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Evolution of Multidirectional Wheels Researches

The problem of the insufficient space for the internal transport in industrial halls have generated new constructive solutions of wheels, able to facilitate the movement of vehicle in any direction without a rotation of chassis. The main types of multidirectional wheels are presented in this paper (Grabowiecki patent, Mecanum wheel, Kilough platform, Blumrich wheel). In the final part of the paper a graphical analyses of the economized space by omnidirectional vehicles is presented. The paper represents a bibliographical study.

1. Introduction

The problems regarding the insufficient space for displacement of the internal transport in industrial halls have generated new solutions of wheels, wheels able to facilitate the movement of vehicle in any direction without any rotation of chassis. The main applications are the omnidirectional conveyor systems, wheelchairs, service vehicles and the mobile platforms of robots.

The start point of the researches was the patent of J.Grabowiecki who certified in 1919 a bidirectional wheel (fig. 1). The assembly consists of a main wheel and 8 transversal rolls, put on the circumference. The main disadvantage of all the types based on this principle is the condition of external actuator for the secondary direction. Also the reduced number of rolls generates a polygonal contour.

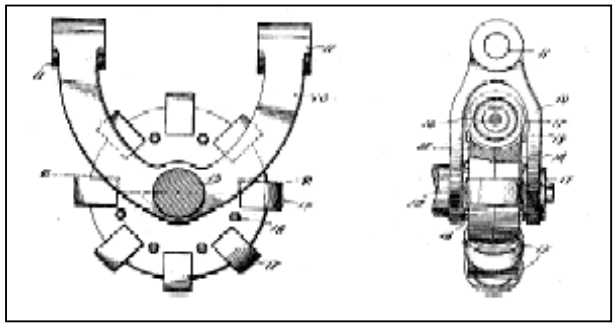

Figure 1. The wheel patented by Grabowiescki [4]

In 1974 Blumrich succeeded in certifying a similar solution having two wheels with peripherical rolls coupled. The advantage brought by this solution is the permanent contact between the rolls and the ground. The contact with the ground belongs alternatively to the two coupled wheels. This type of wheel has considerable advantages over a 30 rolls wheel (fig. 2).

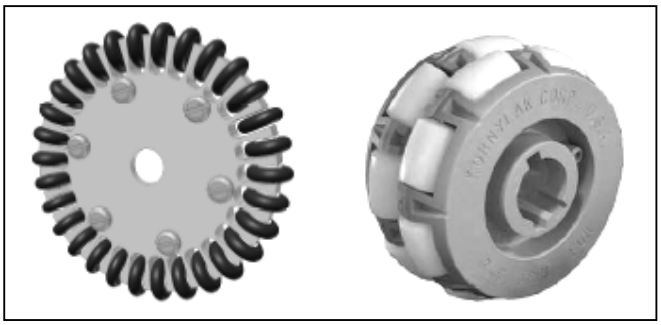

Figure 2. Blumrich's improvement on bidirectional wheels [4]

Another type of bidirectional wheels is Kilough platform (figure 3 a). Based on this construction and on Blumrich's improvement many variants were invented (figure 3 b).

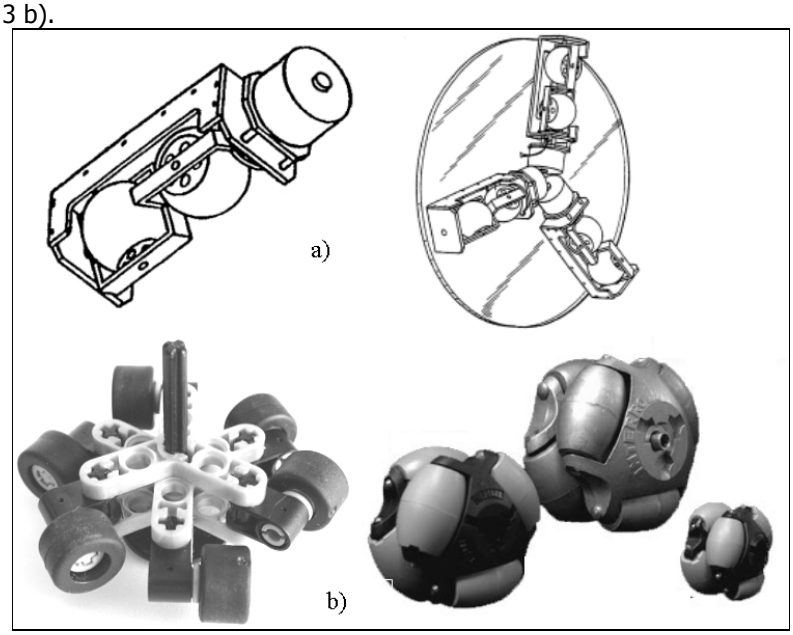

Figure 3. Wheels based on Kilough platform and Blumrich's improvement [14, 15]

2. Ilon principle. Mecanum wheel

All the wheels presented in the first chapter have the disadvantage of multiple actuators and great number of wheels (more that 4). Also these solutions are applicable for two direction movements. Booth disadvantages are eliminated by Mecanum wheel solution, discovered in 1973 by Bengt Ilon, engineer of Swedish Mecanum AG Company.

Mecanum omnidirectional wheel (figure 4) is a conventional wheel with a series of rolls attached to its circumference. These rolls have an axis of rotation at 45° to the axis of rotation of the wheel, the spacing between the rollers and the angle between the longitudinal axes of the rolls and the axis of rotation being selected so that the rolls define together an unbroken wheel periphery (seen from a point on an extension of the axis of rotation). Besides moving forward and backward like conventional wheels, Mecanum vehicles allow sideways movement by spinning a pair of wheels in opposite directions. Every wheel is rotated by independent drive.

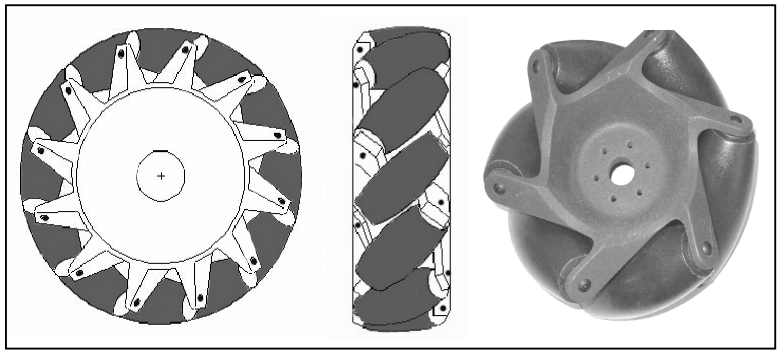

Figure 4. Mecanum wheel [5]

The combinations for obtaining the desired direction are:

- all the wheels have the same sense of rotation; in consequence the vehicle has a linear movement to the front or to the back (fig. 4 a);
- two wheels (from one diagonal) have the same sense and the others are rotated in the contrary sense (fig. 4 b), the vehicle has a movement in lateral direction (right or left, the sense of movement is from the wheels rotated in exterior to the wheels rotated in interior);

- if two wheels (from one diagonal) have the same sense and the others are blocked (fig. 4 c), the vehicle has a movement in a direction perpendicular on the diagonal of the two rotated wheels;

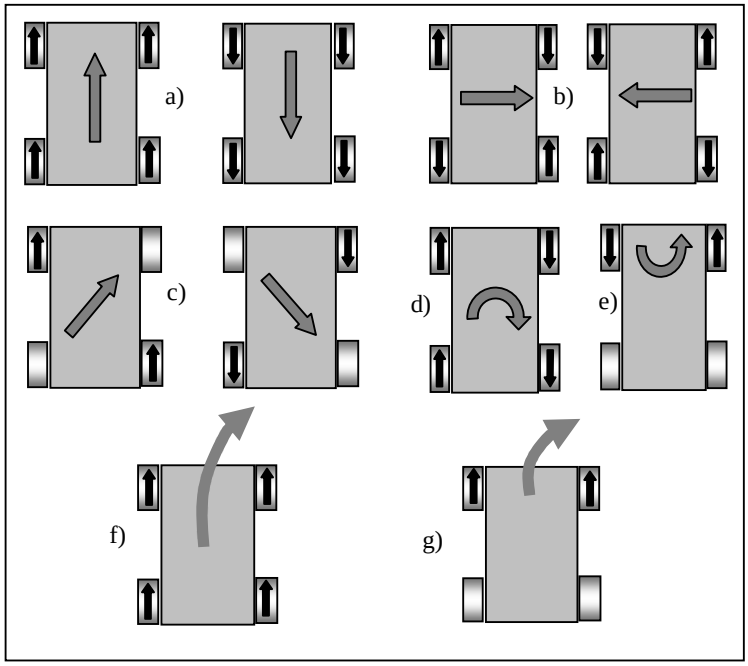

Figure 5. The movement possibilities on Mecanum vehicle

- if two wheels from a side have the same movement and the other two have the opposite movement, the vehicle is rotating (fig. 3.18 d). Also a rotation is obtained with two wheels from the same side with the contrary sense of movement (fig. 3.18 e) or if the speed is not the same for all the wheels (fig. 3.18 f and g).

Due to the problems that appear at the variations of the ground (wheels are blocked due to lateral grasp, central grasp variants were developed. The main disadvantage in this case is the instability of the wheel. The optimal variant is chosen according to the ground used in application and to the load capacity.

After the Ilon researches the US Navy bought the patent from Ilon and put researchers to work on it in the 1980s in Panama City. The Navy has used these wheels for vehicle who transporting items around ships in seaports. In 1997 Airtrax Inc. and several other companies bought the license to build an omnidirectional forklift truck that could work in tight spaces such as the deck of an aircraft carrier. These vehicles are now in production.

3. The space economized by omnidirectional vehicles

For the analyses of the necessary space for rolling are studied the technical characteristics for the next transport systems: simple portal system LP 1000 produced by BLEICHERT Förderanlagen GmbH (Germany); monorail system EMS KB 240 by ROFA GmbH (Germany); omnidirectional Mecanum vehicle SIDEWINDER AXT 3000 produced by AIRTAX (USA); automated guided vehicle ROFA AGVi, from ROFA GmbH (Germany); air cushion system 4 LTM 450-1, made by DELU GmbH (Germany); and roller transporters AL 30 from BLEICHERT Förderanlagen GmbH (Germany). All the systems have chosen to be representative for the class.

In figure 6.4 a) is represented the variation of rolling space and the flexibility level of each system and in figure 6.4 b) the workspace variation.

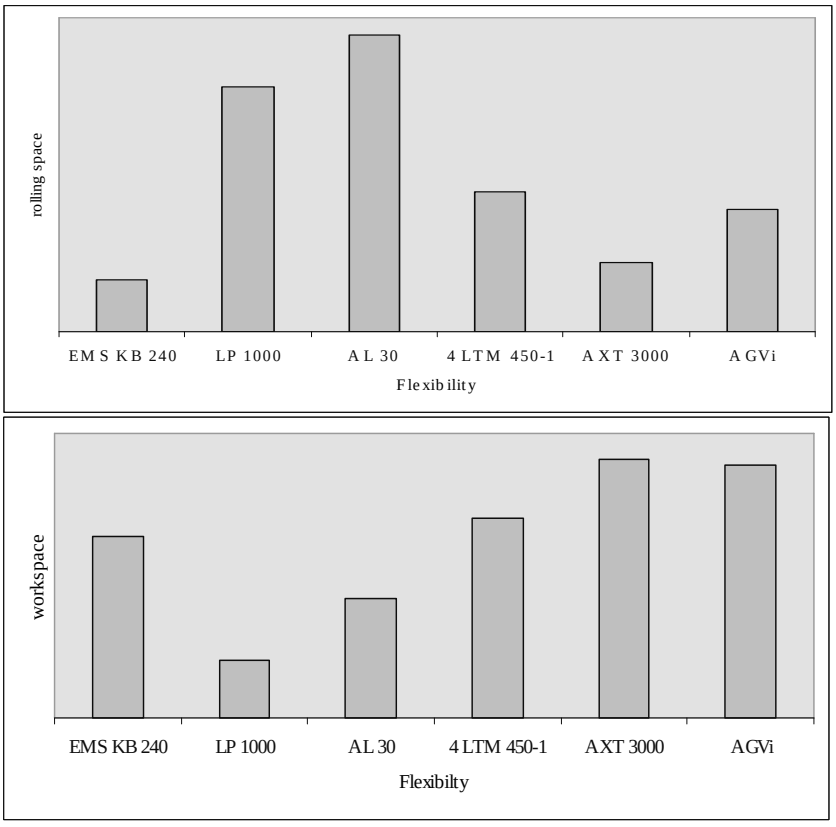

Figure 1. Necessary space and workspace variation

We can observe the case of multidirectional vehicle whit the value of the rolling space approach to the minimum and the value of the deserved working space which is maxim.

References

[1] Conney, J.A.: Visual Dead-Reckoning for Motion Control of a Mecanum – Wheeled Mobile Robot, Massey University Palmerston North, New Zealand, 2004;

[2] Diegel, O.: *Impoved Mecanum Wheels Design for Omni-directional Robots*, Australasian Conference on Robotics and Automation Auckland, 27 – 29 Nov. 2002;

[3] Rădulescu, C.: *Robocare şi sisteme de robocare*, Editura Mirton, Timişoara, 2000;

[4] Rojas, R.: *A short history of omnidirectional wheels*

[5] http://robotics.ee.uwa.edu.au/eyebot/doc/robots/omni.html

[6] http://www.frc.ri.cmu.edu/~hagen/samplers/text/TESSELLATOR_Sampler.html

[7] http://www.airtrax.com

[8] http://www.chiefdelphi.com/media/papers/1731

[9] http://www.delu-gmbh.de

[10] http://www.bleichert.de

[11] http://www.eisenmann.de

[12] http://www.lanner.com

[13] http://www.rofa-gmbh.de

[14] www.h33.dk

[15] http://www.omniwheel.com

[16] www.philophome.com

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