustainability, be light-weight, and be a modular element (suitable for a quick assembly and disassembly).

1. Suspension system – rotation completion

In this part of the work, the suspension system is described, completion of the drive and rotation relative to the platform. The suspension design is a system of independently, electronically controlled articulated elements, transmitting power from electric batteries located inside the platform through the systems of rotating the suspension elements as well as electric motors inset in the vehicle's wheels[1-6].

Fig. 1. Suspension component with wheel

For calculations, the assumed parameters of the platform work were used:

a) maximal platform mass 100 kg,
b) maximal platform load 100 kg,
c) platform dimensions [length/width/height max. (min)] 2.2 m/1 m/1.1(0.7) m,
d) velocity of the platform movement 20 km/h.

Figure 1 illustrates the moments acting on the suspension. At the same time, the described suspension allows for the realisation of the reconfiguration of the whole vehicle. It offers the possibility of reconfiguration of the number of wheels, for example in the case of damage of one of the platform's wheels, where with the damage of one wheel we can eliminate the damaged suspension components depending on the initial configuration, and move using 5 or minimally 3 wheels.

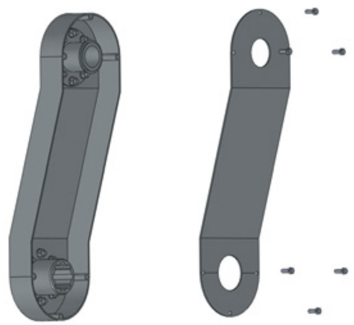

Fig. 2. Body of suspension component

The suspension component is designed so as to reflect the build of the crank arm used in bicycles [7-10]. Its task is to transfer the moment and forces from the "body" of the platform to the wheels, and the other way round. At the same time, when the motors in the wheels become blocked, the platform can move as the walking (legged) vehicle. In the subsequent figure, the design of a suspension component is shown.

Due to such a construction, the suspension component can, theoretically, rotate round the shaft mounted in the platform.

The suspension arm is a construction connected with screws (screw-fitted), which enables at any time disassembly from the platform, and also the service repairs, i.e. replacing the worn flange of the wheel shaft mounting or splines. On the other hand, the space inside the suspension component will serve as a hull for the power supply and wheel motor control wires. By means of dismounting the cover, we gain the access to the suspension inside (Fig. 2).

In order to replace the flange with the splines, eight M8 screws need to be unscrewed.

Next, from the outside the flange needs to be taken from the suspension body. In order to replace the flange of the wheel shaft, eight M8 screws also need to be unscrewed but the flange needs to be dismounted from the inside of the body. To illustrate the necessary activities, the exploded view of all elements constituting the suspension component was created in the SolidWorks programme. Controlling the suspension can be performed by means of a remote panel, where a controlling radio signal is sent to the controllers of the adequate electric motors [11-13].

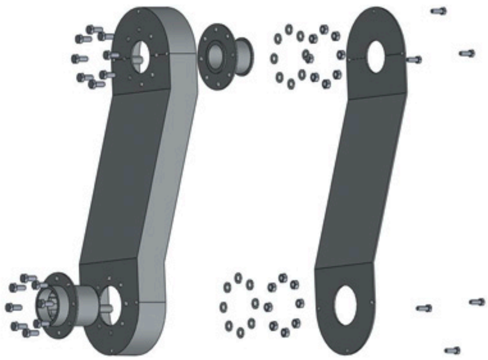

Fig. 3. Scatter view of the suspension component

2. Concept of computer analyses

In order to conduct the sustainability simulation and calculations, a geometric model was designed in the 3D SolidWorks programme (Fig. 4). Moreover, the project allowed for conducting the simulation of rotation of the suspension elements connecting the platform and wheels.

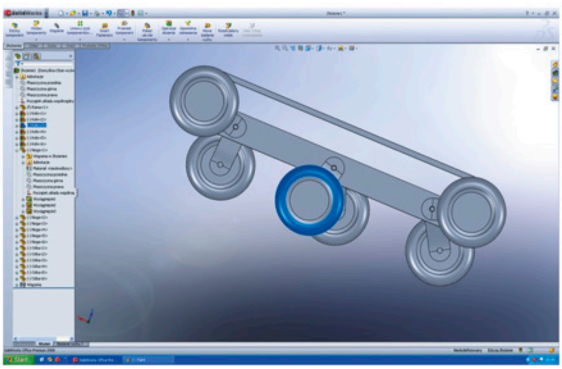

Fig. 4. View of the XZ plane

Due to the suspension with the movable and independent rotating wheels, the platform can change its height and deviate from the horizontal. The vehicle can tilt forward - backward and left – right. This will enable the platform to move across the laterally oriented bumps of a height not exceeding 0.5 m. On the other hand, the operator must be aware that the simultaneous rotation of all the wheels should be performed in one and the same direction because otherwise the tires will collide by converging, which happened as the result of the computer simulation.

The wheels were designed, which will be permanently attached to the rotating elements of the suspension that, in turn, will be modularly mounted to the frame by means of the multi-splines. The modular assembly will allow for a quick wheel removal together with the suspension elements.

In the course of the designing process, the suspension component crucial for the platform was calculated in the Ansys programme, in order to verify the simulation.

It transfers overall drive, reactions, and forces, as well as the moment generated by the direct current motors onto the ground. The suspension component is a body designed so that it matches the bicycle crank so as to transfer the gravity forces of the whole platform.

The model was imported from SolidWorks to Ansys together with the whole geometry. The material was entered that is a WE43 magnesium alloy [14,15].

Next, a detailed model grid was made and calculations for various loads were done. The figure below shows the MES grid made on the suspension component. This element consists of the body, cover, multi-spline handle, and the individual wheel shaft handle. Due to the possibility of importing the whole assemblage, the element's sustainability was tested by simulating the real conditions[16].

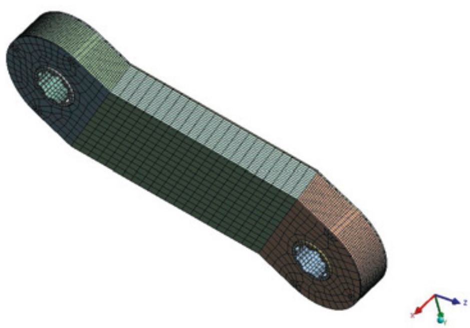

Fig. 5 Suspension component grid

In the subsequent figures, restraining and loading the component with the forces and the torque is illustrated. In the case of this system of cooperating parts, the interaction of the ground was checked, as well as the torque acting from the wheel, at the same time restraining the component at the place of connection of the multi-spline with the bearing shaft in the frame.

Fig. 6 Assumptions for the restraint and acting force

Figure 6 shows the restraint at the place marked with the letter A and the force acting on the suspension. This force was marked with the red arrow and the letter C.

As follows from the calculations, in the case of the preset force the stresses in the suspension will not exceed 50 MPa. The places where stresses occur are concentrated near the restrained multi-spline, mainly around the curvatures of the planes.

In the course of the operation of such a force, the suspension component will undergo deformation by approximately 28 μm at the end, relative to the restraint. Figure 8 illustrates the area where the most prominent deformations are marked red. In such a case, the suspension component is not in danger of being damaged during use [16-18].

Fig. 7 Suspension component stresses

Fig. 8 Suspension component deformations

Subsequently, a series of analyses was performed simulating acting of the forces and moments on the suspension.

The result of the simulation was strengthening the authors' conviction that the dimensions and the material of the suspension component were selected properly.

3. Conclusions

Design of such an arm can be used in rescue and transport platforms, as well as other types of platforms. If the remote control with the use of the control panel is provided, the platform can be self-propelled as well as modular and autonomous. The suspension design is light-weight and ensures quick assembly and disassembly, at the same time guaranteeing a short repair time with no necessity of damage diagnosing.

The suspension design could serve as a prototype for production of the Polish rescue platform.

The full text of the article is available in Polish online on the website
http://archiwummotoryzacji.pl.

Tekst artykułu w polskiej wersji językowej dostępny jest na stronie
http://archiwummotoryzacji.pl.

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