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Possibility of the Kinematics Arrangement of a Mobile Mechatronic System

Ľubica Miková*, Miloslav Čurilla

Technical University of Košice, Faculty of Mechanical Engineering, Department of Applied Mechanics and Mechatronics
Košice, Slovakia
*Corresponding author: lubica.mikova@tuke.sk

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Abstract This article is targeted to bring basic information about the possibility of the kinematics arrangement of a mobile mechatronic system on a wheel carriage. Right choices undercarriage is one of general tasks at early design of mobile service robot. The spectrum of offered service mechatronic systems is large, starting from simple applications up the most complex ones. They represent a category of mechatronic systems involving a large ratio of conceptually and principally new solutions and designs.

Keywords: *kinematics, mobile robot, mechatronic system*

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1. Introduction

At early analysis of design is necessary a complete knowledge all input parameters and demands of function along with environment in which the system will work. Wheeled undercarriages are one of most often chosen form of locomotion in the present. In consideration of large scale theirs applications, in the technical practice is possible find variously constructive solution of this undercarriages.

Spectrum of request setting on mobile service robots is large. New tasks and requirements set up by the dynamic development of the technique cause that designs of wheel carriages are not uniform.

The most vital mechanical part of a robot must be ist mobility system, including the suspension and drivetrain. The ability of these systems to effective traverse whatever terrain is required is paramount to the success of the robot. Basic information about the possibility of the kinematics arrangement of a mobile mechatronic system on a wheel carriage this article is targeted to bring.

2. Service Robot

A service robot is an independent computer-controlled integrated mechatronic system intended for providing partially or fully automatic tasks contributing not to the industrial production of goods but providing services for people, environment or for the reliable operation of technical systems and operational complexes. The mobility, variety of work tasks, model of working ambient data collection, control instruction specification according to the evaluation of the actual condition of sensor information, variable structure of the working ambient, implicit programming, automatic movement planning belong among the typical operation signs of service robots.

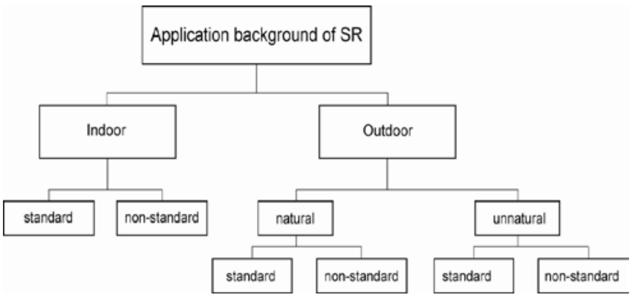

Figure 1. Application background [1]

A trend in the robotics development for the next millennium assumes generally its significant expansion into other than mechanical fields and non-production areas. This fact creates technical and operational conditions for applications and defines requirements on technical means for robotization and automatization within a large scope of services and servicing activities connected with that were not possible until now from the point of view of the onset of classical robots for such tasks. [1].

3. Wheeled Mobility Systems

All mobile service, those subsystem mobility is solved on the principles flywheel undercarriage belong in this part.

The most common form of vehicle layout is the four-wheeled, front-steer vehicle. It is a descendant of the horse-drawn wagon, but major changes has undergone some subtle and some. A motor was added to replace the horses in the many decades since. The suspension and steering systems were the most important changes [2].

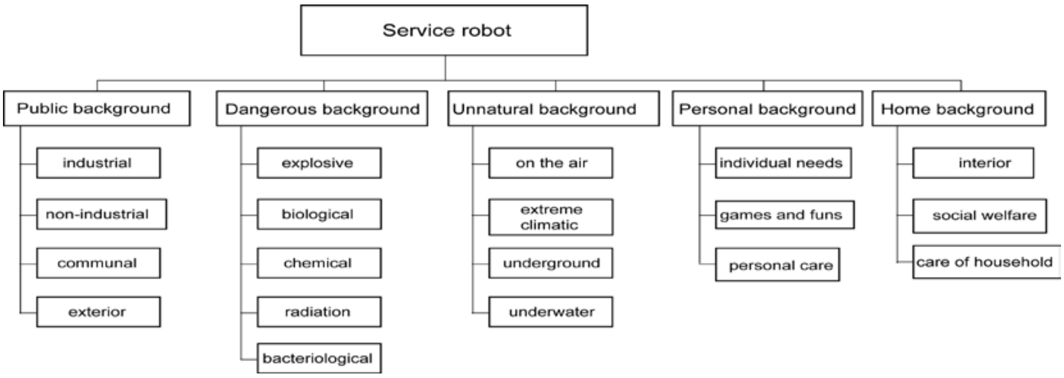

Figure 2. Space of application service robots [1]

3.1. One-wheeled Layouts

The most basic vehicle would have the least number of wheels. One-wheeled vehicle has limited mobility, but can get around relatively benign environments. An actually ball is wheel with an internal movable counterweight that, when not over the point of contact of the ball and the ground, causes the ball to roll. With some appropriate control on the counterweight and how it is attached and moved, the vehicle can be steered around clumsily. The ability is limited and depends on what the actual tire is made of, and the weight ratio between the tire and the counterweight [2].

Single-wheel platforms, on the other hand, are not statically stable - they fall without support. To provide stability and usability you'd have to solve quite challenging engineering problems.

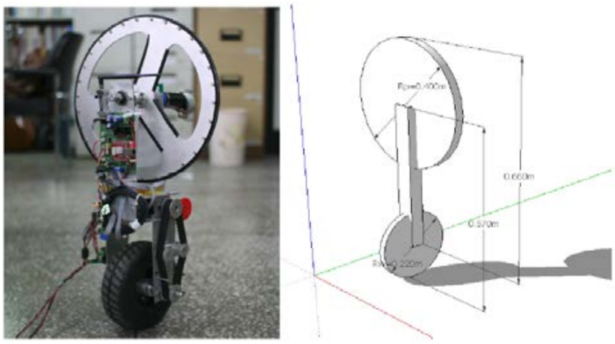

Figure 3. One wheel robot [4]

Solving complicated engineering problems is good for humanity. Dynamically stable single wheel robots have a potential to become very agile and compact. Thus - ideal to use in crowded environments in interaction with humans.

A single wheel robot could be a cheaper solution for a robot receptionist who has to work on one floor only. [4].

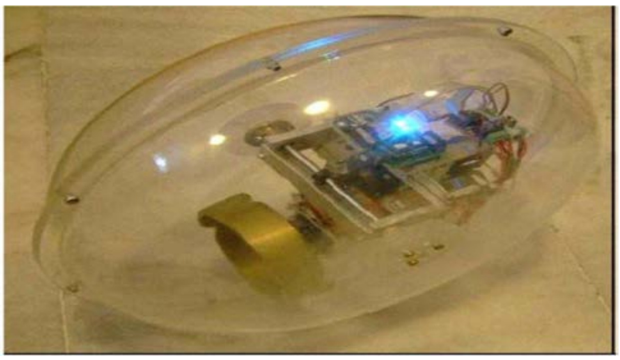

Figure 4. One wheel robot [3]

3.2. Two-wheeled Layout

Its exist two obvious, wheels fore and aft, and side by side wheels. The bicycle is perhaps one of the most recognized two-wheeled vehicles in the world. It is quite difficult for robots to use, because it is not inherently stable. The side by side layout is also not inherently stable, but is easier to control [2].

To drag a passive leg or tail behind the vehicle is the second less obvious layout.

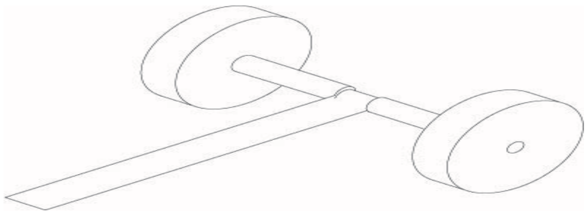

Figure 5. Drag tail [2]

The torque produced by the wheels counteracts this tail, makes the vehicle statically stable, the height of obstacle the robot can get over [2].

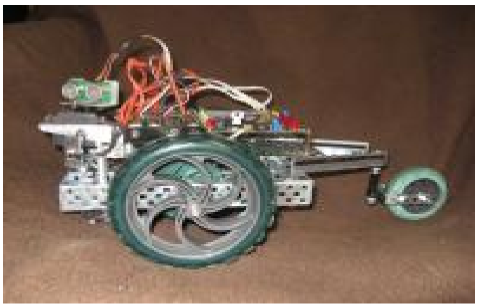

Figure 6. Tail dragger [5]

Dean Kamen developed the Segway two-wheeled balancing vehicle, proving it is possible, and is actually fairly mobile.

Figure 7. Segway [6]

3.3. Three-wheeled Layouts

Three wheels can be laid out in several ways. The most common and easiest to implement, but with, perhaps, the least mobility of the five three-wheeled types, is present by a child´s tricycle. Robot destines to be used indoors, in a test lab or other controllable space [3].

Figure 8. WowWee Rovio [7]

3.4. Four-wheeled Layout

A significant position in the statistics of the currently applied wheel mobile service robot is robots on a four-wheel carriage occupy. This robots are the most used ones overall. They proved themselves successfully almost in all areas of service robot application [1].

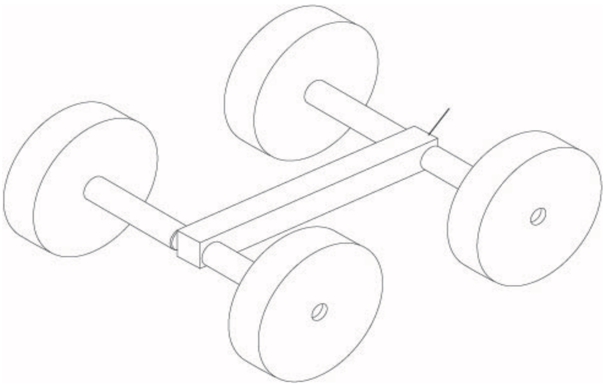

Figure 9. All four fixed, fix steered [2]

The most basic four-wheeled vehicle actually doesn't even use a differential. It has two wheels on each side that are coupled together and is steered just like differential steered tricycles. Skid Steer - its name this steering method.

Greater mobility is achieved if the center joint also allows a rolling motion between the two sections. This degree of freedom keeps all four wheels on the ground while traversing uneven terrain or obstacles. It also improves traction while turning on bumps. Highest mobility for this layout would come from powering both the pivot and roll joints with their own motors and each wheel individually powered for a total of six motors. Alternatively, the wheels could be powered through limited slip differentials and the roll axis left passive for less mobility, but only three motors.

An unusual and unintuitive layout is the five-wheeled drivetrain. This is basically the tricycle layout, but with an extra pair of wheels in the back to increase traction and ground contact area. The front wheel is not normally powered and is only for steering. [2].

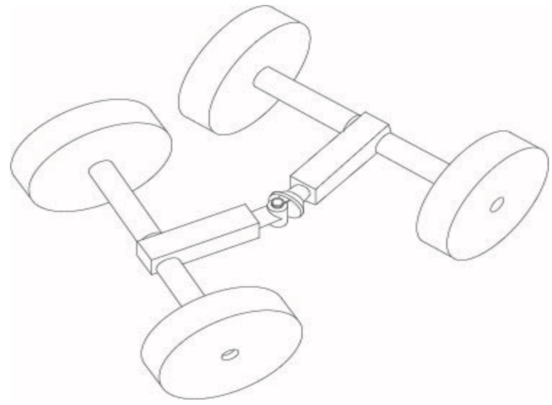

Figure 10. Two-section connected through vertical joint [2]

The longitudinal rocker design divides the entire vehicle right down the middle and places a passive pivot joint in between the two halves.

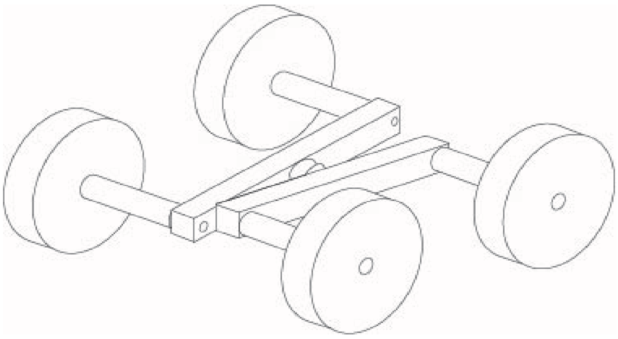

Figure 11. Simple longitudinal rocker [2]

This joint is connected on each end to a rocker arm, which in turn carry a wheel at each of their ends. This layout allows the rocker arms to pivot when any wheel tries to go higher or lower than the rest. This passive pivoting action keeps the load on all four wheels almost equal, increasing mobility simply by maintaining driving and braking action on all wheels at all times.

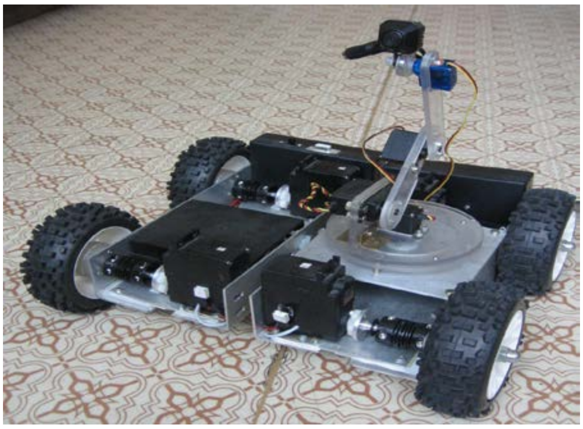

Figure 12. GTR 2010

Longitudinal rocker designs are skid steered, with the wheels on each side usually mechanically tied together like a simple skid steer, but sometimes, to increase mobility even further, the wheels are independently powered. Many of the wheeled layouts are complex enough that they require a motor for every wheel. Although this seems like a complicated solution from an electrical and control standpoint, it is simpler mechanically. [2].

3.5. Six-wheeled Mobile Service Robot

Beyond four- and five-wheeled vehicles is the large class of six-wheeled layouts. There are many layouts, suspensions, and drivetrains based on six wheels. Six wheels are generally the best compromise for high mobility wheeled vehicles. Six wheels put enough ground pressure, traction, steering mobility, and obstacle-negotiating ability on a vehicle without, in most cases, very much complexity. The most basic six-wheeled vehicle, shown in Figure 9, is the skid-steered non-suspended design. This is very much like the four-wheeled design with improved mobility simply because there is more traction and less ground pressure because of the third wheel on each side. The wheels can be driven with chains, belts, or bevel gearboxes in a simple way, making for a robust system.

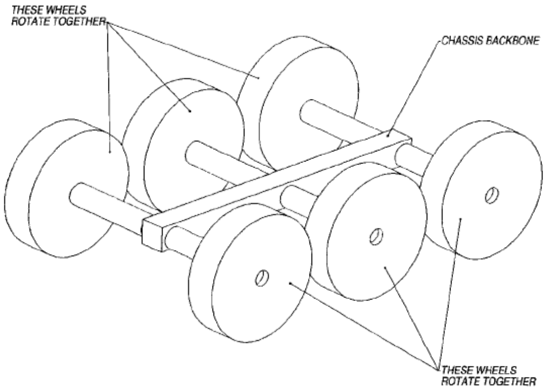

Figure 13. Six wheels, all fixed [2]

Figure 14. Six - wheeled robot. [8]

An advantage of the third wheel in the skid-steer layout is that the middle wheel on each side can be mounted slightly lower than the other two, reducing the weight the front and rear wheel pairs carry. The lower weight reduces the forces needed to skid them around when turning, reducing turning power. The offset center axle can make the vehicle wobble a bit. Careful planning of the location of the center of gravity is required to minimize this problem. [2].

4. Conclusions

Aim of this article was to create an overview of the kinematic design of mobile robots. Area of onset mobile service robots is large, from the inspection work to the antiterrorist robots. This segment presents primary kinematic partitions flywheel mobile service robots.

Acknowledgement

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