MECHATRONICS DESIGN OF A MOBILE ROBOT FOR DETECTION OF METAL OBJECTS

Mihăiţă ARDELEANU[1], Paul Ciprian PATIC[2], Ion Florin POPA[3], Ryad ZEMOURI[4]
[1]) Valahia University of Târgovişte, E-mail: miniarde@yahoo.com
[2]) Valahia University of Târgovişte, E-mail: patic@valahia.ro
[3]) Valahia University of Târgovişte, E-mail: p_florin@yahoo.com
[4]) Conservator Nationale des Arts et Metiers Paris, Franţa, E-mail: ryad.zemouri@cnam.fr

Abstract: *A particular importance will be given to how the principle ideas were managed to achieve an optimal mechatronic product if certain conditions imposed. Schemes in principle on the whole mechatronic product was designed, conducted and completed in detail. The present study attempted to design a robot for the detection of metal objects, being the preferred transportation system with tracks. This system has a high stability and provides a backup speed high enough for such applications. As a result, the mobile robot those covered by this project will adopt this system.*
Keywords: *Bio-mechanism, Mobile Robot, Geometrical Analysis, Simulation, Metal Detection.*

1. INTRODUCTION

Mechatronics is defined simply as "science of intelligent machines." This is the subtitle of international journal "Mechatronics", since the first issue of 1998.
The etymology has given human being the faculty of association. Being smart, in a prime purpose, is therefore, to repeat or create freely some links between objects. This is a more synthetic vision of intelligence.
By extension, today there are other connotations to that word: speed, adaptability, faculty of analysis, ability to learn and perfect itself.
So talking about intelligence for non-human beings or machines, explicitly or not, is made only by human's reference. Turing understand very well when he developed the follow: "a machine is intelligent if its behavior is like the man who can replace."
Intelligence machinery has been set long time a go in literature and before the appearance of computers, has aroused the interest of scientists. Thus first name was "electronic brain" and the "neurons" to describe circuits.
What today is called artificial intelligence (AI) is, in fact, far from being perfectly clear. It is developed around two poles: mechatronics and computer science as a branch of cognitive science, while sources of convergence and divergence. Curiously, the most difficult problems to be solved by machines are simple problems for humans - have a discussion, going, or drive a car.
A generally valid definition of artificial intelligence is difficult to develop because of different views corresponding followers "light" artificial intelligence – in which the machine helps to understand - or "strong" artificial intelligence - when the car is those who understand.
Education tool is a process by which a computer learns to solve new problems. Within certain limits, the machines can learn just like people, through examples of what is right and what is wrong, by comparing them. One of the limitations is the fact that machines do not know what concepts might be relevant to a particular problem, so that those who's in charge for computer education must take care that the machine may focus attention on specific elements that make a distinction between good and one bad example.
To define the basic functions of an intelligent machine is taken into account the above, are shown in Figure 1 basic functions of an intelligent machine:

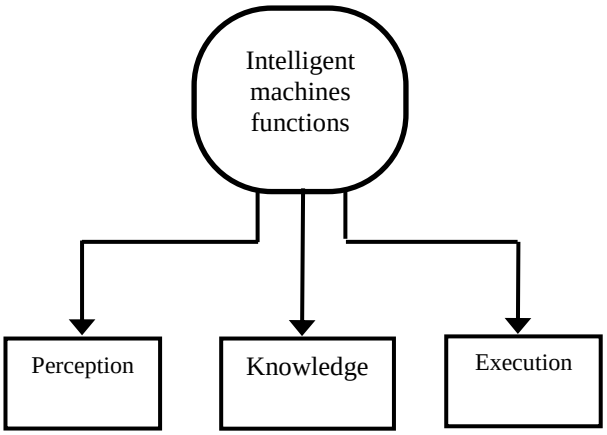


Figure 1. Basis function of an intelligent machine

There is no general method to determine the boundaries between perception, knowledge and execution. These distinct functions of an intelligent machine are not necessarily implemented as physical components or different parts.

2. THE TECHNICAL CHARACTERISTICS OF MOBILE ROBOT AND MECHATRONIC DESIGN OF THE PRODUCT

The technical characteristics of the robot:
a. the maximum depth of detection:

$$H_{max} = 150 \text{ mm;}$$

b. the maximum speed: $v_{max} = 0.08$ *m/s*

The movement system:
- two technical assemblies tracked type;
- guidance by regulating the lead revolution wheels;
- two DC groups gear-motor.

c. perception system:
- sensor for the detection of metal objects;

d. decision system:
- external computer for application management;

e. communication system:
- through radio waves:

f. three command channels for the movement of mobile platform: ↑,↓,←,→;

g. one reaction signal channel: detection of metallic objects;

h. the minimal radius of curvature of trajectory:

$$R_{min} = 1\ m.$$

3. THE SCHEMATIC DRAWING FOR A GOOD FUNCTIONING OF MECHATRONIC PRODUCT – MOBILE ROBOT FOR DETECTION OF METALS

The application, in which is integrated the Robot, requires the generation of trajectories in a given Oxyz coordination system. This system is considered to be the referential system of the application and it is always fixed. In relation to this, the center of robot, or better, the characteristic point which defines it, will have a series of coordinates that will describe his path by their values.

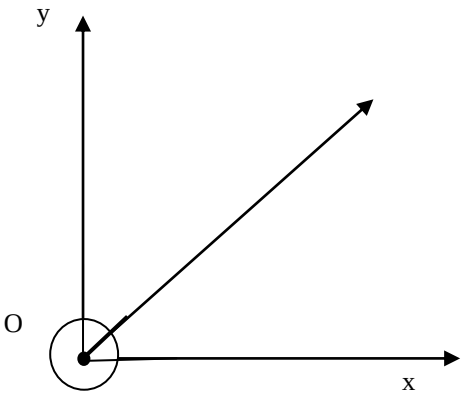


Figure 2. The application reference system

These coordinates (x, y) of characteristic point locates the robot permanently from this system. To control the execution path it is necessary the permanent knowledge of some data to infer the robot's current position when commanding in open loop, or the direct coordinate from the sensory system locator when commanding in closed loop. This case presumes the command of trajectory in open loop.

The command and control system of the trajectory is not located on the robot (on its structure), but consists from a comparator.

The communication way between the computer operating system command and control, and metal detection sensor located in the equipment, is using radio waves.

4. MECHANICAL DESIGN

The scheme of mechanical structure of the robot is presented below, in figure 3:

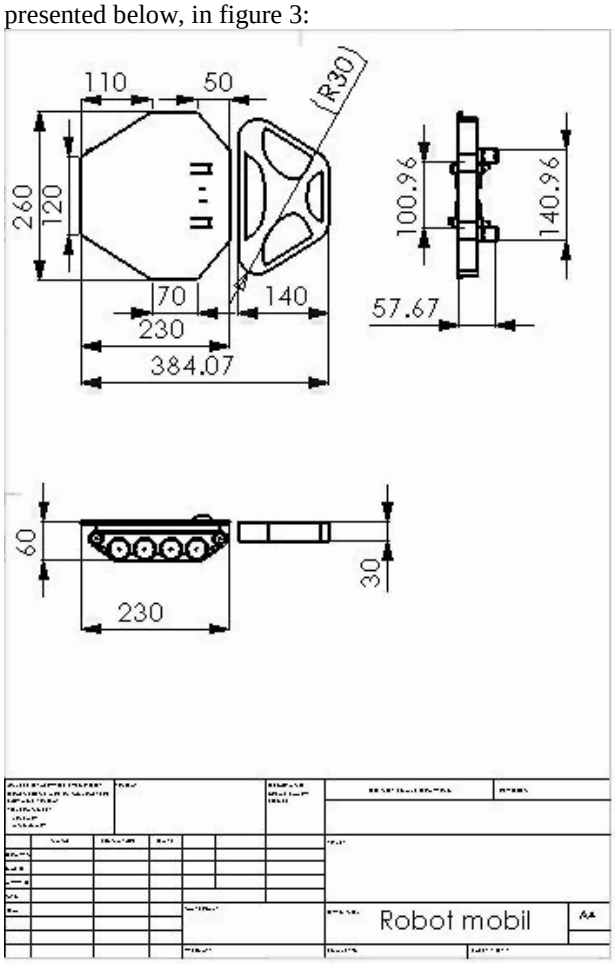


Figure 3. The designing the mobile robot of metal detection

In the case of the loco-motor system with propulsion elements fix targeted enters vehicles with leading wheels non-guidable, their position relative to platform motion is the same throughout the entire robot system. Guiding platform for execution of required trajectory of the management system can be achieved by blocking a wheel motors simultaneously with another operation to make the tournament of the entire platform to a center of rotation.

The kinematic scheme shown in Figure 4 includes the following ideas about the technical design of all mechanical mobile robots - metal detection. Drive system consists of gears groups 1 - 2 and 1'- 2';

The movement system consists of two track assemblies which include:

- The leading wheels 3.1 and 3.1';
- The wheels support 3.2, and 3.2';
- The tension wheels 3.3 and 3.3';
- The tracks 4 and 4'.

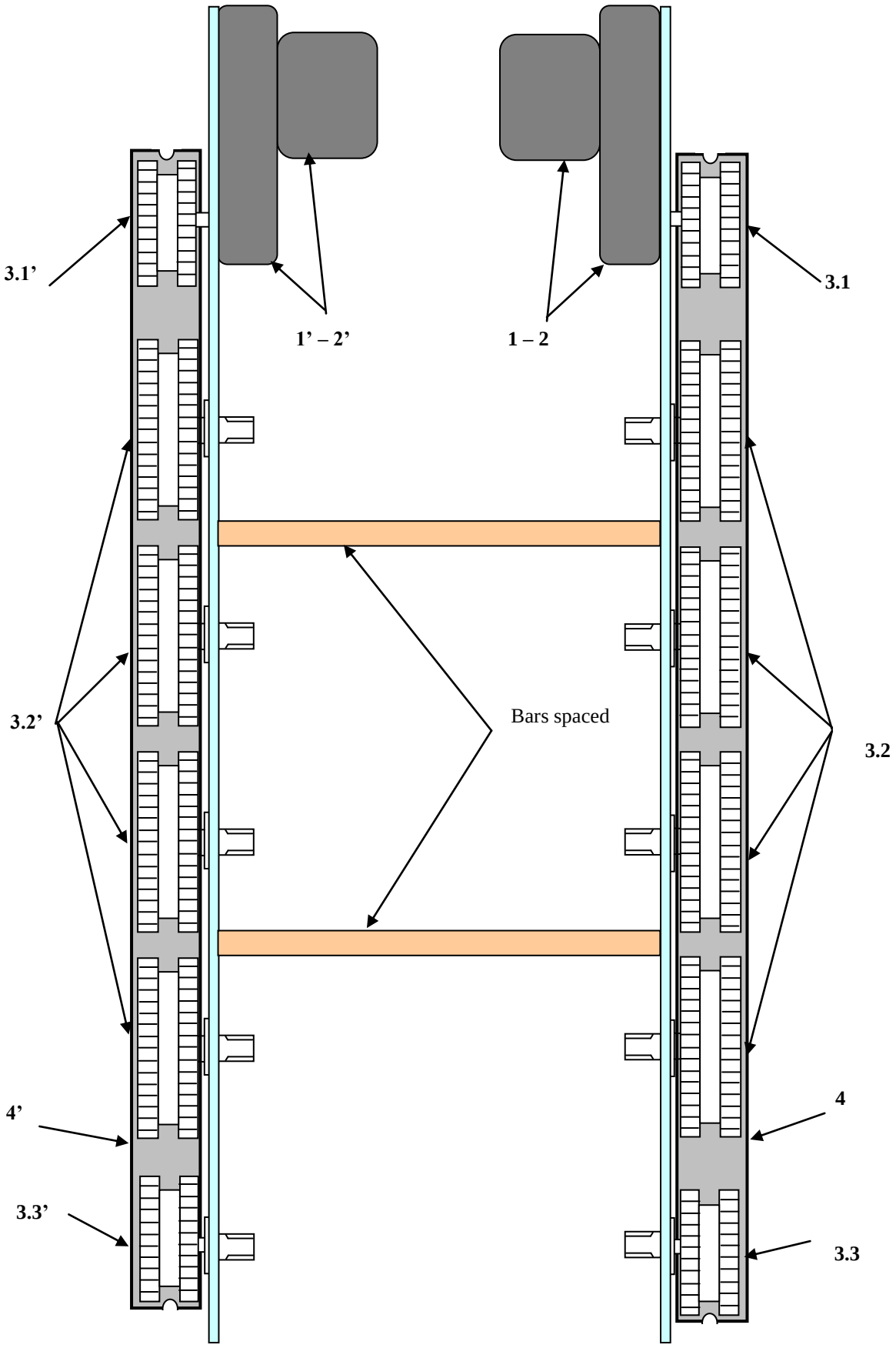


Figure 4. The Mechanical structure of robot

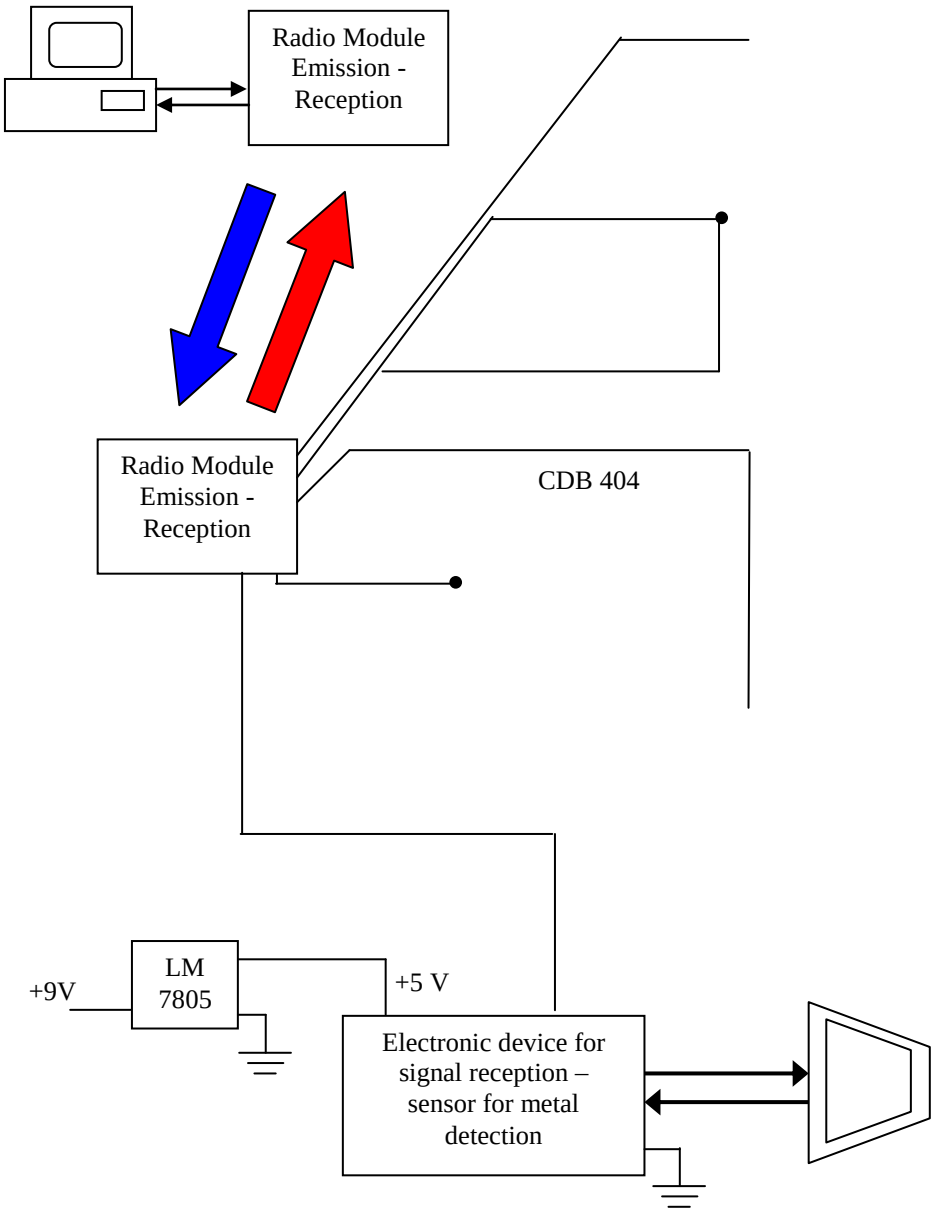


Figure 5. The Electrical scheme of the robot

5. THE DESIGNING OF MOBILE ROBOT ASSEMBLY USING SOLIDWORKS SOFTWARE

DC machine is very spread in electric drive systems because of its favorable electromechanical characteristics. DC machine is used both under the engine and generator system, brake system regime is seen only incidentally in the current machine operation. Inside of the DC machine the induction field is fixed to the armature chokes, realized like stator. Inducing field can be produced by DC machine itself, or with permanent magnets (at low power).

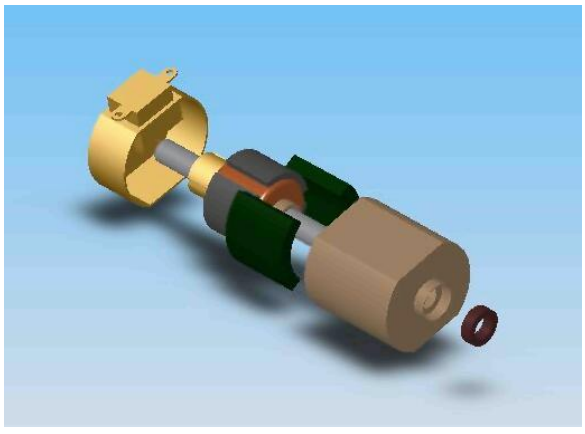


Figure 6. DC machine

Excitation winding of DC machine can be supplied in various ways: from outside sources machine (Fig. 7), when they say that the car has a separate excitation, or even from machine terminals when said machine have a self-excitation. After the connection mode of winding excitation the self-excited machines can be excited in parallel or in shunt with series excitation, or excitation or joint compound.
Nominal operating regime of the DC machine is characterized by nominal sizes, which was sized the machine and entered the nameplate of the machine: operating system (generator, engine), power in kW, the electric power generator terminal , engines, mechanical shaft power, the current main terminal A, terminal voltage in V, or in A, respectively, for duty (the term, intermittent, short duration).

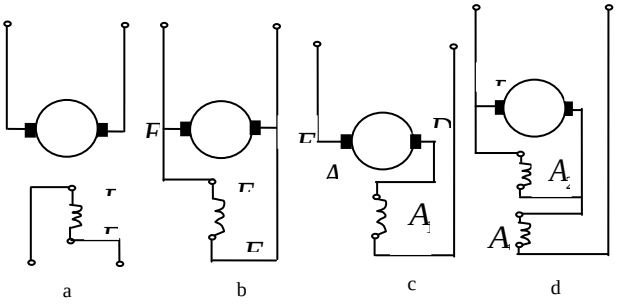


Figure 7. The connections of DC machines: a – with separate excitation; b – with shunt excitation, c – with series excitation; d – with mix excitation.

The presentation of electric power scheme for controlling DC motors using the deck "H".
DC motor should be regarded as a black box in terms of automation, which has two terminals introducing input (such as electricity) and an output shaft which collects in the device output size (of mechanical nature).
There are two bridges that control each engine.

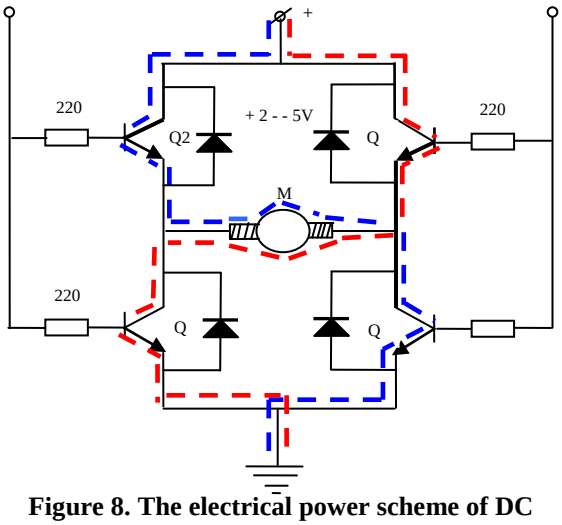


Figure 8. The electrical power scheme of DC machines, using bridge "H".

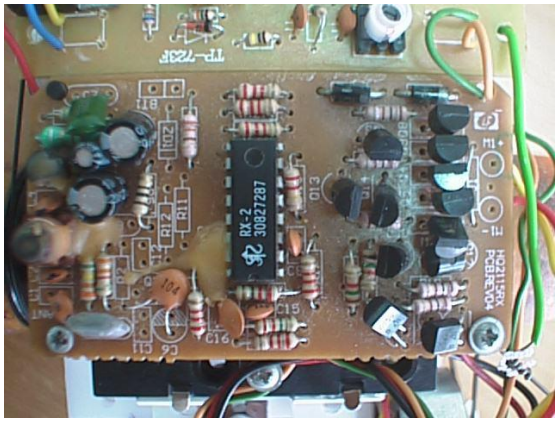
The Radio-command using in application is showing bellow:

Of remote mechanisms, the most successful enjoyed the mechanisms operated by radio. Broadly speaking, such a system includes a radio transmitter located somewhere at a certain distance, a radio receiver and a control mechanism of installation.
Remote control facility which we describe below can be used for small naval models command, to command small vehicle models, plain model or for different parking layouts. It is designed to work on frequency of 27.12 MHz generated by a quartz crystal. It comprises a radio transmitter, low frequency modulated pulse, a radio (which picks up signals emitted by transforming it into current pulses), a control system which is composed of an electromagnetic relay and a DC motor.
The electric motor through a speed reducer, will command the rudder of the small vehicle model, depending on the intended date system.

The radio emitter

Part of broadcasting by radio remote control system is designed to deliver a frequency modulated signal with pulse amplitude low frequency of 1000 Hz. The emitter working on a fixed frequency generated by a quartz crystal, with 27.12 MHz frequency. Transmitter power exceeding 100 mW and the receiver can provide secure command pair to a distance of 150 m.
Transmitter consists of a quartz oscillator realized with transistor T1 and a floor type multi-vibrator modulator realized with transistors T2 - T3.

The radio receiver is shown bellow:



Unlike the transmitter, which is fixed, the radio receiver is mobile, moving with the model which provides remote control signal. For this reason, the remote receiver must be as low in volume and weight, require low power consumption and have a high reliability.

For these reasons, the recipient schemes intended for guided models are generally simple and works on the super-reaction principle, providing the obtain of the parameters mentioned above. Schematic diagram of the radio receiver includes a floor type super-reaction detection achieved with T1, a low frequency amplifier made with transistors T2 - T3, a stage of recovery achieved with low frequency signal T4 and a DC amplifier transistor made with T5.
The scheme is supplied with a voltage of 6V and has an intake with the standby signal, about 8 mA. The receiver sensitivity is about 10 μV/m.
The RF signal from the receiver antenna is routed through coupling capacitor C6, in according L1C1 circuit, where the selection signal occurs. Among the multiple antenna frequencies in this circuit is favored only the 27.12 MHz frequency, which is granted.

6. THE PARALLEL PORT OF P.C.'S. OTHER HARDWARE USED

Computer's parallel port is one that allows electronic control unit connected to the computer. Through this, be transmitted a lot of information, from the sensors to the computer, but, also, one can emit commands from the computer to the actuators of mobile robot.
In figure 9 is shown the parallel port of the P. C.

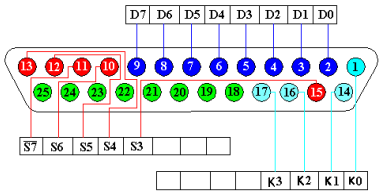


Figure 9. Bits structure of parallel port

The parallel port has three distinct zones:

- Data bits zone (D0 – D7);
- Control bits zone (K0 – K3);
- Status bits zone (S3 – S7);
- Masses bits zone GND (18 – 25).

The transmission of data packet to the external systems of computer is made using data bits (D0 - D7).

Figure 10. The mechanical structure of a mobile robot

Figure 11. Mobile Platform

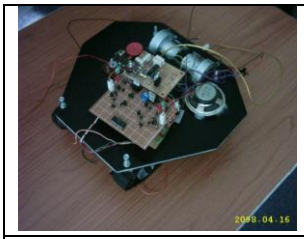


Figure 12. The electronic part of application (a)

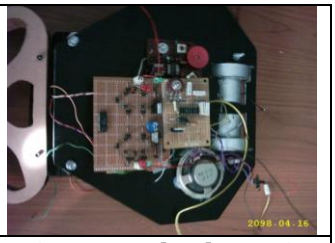


Figure 13. The electronic part of application (b)

7. CONCLUSIONS

Following the study, according to tests conducted on several types of locomotion (skeletal system), it was found that for applications intended for mobile robots detections - monitoring, track-type locomotion system is preferred.
This system has a high stability and provides a backup speed high enough for such applications. As a result, the mobile robot used in application in this research will adopt this system.
In future, other improvements of application can be made on electrical and software parts, where one can obtain better results regarding the reliability of the mobile robot.

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