NURE
Kharkiv National University
of Radioelectronics

M&MS 2022, 21-22 October, Kharkiv, UKRAINE

VI International Conference

MANUFACTURING & MECHATRONIC SYSTEMS

УДК: 005:004.896:62-65:338.3

Виробництво & Мехатронні Системи 2022: матеріали VI-ої Міжнародної конференції, Харків, 21-22 жовтня 2022 р.: тези доповідей / [редкол. І.Ш. Невлюдов (відповідальний редактор)].-Харків: [електронний друк], 2022. – 136 с

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Manufacturing & Mechatronic Systems 2022: Proceedings of VIst International Conference, Kharkiv, October 21-22, 2022: Thesises of Reports / [Ed. I.Sh. Nevlyudov (chief editor).] .- Kharkiv .: [electronic version], 2022. - 136 p.

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МАТЕРІАЛИ

VI-ої Міжнародної Конференції

ВИРОБНИЦТВО
&
МЕХАТРОННІ СИСТЕМИ 2022

(21-22 жовтня 2022)
Харків, Україна

M&MS 2022, 21-22 October, Kharkiv, UKRAINE

Robotic Systems for Cooperative Work

Dmytro Shevchenko[1]

1. CITAM Department, Kharkiv National University of Radio Electronics, UKRAINE, Kharkiv, Nauky Ave. 14., e-mail: dima.sheva22@gmail.com

Abstract: This work is devoted to review exiting robotics systems for cooperative work. Several methods of navigating work in space are considered, certain shortcomings are identified.

Keywords: robotics, multiple robots interaction, robot navigation.

I. INTRODUCTION

The use of robots in production systems, warehouses, offices, hospitals, and transport systems is constantly growing. The use of robots has many advantages, from convenience to use in areas dangerous for humans. Also, an important advantage of the transition to robotic systems is the reduction of the cost of a certain process and the increase of reliability.

Usually, robots are used in interaction with a person, that is, a person controls the robot and the main control falls on the operator. But models of robot-robot interaction systems are increasingly appearing, which can greatly change the principles of using robots.

Systems with robot-robot interaction mean that several robots are used to perform certain tasks, which interact with each other to perform the task together. Such systems, where several robots interact, are suitable for complex tasks, where one robot, even more complex and powerful, may not be able to cope. Also, the use of this approach makes the system flexible, i.e. easier to adapt to other tasks. Currently, similar systems are already being integrated into aerospace, medical, and other industries.

The basis of interaction between robots is the combination of navigation, movement, and communication complexes using artificial intelligence.

II. FEATURES OF ROBOT INTERACTION

Robots to interact with each other usually have a number of systems for navigation, positioning and wireless communication, which are combined with artificial intelligence for analysis and decision-making. It is also possible to use.

A large number of researchers and developers, in particular [1] believe that one of the main problems in the development of robot-robot systems is location and navigation. Location and navigation affect not only the possibility of correct interaction of robots, but also speed and accuracy.

For navigation in robot-robot systems, it is necessary to take into account different positions of robots and different locations, so the navigation method must be accurate for several robots at the same time.

The work [2] presents the development of a semantic grid of objects. This grid is built on the basis of data received from autonomous robot systems, which includes data from sonar, odometer, laser distance sensor, computer vision, and others. Figure 1 shows the scheme of constructing a grid of objects.

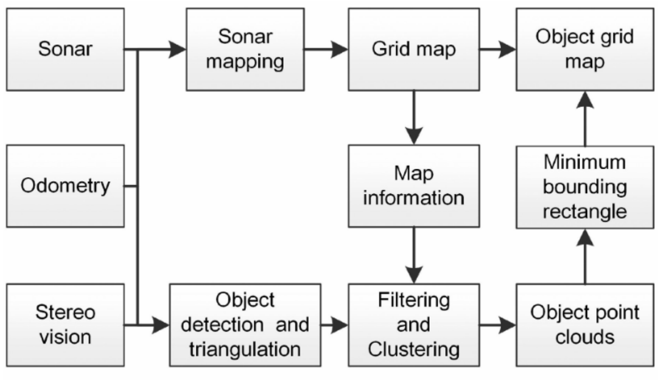

Fig.1. The principle of building an object grid

Figure 1 shows how a grid of objects is created based on input data and software processing. This approach is quite accurate, but under the condition that the objects are static. This is the main disadvantage of using this method for navigation. That is, when developing a system where objects can be moved, or even disappear and be added, this must be taken into account and the grid must be constantly rebuilt, which is not fast and convenient, and will affect accuracy.

Considering the used means for obtaining information, a similar method can be used for humanoid robots, but the method of navigation on the created grid will work only under the condition of constant updating and complex formation of a new grid from the data of all robots.

Also, this author envisages processing the image from the video camera to obtain data about the object and its recognition. Object recognition is an advantage of work [2], and can be a very useful application for systems of cooperative operation of humanoid robots.

In H. Zhang and C. Zhang work [1], it is proposed to use navigation for a limited space with the help of QR-tags and a complex of a laser range finder and a camera for reading tags. Dijkstra's algorithm and the dynamic window approach are used in this work. The experimental work of the authors showed good efficiency. The main disadvantage of using this approach is the complexity of creating a workspace with labels and calibration.

The work [3] was considered. This paper considers an unusual way of navigation based on the assumption that in a room or a certain area, the floor is of the same color. This method consists in processing a video image to determine the boundaries of the floor on which the robot can move. You can also find objects on the floor in this way.

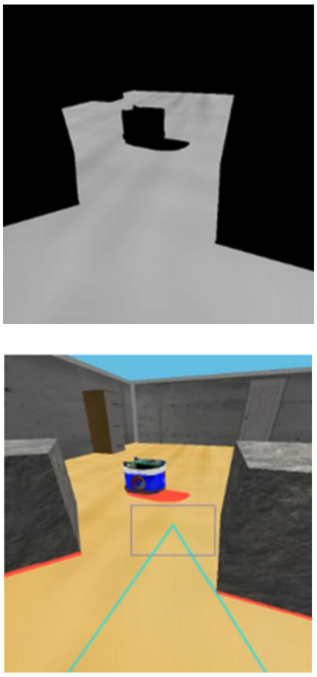

Fig.2 An example of video image processing using the navigation method based on the analysis of floor boundaries

The disadvantage of this approach is the impossibility of using several robots for simultaneous operation without the use of additional systems. To improve this method, you need to use a rangefinder and an algorithm for calculating the distance to the object relative to static objects, walls. A potential disadvantage of this approach for use in multi-robot systems is the difficulty of accurately coordinating the robots.

The authors [4] considered the possibility of robot-robot and robot-human interaction, and also depicted exactly the robot-robot interaction for the difficult work of lifting a load in Fig. 3.

In the considered work [4], a very useful property of robots when interacting with each other was also noticed. This property involves the use of the functions of both robots with partner interaction for minimal energy consumption.

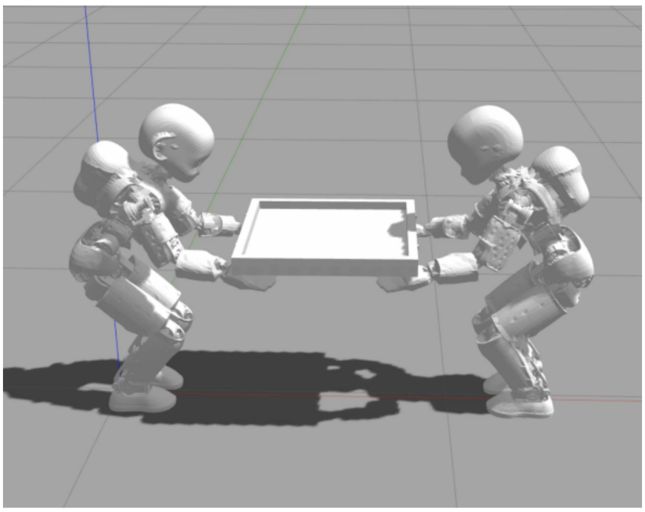

Fig. 3. Joint work of two robots for lifting cargo [4]

One of the most famous robot developers is the Festo company. Among a large number of developments, they presented a system of bionic ants that interact with each other for compatible tasks, as if in nature.

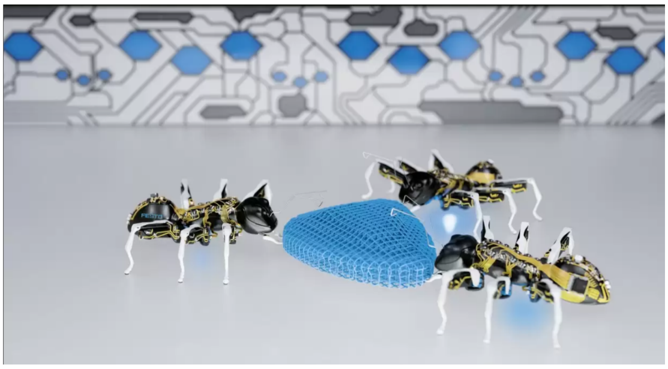

Fig. 4. The collaborative work of robot ants from the Festo company [5].

Robot ants use radio communication to communicate with each other and stereo cameras to navigate in space. The structure of the robot in Figure 5.

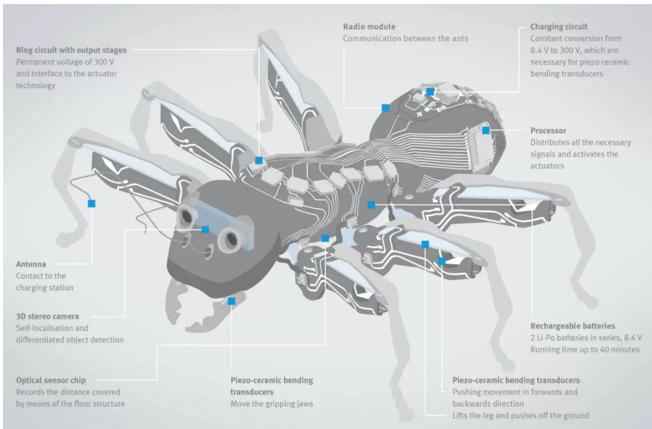

Fig.5 The structure of the robot-ant [5,6]

III. Conclusion

These theses consider robot-robot interaction and several solutions to the issue of robot navigation in space. The creation and use of robot-robot systems is a direction that is in constant development. These systems can be used in different areas for very different tasks. For example, robots can be used to lift and move loads. The considered works present various methods of navigation with various disadvantages. Navigation based on a constructed grid of objects is accurate, but difficult to use in systems where objects can move. The use of QR-tags is quite a good tool for indoor navigation, but has the disadvantage of complex preparation of the work area and potentially low accuracy. Using a video camera for navigation is a good way, but difficulties arise when using multiple robots. To improve this method, it is better to use a camera on the ceiling, in addition to the cameras on the robots.[6-12]

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