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INFORMATION SYSTEM FOR AUTOMATIC ORIENTATION IN 2D SPACE OF MOBILE ROBOT

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Abstract. In the modern intelligent robotic systems, the most common problem is that the development methods, techniques and technological solutions for autonomous navigation of robots. Under the navigation, orientation should be understood smart device in space. This article describes a way to autonomous robot movement in the room a hallway-type room on a horizontal surface within the same floor. The solution of this problem is achieved by performing three processes: selection of areas, conservation areas, and target detection. Unlike existing solutions, we propose an improved method for the orientation of the object in a horizontal plane based on using neural networks as base classifier data. The proposed method makes it possible to install four ultrasonic sensors on the robot body with a further detection of the distance to objects and walls, as well as remembering, recognition and forecasting of the route. Functionally, this method allows a certain accuracy, as well as the measurement errors, determine the coordinates of the robotic device to the smart card on the horizontal surface area without the use of global positioning systems GPS and GLONASS, and the cellular GSM network.

Keywords: robot, neural network, spatial orientation, automatic route, independent movement, the ultrasonic sensor.

Introduction. To date, there are a lot of ways, devices and information technologies for Autonomous navigation and orientation of intelligent robotic systems in space [11-15]. Sufficiently known, for example, the method of orientation, navigation and position determination using GPS and satellite communication systems Glonass [1]. These systems for civil society organizations and actors are able to determine the location of an object with an accuracy of up to 5m. More precisely determine the position is only possible when using the military equipment that is inaccessible to civilians.

Also of note is the wide popularity of the use of technological solutions presented in the form of a receiver and transmitter of the ultrasonic signal to detect obstacles along the line of motion of the robot, as well as the absence of a surface beneath it, for example, access to the stairs [2, 3, 5-10]. Some systems use advanced laser, which allows to determine the distance to the object [4].

The main limitations of the reviewed methods, techniques and technological solutions include:

- the low accuracy of determining the position, in the case of using GPS and GLONASS navigation. It is invalid when used in small spaces, for example apartments, houses or cottages;
- the high cost of the equipment used, provided the use of specialized laser systems;
- orientation to a horizontal surface without possibility of recognition position in the route.

Accordingly, the task of eliminating the above disadvantages by using the ultrasonic transceiver device and to determine the mathematical obstacles neural network apparatus as an information unit to determine the position of a route.

Materials and methods. In general, the logical function diagram of the process in a horizontal orientation of the space presented on Fig.1.

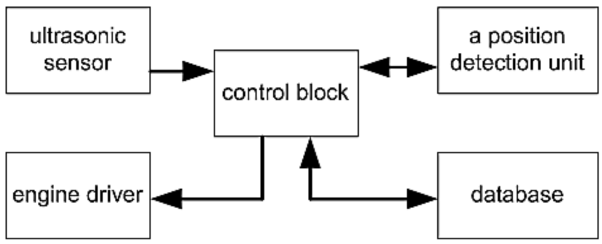

Figure 1. The generalized logical function diagram of the process orientation

Where ultrasonic sensors – four standard ultrasonic sensors located on the case intelligent robotic device (robot) in four directions perpendicular to the direction of movement forward, backward, left and right; engine driver - motor unit, which allow the movement; control block - a block that is responsible for analysis of the data from the sensors and the further decision-making; position detection unit - the unit responsible for the recognition of the robot position in the itinerary; database - map - space plan, there is information about the route traveled.

Map-plan space in memory is represented as a two-dimensional array M [W, L], where the matrix has a dimension of the geometric dimensions of the room or floor with rooms: W - width, and L - length. The algorithm for generating the card plan, for example, one room and a corridor can be represented as follows:

Step 1. Each room (place) and corridor have their own coordinate system $\{X_P;Y_P\}$ and $\{X_K;Y_K\}$, and besides $\{X_P;Y_P\} \in M$, $\{X_K;Y_K\} \in M$.

Step 2. Depending on the size of rooms or floor unit selected distance R and the share of one-step robot S, for example, S = 0.5, R = 1m.

Step 3. Immediately upon the robot motion are filled with card-plan rooms where 1 - the presence of obstacles, 0 - free running. It should be noted that initially expected M {W; L} = {1}.

Step 4. In the case of the entrance to the obstacle, based on data from its sensors, the movement is clockwise, that is, there is analysis of the availability of free space. Also, when moving an existing card is analyzed, the M plan, and a determination of its location based on neural network testing W_P and W_K, responsible for the recognition of the room and corridor. This feature allows the unit control block in advance to coordinate the movement of the robot and perform bypass obstacles.

Step 5. At regular intervals of time, at what Δt, which depend on the speed of movement of the robot, the area on the map plan, with the greatest number of 0 are taken as the coordinates of the room and the corridor, and $(X_P*Y_P) > (X_K*Y_K)$.

Step 6. In order to memorize the location of the room and corridor used two neural networks (W_P and W_K) with structure of the multilayer perceptron. The arrays are chosen as the reference sample $\{X_P;Y_P\}$ and $\{X_K;Y_K\}$. The number of neurons of the first layer is calculated by the following equation:

$$X_{nl} = X_n * X_m \qquad (1)$$

where X_n – the width of the room (corridor), X_m – the length of the room (corridor).

In order to determine the optimum number of neurons of the inner layer and the proportion of one step movement operation test was performed on the basis of the method use Monte Carlo. The test data are presented on Fig.2-3. As seen from the results, the optimum proportion of pitch movement of the robot, at which the fewest iterations (cycles of movement) is 0.5 to 1.

In turn, according to the study on the amount of time training the neurons in the inner layer be the expected trend is observed - the learning time increases with the number of neurons from 50% to 250%.

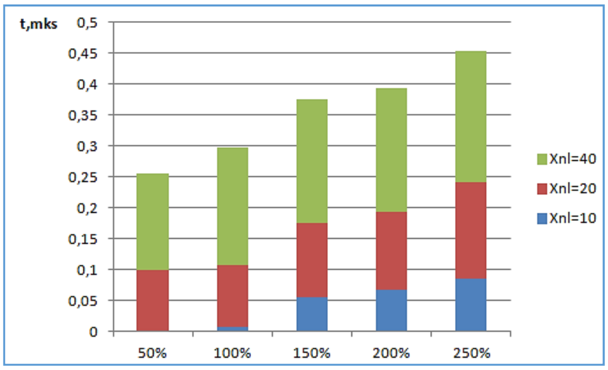

Figure 2. The result of the test according to the number of neurons in the internal rate of learning

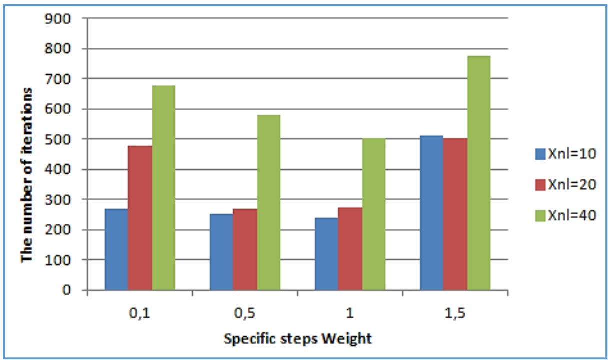

Figure 3. The result of the test according to the specific steps weight

Conclusion. Based on these results, we can conclude that for sufficiently large premises ($S>40м^2$), as the proportion of step movement rational use 1 or 1.5, which allows you to reduce the number of unnecessary iterations, on average, to 40%. Conversely, when small amounts of premises ($S<40м^2$), the specific gravity of the step movement should be taken equal to 0.5 or 1. It should also be noted that the number of iterations performed during the robot movement, also affects the state of charge of its battery, and as a consequence, at the time of its battery life without a net. According to

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tests carried out to the standard deviation of a series of measurements made Δt=0,078mks. The relative error for reliability 95% (coefficient of Student t_{α}=2.093 at α=0,05 and n=20) amounted 8,74%.

The aim of further research is the development of adaptive self-organizing neural network to memorize the route and structure of the building with lots of space.

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