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CONTRIBUTIONS REGARDING THE ADAPTIVE DRIVE OF ROBOTS

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Abstract: In this paper are presented a few contributions of the authors in the scientific research activities, as for elaborating doctoral theses, regarding a important problem in robotics and namely the dynamic control in real time of the robots and for their stable functionality according to the variation of the reaction forces with the environment. Is presented a experimental stand, a force command of en electric engine, and a electro-pneumatic disruptive system conceived and realized. The theoretic base was used for the experimental stage realized by the authors.

1. Introduction

Generally the usual theories for driving a physical system are based on the following assumptions:

- the system can be modeled and its structure is known;
- the module parameters are known.

These assumptions, necessary for developing some systematic theories of system driving, and especially here for robot driving, are bringing numerous practical problems. In these cases the module represents only a optimization of the physical behavior of the process with effect only in a restrained functional field. Usually the parameters that come into action must be determined experimentally and usually their values are supposed to be stable.

Obtaining and maintaining the classical driving systems performances, in conditions of some disturbing admeasurements existence, at acceptable values is a veryhard to achieve goal. From this reason have appeared different solutions for resolving these situations, by using adaptive systems.

These driving systems require (impose, ask) reduced antecedent information's and it modifies its structure and/or its parameters while functioning using the actual information furnished by the process. It is said that a system is adaptive if it's capable to reach the driving objectives, in the situation in which the construction information, available initially, is not complete.

So an adaptive system must complete itself the construction information for the process in real time, based on the functionality information, and to have a on-line recognition of the process. The adaptive system is not destined only to a certain process, but to a class of processes, realizing to adjust itself in real-time – based on the functionality information's – to the given situation.

2. Adaptive driving of a robot axis

The industrial robots for sale, available in present are operated electrically, hydraulically or pneumatically, presenting a control loop at each driving cinematic couple level. So, each couple is itself a positioning device and presents a position control system.

In case of a sequential movement of the robot, each controller for each couple level can be a classic regulator: Proportional Integrative Derivative (PID) or derived, and the compensations from each couple level by direct cinematic analyzing will give the compensation at the level of the characteristic point of the robot. A solution like this can be accepted only if the parameters characteristic to the each couple dynamics and all the interference generalized forces can be rated exactly.

In practice some of these measures are not entirely known and sometimes there are unforeseen changes in the execution assignment of the robot and from this it results that is necessary an adaptive control, which can eliminate these uncertainties.
This paper brings a contribution to the adaptive driving by force of robots.

3. Experimental stall

The experimental stall conceived for realizing the adaptive driving, using different types of regulators is presented in figure 1.
The bounds between different components of the system, their surveillance and the process running are made by computer with the help of the authors conceived software.

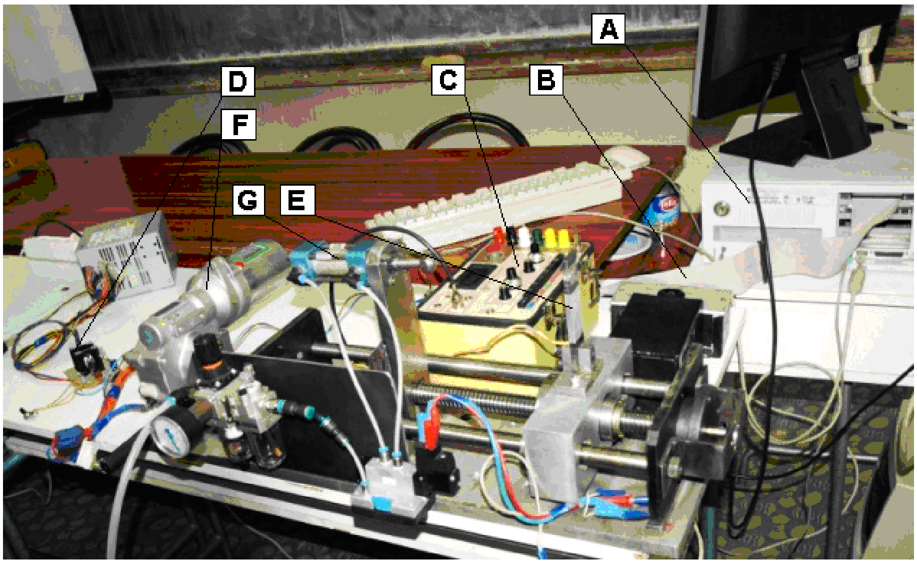

Figure 1.Sample of the translation module, operated by the computer.

The assemble scheme of the conceived command system is presented in figure 2.

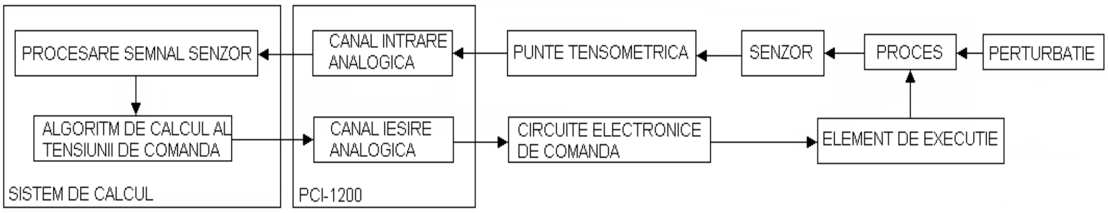

Figure 2. The assemble scheme of the command system

The components of the system are:

- calculus system (A)
- coupling point of data acquisition board (B)
- voltage bridge (C)
- command circuits (D)
- power encoder (E)
- execution element – electric engine (F)
- exterior disturbing system (G)

Disturbing forces system

By applying exterior forces, called disturbing forces, is simulated the system of forces which appear in different applications.

The application of these forces is realized with the help of a electro-pneumatic system, which is composed by the following components with the cinematic scheme presented in figure 3.

- MPL – linear pneumatic engine with piston and double action
- D – distributor 4/2 with electro-pneumatic command
- R_p – proportional pressure regulator
- Force strain gauge
- Elastic element – helicoidally spring

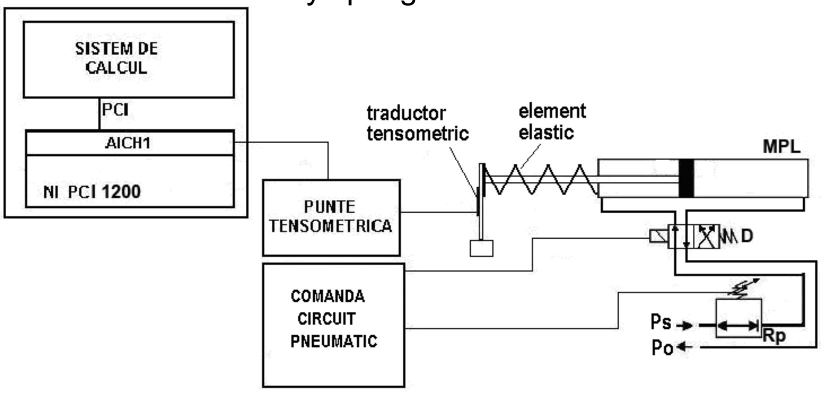

Figure 3. Electro-pneumatic disturbing system

With the help of the proportional pressure regulator (R_P) or the classic regulator we can adjust both the pressure of the compressed air and at the final perturbing force developed by the pneumatic engine rod based on the relation:

$$\tau = \rho * A \quad (1)$$

where:

- ρ – compressed air pressure (in variation with the voltage or intensity applied at the electromagnet pressure regulator R_P)
- A – the effective area of the pneumatic engine piston

The elastic element put between the pistons rod and thevoltmetric strain gauge lamella assures a linear variation of the disturbing force on the compression field x.

These disturbing forces are trapped by the force transducer type elastic lamella, with transducer stamp, fixed on the module mobile table, and the information's are purchased by the acquisition board and transmitted to the computer.

4. The conceived and realized system of adaptive driving

In the driving system of a robot enters:

- The auctioning system of a robot
- The command system of the system

4.1. Structure of the auctioning system of the realized and conceived module

To drive a translation module, we used a D.C. engine with brushes with excitation by permanent magnet having the nominal voltage of 12 V (existing in subsidy).

It has been used a mechanical transmission like a reducer snail – snail wheel, having the transmission ration of 1:20. At the exit from the reducer has been put a bolt with balls with the diameter of 25 mm and the step of 5 mm. For the adaptive driving is necessary an engine speed variation and a direction change in real time.

In principle the speed modification of a D. C engine can be made mechanically or electronically.

To electrically control the engine movement is necessary to be able to control the voltage and intensity of the current by its coils, both in amplitude and in direction.A method is the application of the source voltage on the engine, but only for a variable period of time.
Modifying the voltage impulse duration applied to the engine, is modified the medium value of the engine voltage, and so of the speed engine. This is the method used in case of the conceived and realized application.
To change the rotation way of the engine we must reverse the voltage polarity applied to the engine. This facts can be realized, or by using the electromechanically contacts, or by using static interrupter type solid state.
The electronic switch solution is clearly superior.
The operation of a D.C. engine with brushes with permanent magnet excitation, with the help of electrical switchers, in both directions is made using a circuit in H bridge, according to figure 4.

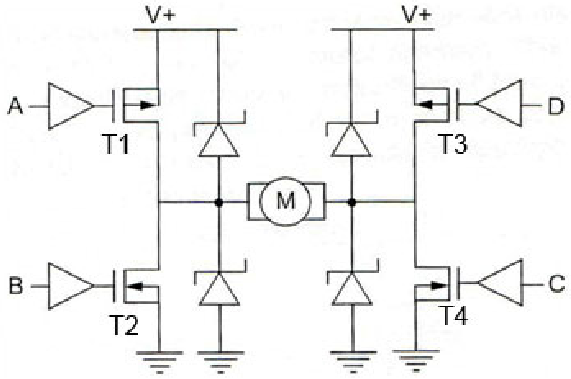

Figure 4. Circuit in H bridge – fundamental circuit

This circuit represents, in fact, the force part which generates currents which assures the engine movement. The commanding part which assures the processing of the entry signal, in a signal which realizes a direct command of the force floor, represents the engine speed controller.
The assemble scheme of the controller used for engine running is presented in figure 5.

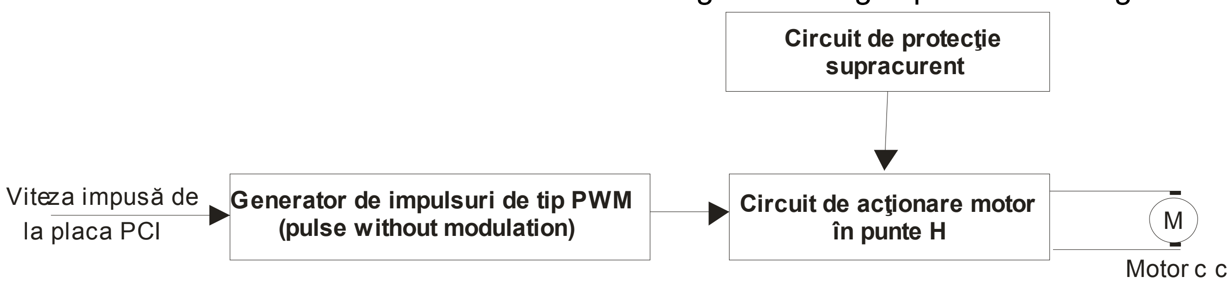

Figure5. Assemble scheme of the controller

The pulse generator type PWM has the role to produce pulses with variable bandwidth, according to the commanding voltage (imposed speed). This pulse is a analogical voltage signal 0÷10 Vcc, produced at the analogical exit of the user acquisition board PCI 1200.
The assemble scheme of the generator PWM is presented in figure 6 and was conceived for the application which has to be resolved.

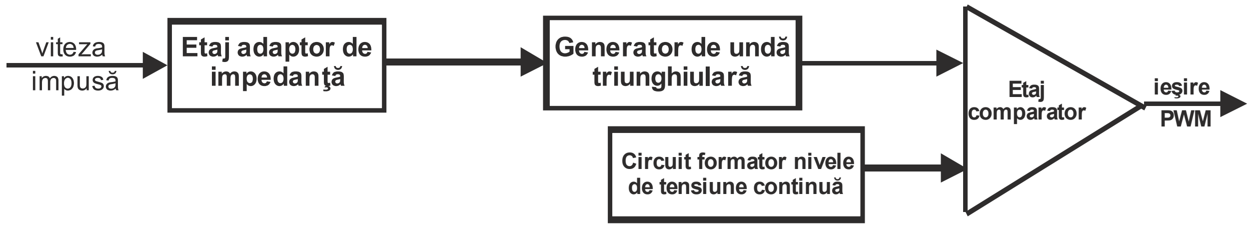

Figure 6. Assemble scheme of the PWM generator

The used scheme for the PWM generator is different from the classical method in which a level of continuous voltage is compared with a “saw tooth” signal.
The impedance adapter floor is realized with a operational amplifier in an voltage receiver assembly, assuring a big entry impedance for the speed signal imposed by the acquisition board PCI 1200 and also a small exit impedance for the exit signal applied to the triangular wave generator, realized with the help of a downstream operational amplifier, this generating a saw tooth signal with a frequency of approximately 270 Hz.
The triangular wave signal is centered on a level of variable continuous voltage. This signal is composed, applied on a entrance of the dual comparer, is compared with two level of continuous voltage obtained with a creative circuit realized as a resistor splitter.
The comparer is a dual one, realized with two operational amplifiers.
At the exit is obtained a train of pulses modulated in time, pulses that command the operating circuit of the engine. This circuit is a H bridge one, realized with MOSFET transistor, which have the advantage that can drive currents with high values, having a very low resistance in the conduction stage.
The controller is provided with a protection circuit at overload, realized on the principle of using some resistors with limitation role for the currentin case of appearance of some accidental overload or some defects.
The electronic scheme of the controller for the considered engine is presented in figure 7.

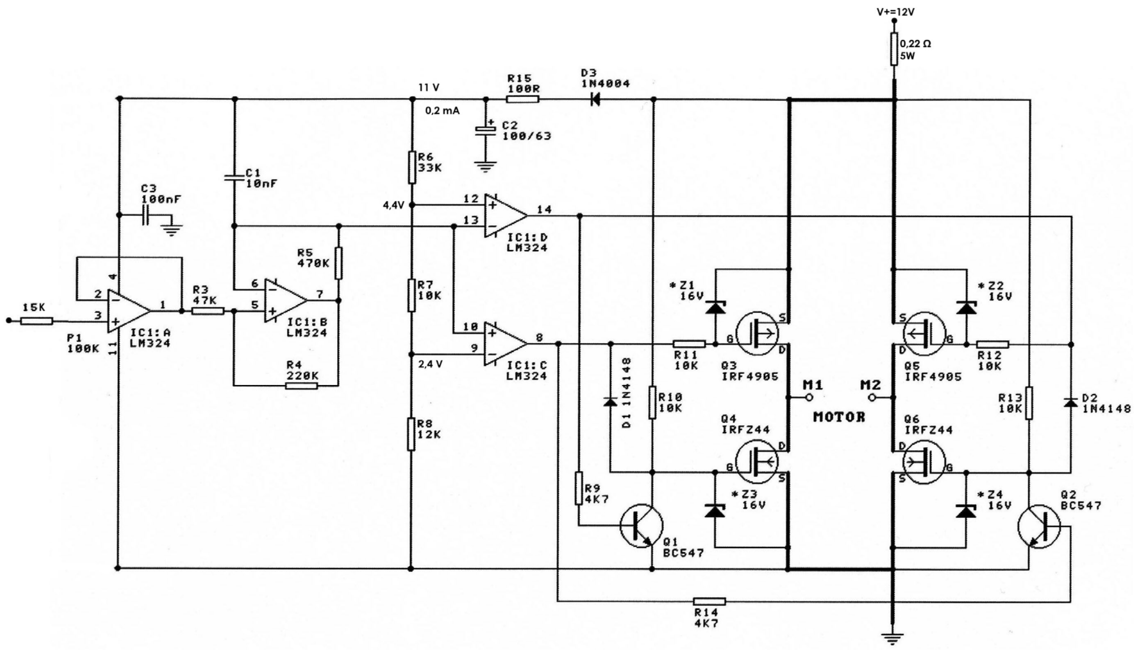

Figure 7. Electric scheme of the controller

5. Conclusions:

These achievements have been used in a previous phase of the researches and applied in a experimental system, based on which have been applied several classic driving system, and in the end the running using fuzzy regulators. The obtained results are presented in another scientific work and in the doctoral thesis [].

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