MAKING AN AUTOMATED CONTROL SYSTEM ROBOCOP

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Rezumat. *Am ales această lucrare, deoarece considerăm că în viitor totul va fi automatizat pentru a uşura munca noastră. Aceasta lucrare se poate adresa în mod special armatei, dar nu numai. În stadiul la care se găseşte, în prezent, robotul poate căra greutăţi, dintr-un loc în altul. Desigur că se pot monta pe el diverse alte device-uri (braţe), pentru a efectua şi alte operaţii, cum ar fi: vopsire, manipulare obiecte şi dispozitive pirotehnice. Este o jucărie periculoasă, de aceea el se manevrează foarte uşor, fiind foarte, foarte sensibil la comenzi. În prezent, eu împreună cu tatăl meu lucrăm la un alt robot, mai puternic cu motor termic, cutie de viteze în 5 trepte automată, toate roţile viratoare şi tracţiune 4x4.*

Abstract. *We have chosen this work because we believe that in the future everything will be automated to facilitate the people's work. This work can specifically address to the military, but not only. In the current stage, the robot can carry weights from one place to another. Of course, various other devices or arms can be mounted on it to perform other tasks as well, such as painting, handling objects and pyrotechnic devices. It is a dangerous toy, very easy to handle and very sensitive to operate. Currently, my father and I work to another robot, more powerful, with combustion engine, 5-speed automatic gearbox, all steering wheels and traction on all wheels.*

Keywords: automation systems, robot, pyrotechnic devices, combustion engine

1. Chasses

The chassis was made of rectangular pipes of 15 mm × 15 mm × 3 mm [figure 1]. We chose this rectangular pipe shape because it is light and easy to maintain against the external agents, such as corrosion (the enemy of all metals). The first step we did, it was drawing a pattern and then we did start working on the rectangular pipe. The entire frame has connections made at 45° and the welds were carried out in argon gas.

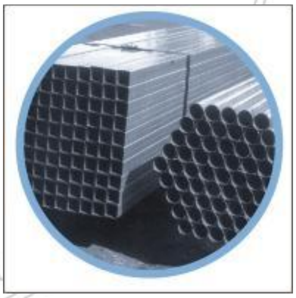

Figure 1: rectangular pipes

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The image below is the chassis [figure 2a)]. In the next step, we installed the traction, which includes the engine, sprockets, chain, differential subassembly, planetary shaft and bearings [figure 2b)]

Figure 2a) chassis

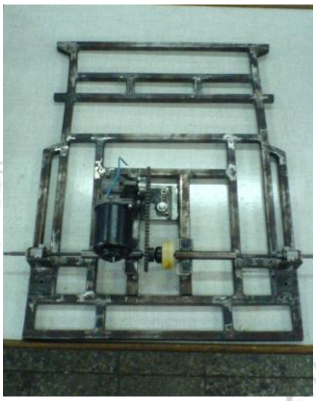

Figure 2b) the traction

In the following we present the elements of which we have spoken above. Like any machine, the main element is the engine. What is the engine? This is a question that we all ask ourselves. The engine receives electricity and converts into mechanical energy. This is the electric motor.

2. A little history about the DC motor

The DC motor was invented in 1873 by Zénobe Gramme by connecting a DC generator to a like generator. Thus, it was observed that the machine rotates, making conversion of electric energy absorbed from the generator. The DC motor has on the stator the magnetic poles and concentrated polar coils which create the excitation magnetic field. On the engine shaft a manifold is located which changes the direction of current flow through the rotor winding, so that the magnetic field excitation exerts continuously a force to the rotor.

Components of a motor:

1. motor shaft
2. stator
3. clamping screw
4. brushes holder
5. collector
6. carbon brushes

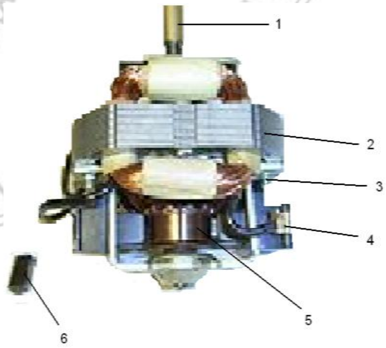

Figure 3: components of a motor

The current conductors of the rotor winding will have one or more pairs of equivalent magnetic poles. The rotor moves in the excitation magnetic field until the rotor poles align themselves right opposite to the stator poles. In the same time, the collector changes the direction of the rotor current so that the polarity of the rotor reverses and the rotor will continue moving to the next alignment of the magnetic poles. The motor speed is proportional with the applied voltage to the rotor winding and inversely with excitation magnetic field. The speed is adjusted by varying the voltage applied to the motor up to the rated voltage. Higher speeds are obtained by weakening the magnetic excitation field. Both methods target a variable voltage that can be obtained using a DC generator, connecting a set of resistors in the circuit or using the power electronics.

Engine of the figure represents a double gear motor:

1. plastic housing
2. brushes holder
3. carbon brushes
4. stator
5. motor housing
6. collector
7. permanent magnet
8. shaft
9. bearing support
10. bearing (ball bearing)
11. motor sprocket
12. gear housing
13. tray sprockets
14. sprockets
15. housing
16. bearing (ball bearing)
17. clamping flange
18. output of the reduction gear

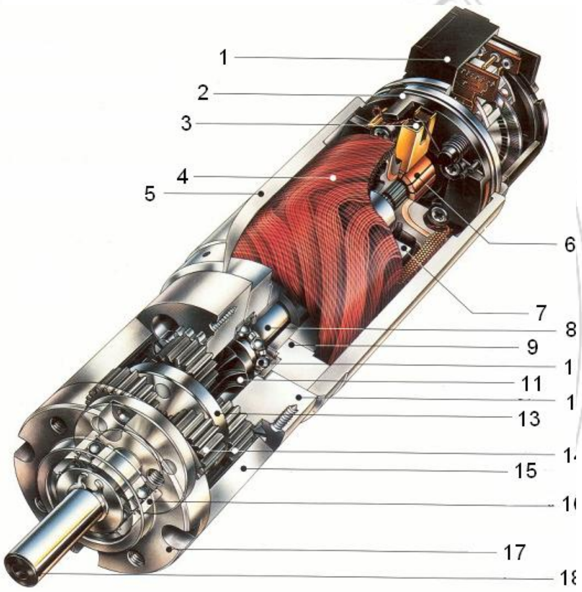

Figure 4: double gear motor

The torque developed by the motor is proportional to the electric current through the rotor and magnetic field excitation. Speed control by field weakening is therefore to decrease the torque developed by the motor. At the series motors the same current passes through the excitation winding and rotor winding. From this consideration we can deduce two engine series features. One of them is for low load motor in which the torque depends on the square of the electric current absorbed. The engine should not be allowed to run without load. For that in this case the value of the electric current is very low and therefore excitation field is reduced, which leads to packaging machine to self-destruction

Reversing the direction of rotation is done by changing the polarity of the supply voltage, or by changing the direction of the excitation magnetic field.

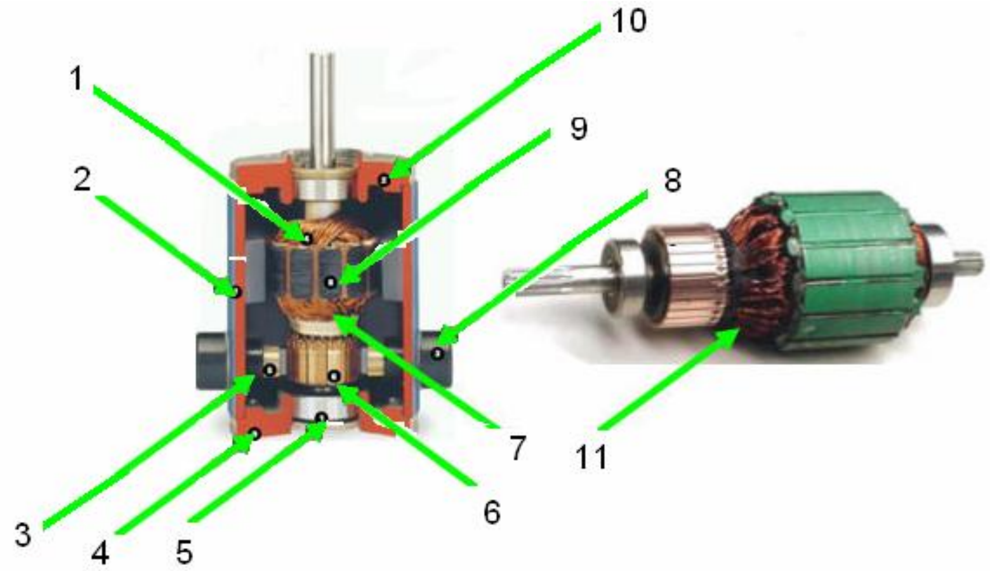

Figure 5: Engine components - 1. rotor; 2. permanent magnet; 3 carbon brushes; 4. bearing support; 5. bearing (ball bearing); 6. collector; 7. rotor windings; 8. brushes holder; 9. iron blades; 10. bearing support; 11. rotor

We used a car windshield wiper motor because it is very quiet. Figure 6 depicts the motors we used:

Figure 6: motors

The image below gives the inside of the motor gear which is made of two worm wheels.

Figure 7: inside the motor gear of two worm wheels

3. Sprockets and transmission chain

Traction is on the rear wheels and therefore the system is provided with bigger wheels. The connection between the motor and the planetary shaft is carried out by a transmission chain and two sprockets. The driving wheel is larger than the driven wheel and therefore it was mounted on the motor shaft to earn a higher speed at the wheels.

Figure 8: driving wheel

The driven wheel, being smaller, was mounted on a differential which is designed to change the speed depending on the steering wheel. Another component which belongs to the transmission is the differential. It allows the rotation at different levels per minute of the left and right wheels. At curves, outer wheel is spinning faster than the inner one to compensate the greater distance it needs to travel. The picture below shows the differential subassembly:

A. differential housing
B. output shaft
C. worm gear
D. worm sprocket
E. synchronization sprockets
F. hypoid wheel (from engine)
G. output shaft

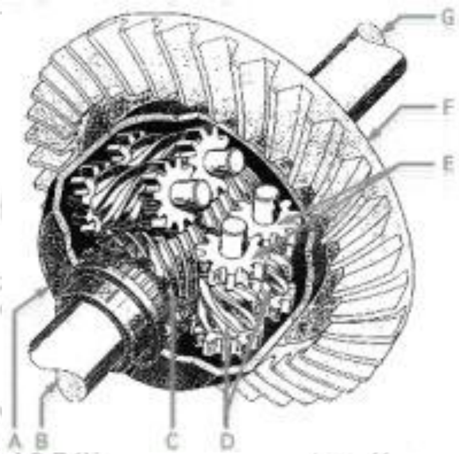

Figure 9: differential subassembly

The link between the two sprockets are made using a transmission chain. (Figure 10)

Figure 10: transmission chain

4. Direction

Direction is another important element. The maximum slope is 15° and it was made from a motor supplied with 6 V, the steering rods being adjustable.

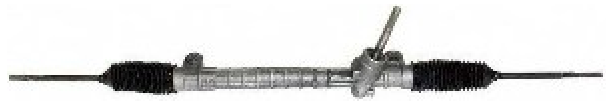

Figure 11: the steering box

We chose to act directly by electric motor (servo motor), because it can be controlled much smoother than other ordinary motor. Something that helps me a lot is a position transducer, which it always indicates the angle at which the wheels are tilted.

5. General structure of a transducer

“*Sensor*” is very popular in the US region, while the notion of “***transducer”*** – is commonly used in the European area. The word "sensor" is derived from the Latin –“sentire”- meaning "to perceive", while the "transducer" in translation means "to cross". A dictionary definition assigns the word "sensor" means "device that detects a change in a physical stimulus and converts it into a signal that can be measured or recorded", while the word "transducer" is the definition of "device transferring power from one system to another in the same form or in a different one". Sensitive boundary between the two notions: one can use the word "sensor" for the sensing element itself and the word 'transducer' for the sensing element and associated circuitry. Example: we may say that a thermistor is a "sensor", while a thermistor plus a measuring resistive bridge (which converts the electrical resistance variations in the voltage variations) is a "transducer". In this sense, all transducers will contain a sensor but most of the sensors (but not all!) will be transducers. In a general framework, a transducer is a device that converts a signal of a certain physical nature in a corresponding signal having a different physical nature. A transducer basically is a power converter in which the input always has energy or power. However, the power (which by integration gives energy) associated with the input signal must be large enough not to be disturbed by the measuring transducer size. Or, the transducer must influence through its input circuit negligibly the size measured (it says that the power taken from the size measured should be below a certain value called the available power). Example: measurement of a force using a strain gauge. Since there are six different classes of signals - mechanical, thermal, magnetic, electrical, optical and chemical - we can say that any device that converts signals from one class to another is considered to be a transducer.

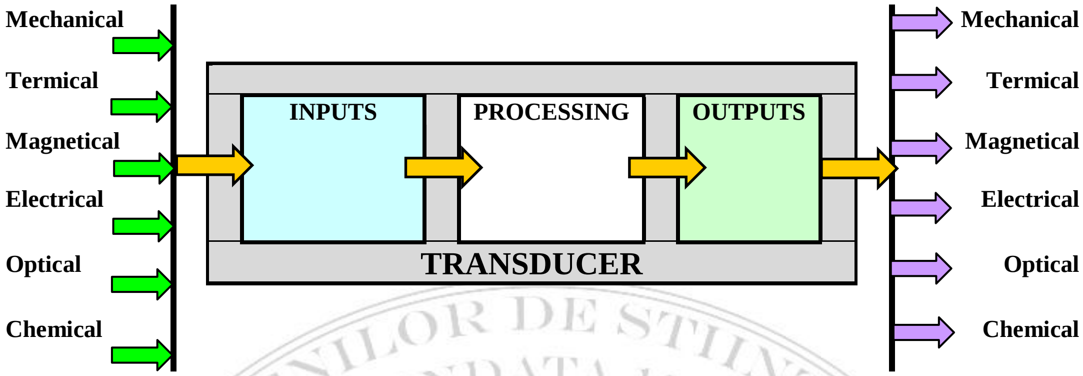

Figure 12: schematic transducer

Definition: transducer is a device that establishes correspondence between a physical quantity (process parameter) varying in a certain defaulted range and a calibrated electrical signal suitable to a measurement situation.

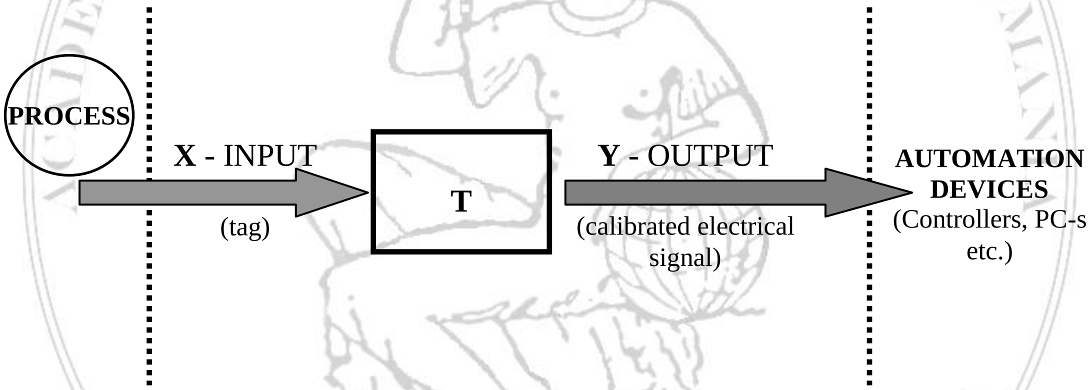

Figure 13: the transducer as component of the automated system

Considering the definition introduced at the beginning of the paragraph, there are authors and even companies that use the concept of transducer for those elements that convert primarily. The sensor is linked to the perception of measured values, suggesting a similarity with human behavior in the manner of obtaining information about physical quantities. Definition: sensor means assemblies of sensing devices for determining a field of values for the physical quantity in a similar manner to the human sensing organs.

6. Conclusion

The sensors allow obtaining images or maps of a scene through similar human paths. This should be understood as a defined input, i.e. field values obtained by sensors must be processed to more accurate picture in order to playback the image. So, it has to have a similar representation to that formed in the human thinking. In light of the definition, a sensor performs the same function as a transducer, i.e. charge the state of a physical quantity which converts the electrical signal.

Consequently, the functional structure of a sensor complies - in principle – with the same pattern as a transducer. This explains why the two notions are frequently used in explaining the functional principles for various constructions. However, at least three characteristics define the sensors:

► miniaturization, which allows measurements of the investigated quantities;

► functional multiplication, meaning existing in the structure of a sensor of a large number of sensitive devices fulfilling the same function, arranged in a linear or matrix distribution;

► sensorial fusion, which involves the gathering of several sensors in a unique configuration to provide the desired functionality;

► these features, together with the property of "imitation" of the human senses, make the sensors to differentiate out of transducers. Illustration: the phenomenon of piezoelectricity used in construction of the force transducers and tactile sensors, as well;

► functional multiplication, specific to sensors, makes the local processing to be different - even in principle – of those of transducers, something which leads to a further differentiation of the two concepts.

We use differentially the two concepts considering the structural composition and scope of the applications. Illustration: to control a robot arm one uses linear displacement transducers (forward / reverse), rotation (left / right) and proximity to sense the approach of a particular landmark. But also, a number of the sensors such as visual sensors for recognition of the objects, effort (tactile) sensors for clamping the parts, auditory sensors for recognizing the voice commands.

7. Place of the transducer in the automated systems

The two cases presented show:

- place of the sensor in the process automation as element located on the information path;
- carry out its role of the measurement tasks;

Consequences:

- transducer has metrology features well established that guarantees the quality measurement

● diversity of the process variables, that must be highlighted, lead to a variety of the constructive principles used in the transducer input

● its output is restricted to electrical signals compatible to elements of automation installation to which they are coupled.

Figure 14: position transducer used for "ROBOCOP"

8. Electronic subassembly

Electronic subassembly is the most complicated part of the robot. As the most important component, we called the set of the several components working "together", artificial brain. It includes a number of electronic assemblies each designed to perform a specific function, such as:

- reception subassembly
- power supply
- sense exchangers
- high power inverters
- voltage stabilizers

Reception subassembly

The robot is controlled by a remote control and can reach a maximum distance up to 4 km. The reception assembly is supplied with 4.8 V stabilized. The remote control is proportional and allows a very smooth motor variation. The receiver is fed to 4,8V generated by four rechargeable batteries of 1.2 V and 2700 mAh (NiMH) (see figure 15).

Being controlled at such a great distance, it was provided with a surveillance camera wirelessly. All images are transmitted in real time.

Figure 15: surveillance camera wirelessly and batteries group

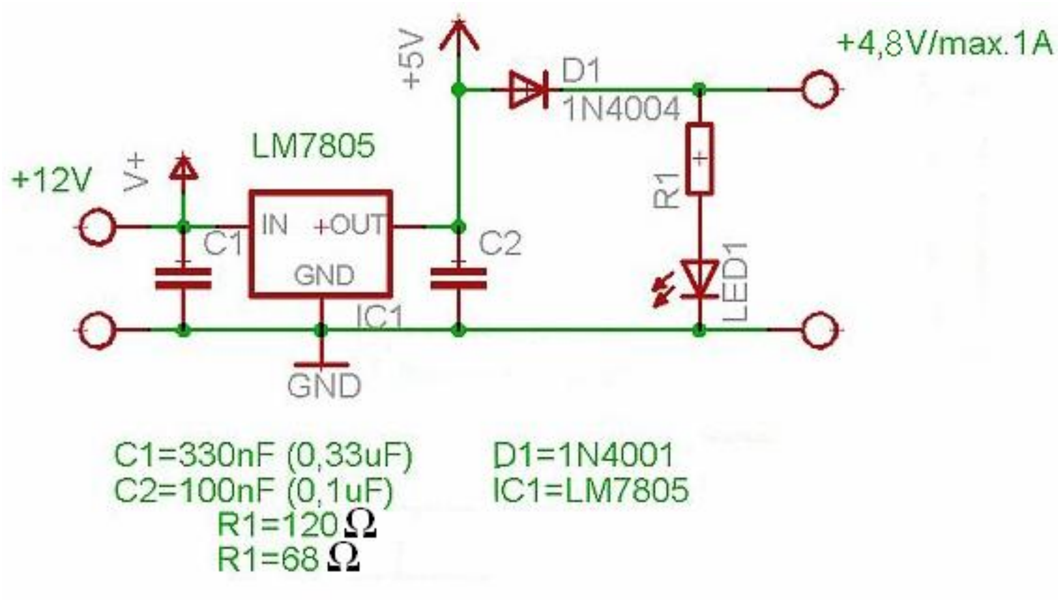

Figure 16: schematic voltage stabilizer, which supplies the receiver

9. Power supply

All assemblies are supplied at different voltages, so voltage regulators have been provided similarly to the above one, but working at different voltages. The entire robot, fully mounted on the chassis, weighs about 20 kg.

All power supplies are generated by rechargeable batteries. The traction engine is provided with 2×12 V/7 Ah (Pb) batteries and the steering engine has a battery of 6 V / 12 Ah (Pb). Two batteries of 12V/7Ah (Pb), shown below have been used to supply the traction motor (figure 17).

Figure 17: batteries of 12V/7Ah (Pb) for the supply the traction motor

The battery is 6V/12Ah (Pb) and we used it to supply the power to the steering motor.

Sense exchangers are needed to change the direction of the motors. Large power exchangers increase or decrease the motor speed. Figure 18 contains electronic components printed circuit, a traction motor subassembly.

Figure 18: electronic components printed circuit

In this period, the robot has undergone a "radical" transformation: the maximum steering angle was before 15° and now it is 45°. Modifications brought up:

- The machine has been "cut" into two parts, the whole front was removed;
- It was welded other profiles so that the robot allows a 45° angle;

We are working at another more refined robot, with thermal engine on gasoline. This robot will be 4×4 (all driven wheels), all wheels will be turning wheels, 5-speed automatic gearbox and reversing system.

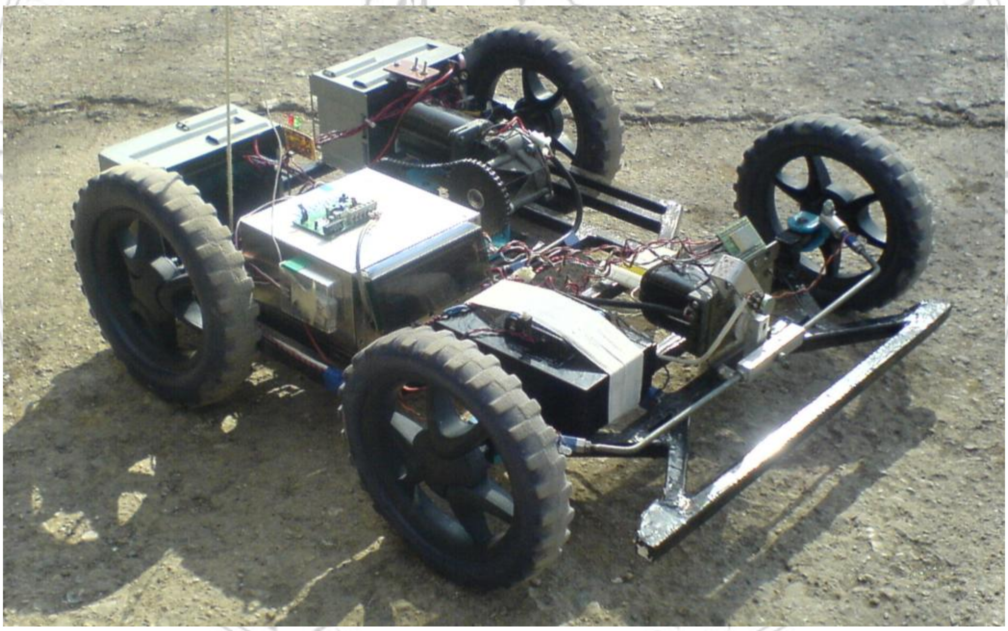

Figure 19: Functional Assembly Robocop

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