EUROXCHANGE

7 (Spring), 2002 Editor A. Bobovitch

IN THIS ISSUE

The District 12 2001 Students Activities Results.

2001 year- the first year of the 21 century was very happy for District 12 students!

International students team got golden medals in practice and silver medals in theoretical parts of the International students competition in Houston, TX. We were going to that success during long 7 years. European region first students section was created in 1995 on the base of St. Petersburg State University of Airspace instrumentation. Many thanks to P. Zani, A. Mansutti, M. Brancaleoni, W. Rampini (Italy). They were Russian students first sponsors. Then section was created in Cork (Ireland), Catania (Italy), Genova (Italy), Valladolid (Spain)and Gliwice (Poland). Number of section grew in 6 times and number of students grew in 12 time from 1995 till now. For the first time European team took part in International students competition in New Orleans in 1995. We didn't miss any competition till now. In 1999 in Philadelphia European students got silver medals. In 2000 in New Orleans they got bronze medals. Many thanks to District 12 students advisers professor Orazio Mirabella (Catania, Italy), professor Valery Elkin (St.Petersburg, Russia), Harvey Makin (Cork, Ireland) , district 12 (European Region) leaders :Cor Van Rauvendaal (Holland), David Keast (UK), Taco Coolen (Holland), Maurizio Brancaleoni (Italy), Declan Lordan (Ireland), David Norman (UK) and ISA staff Sally Walter and Laura Crumpler for many help for students during many year!

The first ISA knowledge center was open for Gliwice University (Poland) at October, 2001. Dr. Jaroslaw Smieta (students adviser) was one of the creators of this centre. ISA president-elect secretary P.Zani took part in official ceremony of opening this Center.

The first agreement about cooperation between Catania University and St.Petersburg State University of Airspace Instrumentation and their students sections was signed in March, 2001 and now we are preparing the first students exchange program.

The agreement about cooperation between Valladolid University and SUAI and their students sections was signed in November 2001.

District 12 students conference and round table via internet were organized in April, 2001.

2 issues of students EuroXchange were published in 2001.

Spain section has organized a special students paper award. 5 papers were presented. 2 Valladolid's students got award at ISA Spain section annual conference on June,2001 in Madrid.

Catania section organized two 1 day visit to large plants in Catania. One is semiconductor manufacturing plant and the other one is the large chemical site. Many students are developing study and work activities at several industrial and research centers. They also organized several meetings with companies that were searching for young engineers to recruit.

3 Russian students member changed ISA status as regular member (now there are 5 former students who continue ISA life after graduation from Universities).

The 3-d International students seminar BICAMP-01 was held at May 25-29,2001 in St. Petersburg (Russia). 17 students got the ISA district 12 students committee diplomas.

Month before Xmass we had received good news from Valladolid University- Dr. Jesus M. Zamarreco and Dr.Miguel A.Garcia (students section advisers) took their exams for next teacher positions and show very nice results. From the name of District 12 students committee we congratulate our Spain colleagues!

I'd like to wish to all ISA students and members Happy New Year and good luck. I look forward for 2002 and hope that it will be successful again . We have a big plans for 2002.

Alex Bobovitch, district 12 students committee chairman

The Third International School-Conference BICAMP-01, dedicated to the 60-th anniversary of University of Aerospace Instrumentation.

The School-Conference was held in Saint Petersburg in June 25-29, 2001.

BICAMP-01 is an excellent opportunity to present your ideas, to exchange opinions and to share practical skills with your co-workers and elder colleagues from all over the world.

School Application Areas:

- Bio-technical Problems
- Aerospace Instrumentation
- Information Technologies
- Radio Engineering, Electronics and Communication
- Electro-mechanic Systems and Complex
- Systems and Technologies of Intellectual Management
- Economics
- Management and Marketing
- Law

Participation in the School-Conference gove to students a chance to:

- Lay claims to the science of the XXI century
- Learn about perspective researches in adjacent fields of science and industry
- Publish report's thesis in the collected works of the Conference Increase own status
- Estimate achievements and potential resources.
- Meet future colleagues during joint work.
- Immerse yourself into the magic of the White Nights of Saint Petersburg.

The School-Conference Program included:

- Plenary and sectional meetings
- Master-classes
- Cultural program (sightseeing tour around Saint Petersburg, a big students' feast on the shore of the beautiful river of Vuoksa – the heart of Russia's Lake District - Karella).

The best students got the ISA district 12 students committee's diplomas.

They were:

Analysis of main reasons of transmitters failures in complexes of onboard equipment of flying vehicles.

Asrul Sharaf Omar (Malaysia).

Given is the analysis of main reasons of transmitters in complexes of onboard equipment of flying vehicles. This analyses is based on experience of maintenance of civil and military aircraft under climatic conditions of Malaysia. Suggestions on measures to be taken to increase reliability of onboard cable and electric connectors are formulated.

The design stages of microprocessor management systems.

V*olkov Alexy (Ivanovo, Russia).*

Their practical realization being an example of a polymeric optic fibre forming process, with the usage of various simulating environments and Forth-system, as a instrument of microcontrollers programming, are considered.

Base methods of triangulation for mesh generation and using in industrial aims.

Alex Sergeev (St. Petersburg, Russia).

In this paper described base methods of triangulation for mesh generation and using in industrial aims (airplane building, for example).Also described new method for optimal sets of control units in fuel tanker of airplane, based on results of mesh generation and som mathematical functions.

Criteria of the Choice of the exploratory measuring system.

Alexey Komarov (St. Petersburg, Russia).

At development of the measuring system developer must take into account the big amount of the heterogeneous requirements of the customer, which concern the different aspect a production and of the system usage. As a rule this requires the long mutual co-ordinations. Much in a complicated way define the general beliefs about quality of the decisions. The standard of judgement quality measuring system is offered. It is system value. Stand out 4 groups parameter systems, which also serves the separate parts forming quality of the system.

Information features of the biotechnical information measuring system.

Alexey Komarov (St. Petersburg, Russia).

The organism balances and closely keeps a check on small Change the external environments and simultaneously stable Keeps the internal ambience. It is impossible without Reception, transformations, keeping, and using unceasing flow to information. Possible with confidence to confirm that in alive hutch and even in its element functions the full- fledged information system. This follows to take into account when are measured parameters of the condition biological object. The Sensors must be an interface between biological object and measuring system. We offer variant of the features of such interface.

Elaboration of the urofloumetric curve model.

Andrew Smuglin (St. Petersburg, Russia).

The article is devoted to the urology direction in medicine, and to the urodinamic research data processing in particular. The task of application of the existing algorithms of statistic analysis to the urofloumetric signals model construction is raised. These are the first step in program complex elaboration for the express diagnostic problem solving.

Joint medelling of software and hardware for built- in real- time systems.

Konstantin Okunev (St. Petersburg , Russia).

This work aims at developing a uniform approach in description of software and hardware. The author investigates the structure of the software and possibility of its designing from standard components and analyses the possibility of software development automation. Models and facilities for building of exportable projects for built- in real-time systems are presented in the paper.

A methodology for solving problems of Interdependent operative enterprise scheduling during design of corporate information systems of EPR standard.

Sergey Popov.(St. Petersburg, Russia).

Perspectives of turbo coding in communication systems.

Alexander Smorodinov. (St. Petersburg, Russia)

Principles of building performance and decoding methods of turbo codes are considered. As a new result of practical application of turbo coding the performance of 8-ary MFSK for noncoherent demodulation and binary turbo coding is presented. Implementation of turbo code with two same binary constituent recursive systematic convolutional codes of memory 5 and 1024 block size of pseudorandom interleaver results in achieving more than 4dB coding gain for BER 10-5. Results of computer simulation are given for SOVA and Max-log-BCJR algorithm implemented in interactive turbo decoder.

Development tools for automatic control system.

German Kuzmin. (St. Petersburg, Russia).

The engineering of any automatic control system consist of the following stages: the system analysis and development of algorithms, functional and structural engineering, programs development, coding and debugging of the programs. Majority of tool software allow automating only last development cycle of automatic control system. This work offer necessary tool software, permitting to execute all development cycles.

For organization of the control algorithms development and system analysis the use of the intellectual system based on definition of a format system on basic data about data domain and solution of delivered problems with the obtained theorems is offered.

Decision-making by means of Excel packet.

Elena Zinenko. (St. Petersburg , Russia).

Decision- making is a very important function of management. The author offers a new program product based on the decision- making in inventory management and realized by means of Excel. There is an example of program application for the trading firm sailing the Opel spares.

Description and research of economic process in the business conflict situations by mean of Excel table.

Natalia Timoshkova. (St. Petersburg, Russia).

The work is devoted to the game theory methods. The author suggests to solve the conflict situation which don’t have the decision in pure strategies with the help of Excel.

The law regulation of biology, medicine technologies: the problems and future.

Anastasiya Nikitina. (St. Petersburg , Russia).

The scientific advances in the sphere of biology, medicine in the last century have changed our life completely. The cost of all these advances need in special discussion. The author is trying to make the government to pay the attention to the problem of the law regulating in the sphere of medicine.

The law regulation in sphere of sea trade.

Anton Georga-Kopulos. (St. Petersburg, Russia).

In 1999 a new Law, regulating sea trade was adopted in Russian Federation. The author try to discuss some items of this Law.

The 8th District 12 Students Conference
Poland Section

Nonparametric techniques: Parzen - windows estimator

Sebastian Budzan
sebabudz@zeus.polsl.gliwice.pl
Silesian University of Technology, Gliwice, Poland

Introduction

Nonparametric techniques do not assume a particular form of density function but usually estimate one. The Parzen - window classifier is a popular nonparametric approach becauseits excellent performance and firm theoretical foundation. The Parzen - windows approach can require significant computational resources in terms of processing time and storage.

Use:

1. Measurement systems.
2. Image processing
   a) Median filtering,
   b) Clustering,
   c) Segmentation.

The Parzen classifier

The Parzen estimator is a kernel density estimator, in which a density function is aproximated by the superposition of a set of kernels. Popular choice is the use of the Gaussian kernel.

$$\hat{p}_m(x,s) = \frac{1}{m}\sum_{1}^{m}\frac{1}{\left(s\sqrt{2\pi}\right)^d}\exp\left(-\frac{\left\|x-\xi_i\right\|^2}{2s^2}\right) \qquad (1)$$

Here the m. Samples of the training set in the d-dimensional feature space are denoted by xi

iO(1,m.). The problem with a Parzen density estimator is how the parameter s should be chosen. In a classification context, a general observation can be made on the consequences of the two extremes s®0 and s®µ, if s®0 the decision function is essentialy equal to the decision function of the 1-nearest neighbour classifier. This is generally a rather complex decision surface that is sensitive to the noise in the data. For s®µ, the resulting decision function converges to the decision surface if the nearest mean (or minimum distance) classifier. This decision function is by definition a linear surface, which is hardly influenced by noise or outliers in the data.

The Problem of choosing an appropiate value of s has been investigated by many researchers. Under various assumption several authors have obtained results (Fukanaga, Duin, Devroye). Duin's method is based on the observation that Eq(1) can be considered as a specific

parametric form of the density function p(x,s), of which the parameter s is unknown. Using a maximum likelihood principle,:

$$s = \sqrt{\frac{1}{dm}\sum_{j=1}^{m}\left\|\xi_j^* - \xi_j\right\|^2}$$

Where: x*j represents the nearest neigbour of the sample xj

See figure (1).

Figure (1)

Parzen - windows estimator algoritm (in median filtering):

1. Calculate Parzen estimator using eq(1) with all pixels in mask : p1
2. Remove central pixel (in mask)
3. Calculate Parzen estimator using eq(1) without central pixel : p2(i)
4. New value of central pixel is obtained by difference p2(i) - p1. Difference must be minimal, where p2(i) > p1

Example 1 - Image processing

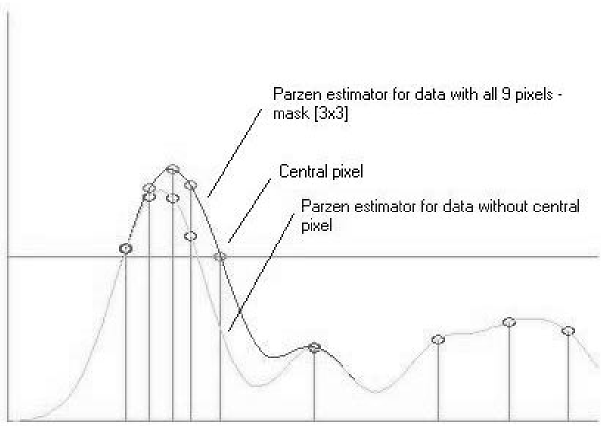


Figure (2)

In Figure (2) you can see that new value of the central pixel is value pixel no 1.

Why? Because for pixel no 1. equation p2(i) - p1 is minimum.

Example 2 : Measurement systems

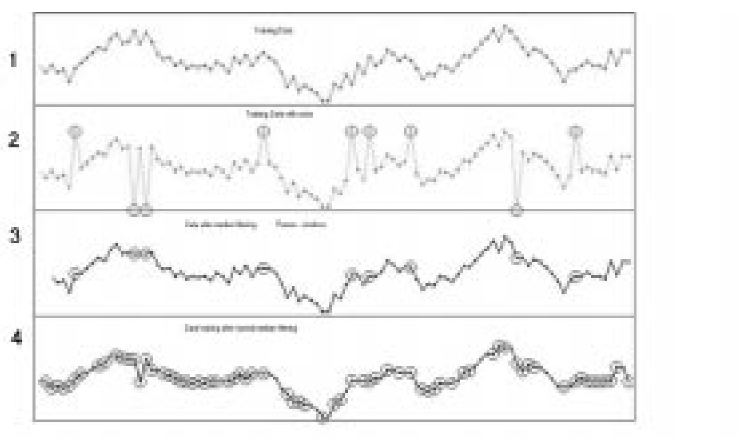


Figure (3)

1 - training data,
2 - Data with noise - here is impulse noise 10%,
3 - Data after median filtering with Parzen-windows algoritm.
4 - Data after "normal" median filtering.

Here you can see, that median filtering Parzen-windows algoritm is better than "normal" median filtering - 90 % data (3) is the same like training data (1)!!!

Italian Section

Active bait with IPMC

R. Castorina,G. Dongola, T. Gagliano, R. LaRuna
Electric, Electronic and Systemistic Department
University of Catania

Extended abstracts

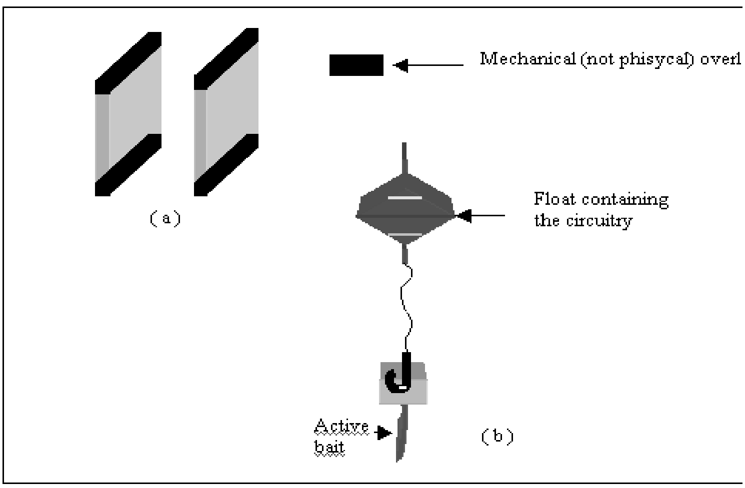
This work presents an application of the IPMCs (Ionic Polymer-Metal Composites), which belong to the class of EAP (Electro-Active Polymers).

The purpose is to achieve an artificial active bait which have to emulate a worm's motion by an electric activation signal.

To this aim IPMCs have been chosen because of their good performances in humid environment, moreover they are valid motion actuators and they need low power supply to operate.

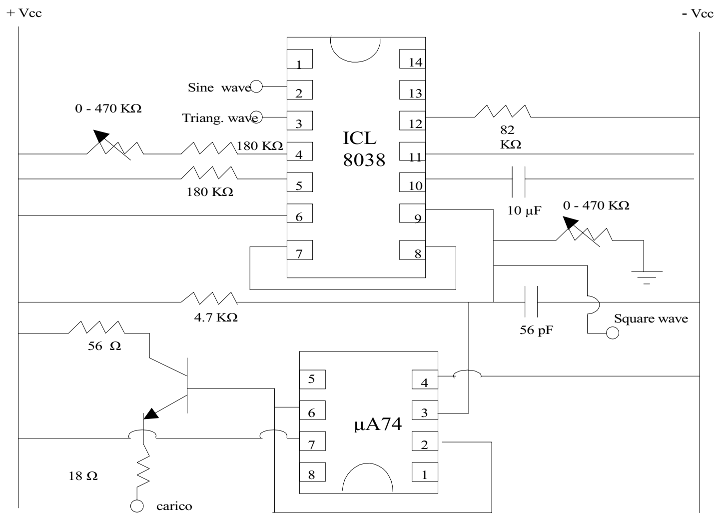
Strips of these composites can undergo large bending displacement if an electric field is imposed across their thickness. The IPMC used always bend toward the anode.

The bait has been made of two IPMC actuators connected as in FIG.1 and activated separately.



To generate the waveforms (sine, square, triangular) which have to make the bait move, a circuit has been designed and implemented. This circuit has been placed in a float linked with the bait.

The activation signals have been achieved with the use of the ICL8038 integreted circuit. After different tests on the membrane, the square waveform has been chosen. In order to obtain a clear square waveform on the IPMC, to avoid the load capacitive effect caused by the polymer, the current has been amplified. A mA741 op-amp has been used as a buffer linked to the output of the ICL8038 followed by a NPN medium power transistor 2N1711 opportunely biased (FIG.2).



Characteristic of this circuit is to work at very low frequency as required by the IPMC material for its usual working mode.

A mechanical structure has been developed to electrically contact the IPMC, because this material is perfectly anti-adherent. Plexiglas has been used with copper layers and solded wires to form the external contacts as shown in FIG.3.

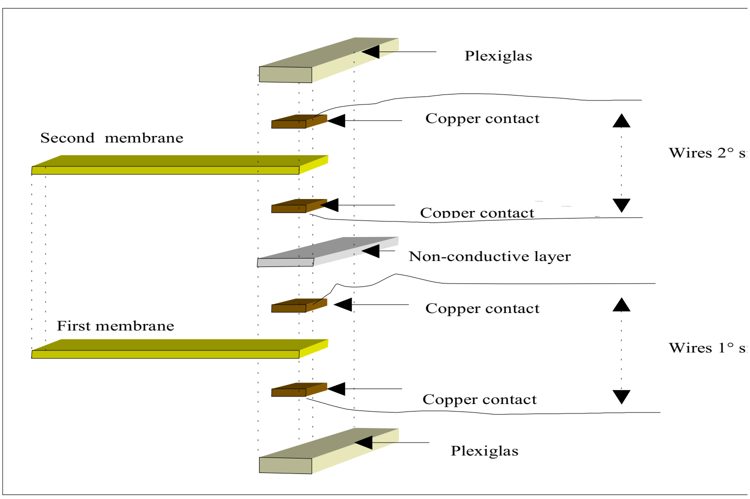
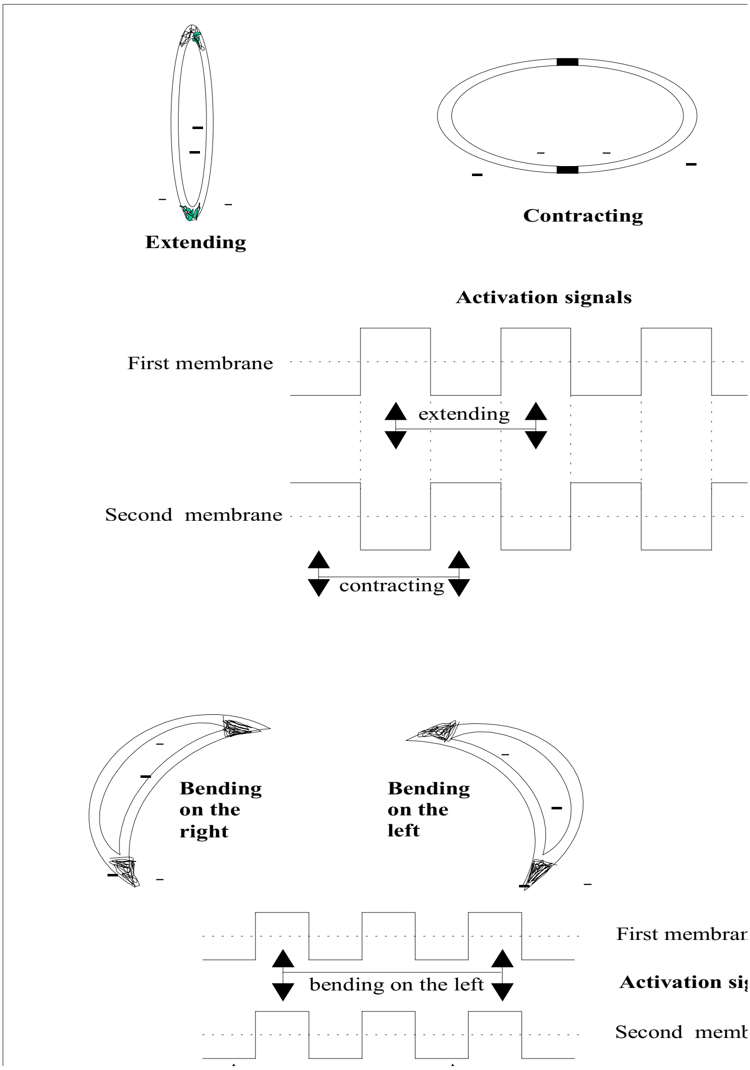


FIG. 3

Since the IPMCs have to be connected from both sides, to electrically isolate the two contacts a non conductive material has been interposed. To obtain the four possible movements (extending, contracting, bending left and right) the two IPMCs have been activated with two equal square waveforms with different phases as follow: the extending movement occurs when the shift is 180° and the anodes are external; the contracting movement when the shift is 180° and the anodes are internal; the bending movements when the shift is 0°. These four cases are shown in FIG.4.



Conclusions

An active bait has been designed and implemented in both mechanical and electrical parts.

Good results have been obtained.

References

(1) P.Arena, C.Bonomo, L.Fortuna, M.Frasca "Electro-Active Polymers as CNN actuators for locomotion control", Proceeding of ISCAS 2002 (Accepted).

(2) M.Shahinpoor,Y.Bar-Cohen, J.O.Simpson & J.Smith "Ionic Polymer-Metal Composites as Biomimetic Sensors , Actuators & Artificial Muscles.A Review", Int.J. Smart Materials & Structures,Vol.7,1998.

A New Walking Piezoelectric Autonomous Microrobot

Antonino Arcieri, Davide Bruno
DEES Universita degli Studi di Catania, CATANIA, Italy

Extended abstract

We present a new piezoelectric autonomous microrobot, which is an evolution of the piezoelectric walking PLIF microrobots developed at the University of Catania. The system adopts piezoelectric actuators as legs: two active legs moving and one passive leg as a support. Each leg has two degrees of freedom, as is shown in figure 1; it is constituted by two separate elements glued together; the top element moves up and down, while the bottom element moves front and back. The motion of the robot is then realised moving with a particular sequence at a given frequency each element of the two legs.

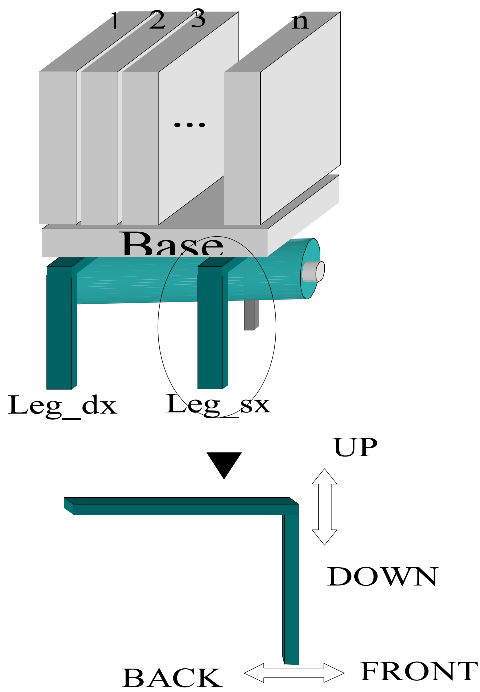


Figure 1: Schema of the new autonomous PLIF

The system has been divided in several layers each one including the circuitry needed to implement a functional unit of the system. The layers are mechanically connected by using the same connectors used as a bus to supply energy and to exchange data with the other layers. The layers are connected on a base where also the legs are linked. The adoption of modularity both in the electronics and in the mechanics, was a mandatory requirement to experiment new solutions in these small structures. In this way it was possible to test the different modules individually and to compare several leg configurations, various sensors, power units without building each time a totally new microrobot.

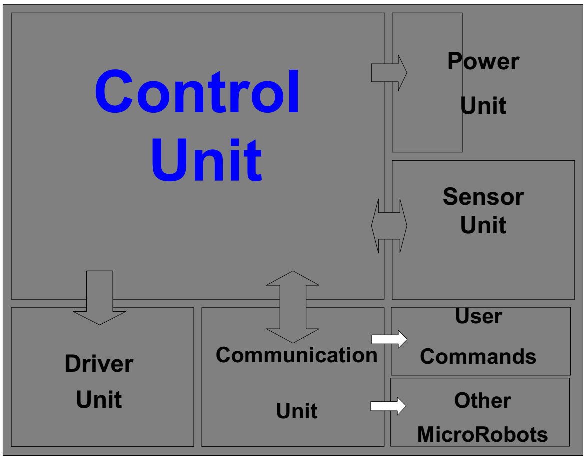


Figure 2: Block diagram of the new architecture

In this new version of the microrobots all the electronic controls have been integrated inside the device by using a microcontroller. In this way the system is capable to define its trajectories also by using several sensors as infrared proximity sensors and a compass. Moreover each robot can exchange data with other microrobots, thus allowing the implementation of collective behaviour strategies. The other important modification is related with the design of a new power supply system that allows the system to adopt a small battery as energy source. Modularity of the system is a priority for this mcro-robot design. This approach is imposed by the complexity to have a system completely autonomous in a very small volume. We have five units 1) Control Unit, 2) Power Unit, 3) Driver Unit, 4) Sensor Unit and 5) Communication Unit.

- Control Unit: consists of a flash microcontroller PIC16F876 (made by Microchip) that can be programmed directly on board. It communicates by using a custom designed serial protocol with another smaller flash microcontroller PIC16F84A (made by Microchip) used as runtime programmable digital I/O port. The CPU controls also the step-up stage in the Power Unit.

- Power Unit: consists of a step-up stage controlled by the Control Unit with a 90 KHz wave square. This stage converts the 12VDC of the battery to 200VDC with a leakage current of about 20mA when the stage is enabled by the control signal and a null current when it is disabled.

- Driver Unit: used to move the piezoelectric actuators, consists of four differential stage one for each actuator. Each differential stage is realised by using two opto-isolated transistors with a Vcemax =300 Volt, the signals to control this stage are supplied by the microcontroller used as runtime programmable digitalI/Oport.

- Sensor Unit: allows measuring the state of the system during its motion. It includes an electronic compass to know the relative orientation and an infrared proximity sensor to avoid the obstacles in the working area.

- Communication Unit: this unit consists of two infrared stages, one to receive and one to transmit the data. In this way an exchange of information between other microrobots in the working area or with a PC that could act as user interface or as supervisor, is possible.

Two different autonomous prototypes have been implemented. The first one, shown in Fig. 3, was built just to proof that the integration of the control unit and the power unit was possible. So no sensors unit and communication units were included. The dimensions were 2.5cm X 2.5 cm X 3 cm height. The system was pre-programmed to perform a given sequence of steps without any external feedback. This microrobot was able to walk autonomously with a maximum linear velocity of about 1cm/s and a rotational velocity of 10°/s. With a standard cheap LR23 12V alkaline battery the power autonomy was of more than 1 hour. In the second implementation, shown in Fig. 4, also the communication units and the sensor units were included. In this way all the parameters of the system can be programmed on-line by using the infrared communications. The dimensions were 2.5cm X 2.5 cm X 5 cm height. Similar performance of the previous systems in terms of speed and autonomy were obtained. The compass allows to know the orientation of the system with a precision of 9°, that is considered sufficient to allow large movements. The proximity sensor installed in front of the microrobot detect the presence of an obstacle at a distance lower than 3cm.

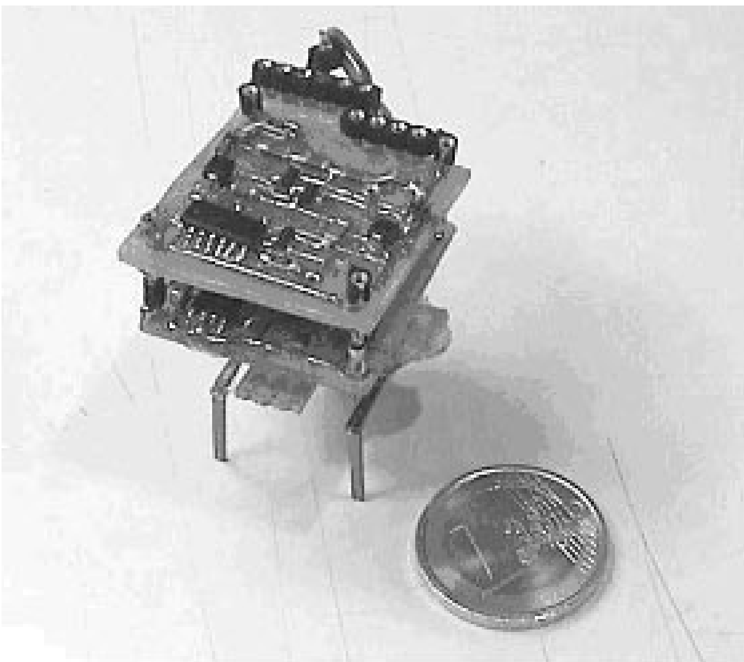


Figure 3: The first Autonomous PLIF built in comparison wit a 1€ coin

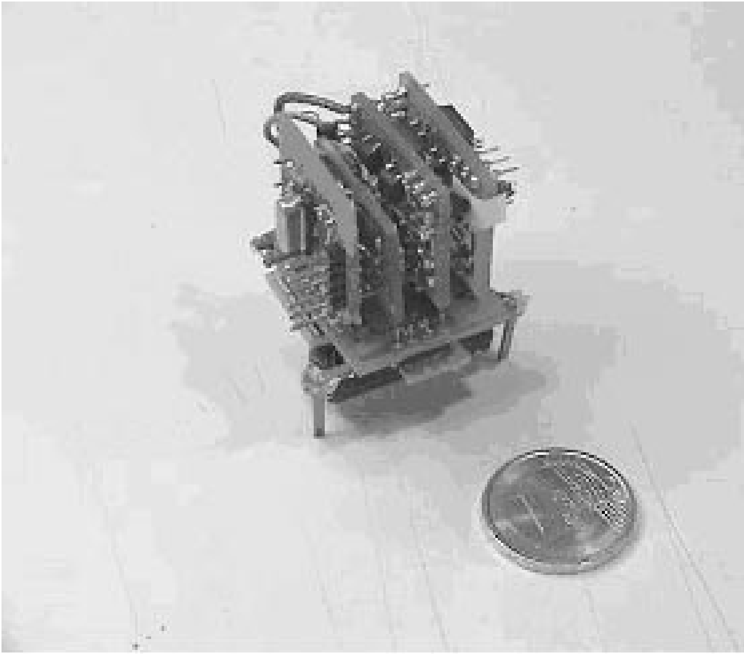


Figure 4: The second Autonomous PLIF built in comparison wit a 1€ coin

A modular platform for a CAN network

Giacomo Spampinato, Scibilia Fabio
Dipartment of Informatic and Telecommunications Engineering
University of Catania

Extended abstract.

The aim of this project is the development of a modular platform for analysing and testing the features of a CAN network.

The main features of the project are :

Modularity: Always a new Can node can be add to the network without changing anything in the system.

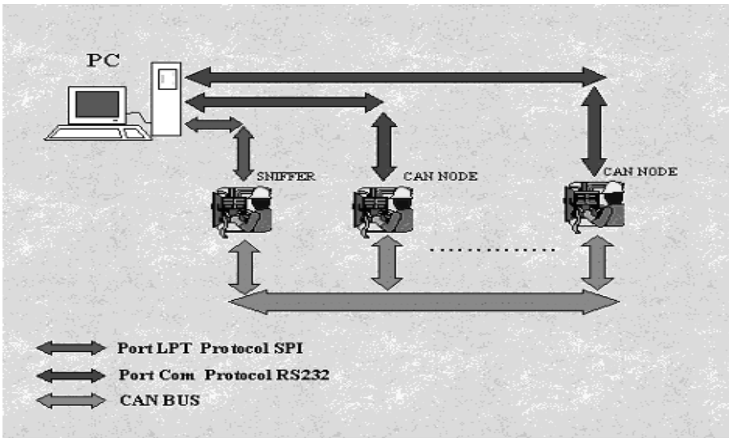
Configurability: Each of Can node can be configured off-line and then all configuration parameters become active only by pushing a proper reset button. Moreover configuratinon parameters are saved on EEPROM so it is not necessary to reconfigure each Can node after the system turns on.

Monitoring: There is e special hardware board named "Sniffer" that is connected to PC and provides monitoring services about status on each Can nodes.

Low cost: All part of this project was realized self made, using economic chip avalable on market,

so the total amount of each Can node is about 25$.

The structure of the system is represented as a block scheme in the following figure:



The structure of the project consists of both hardware and software realization:

The hardware structure:

The hardware realization is based on three foundamenteal chip:
PIC16F876: it is an 8 bit micricontroller made by Microchip, that allow Can node to acts a lot of different operations.
MCP2510: it is an 8 bit chip made by Microchip tha implements Can data link. In order to comunicates with this chip it's necessary to implements SPI protocol.

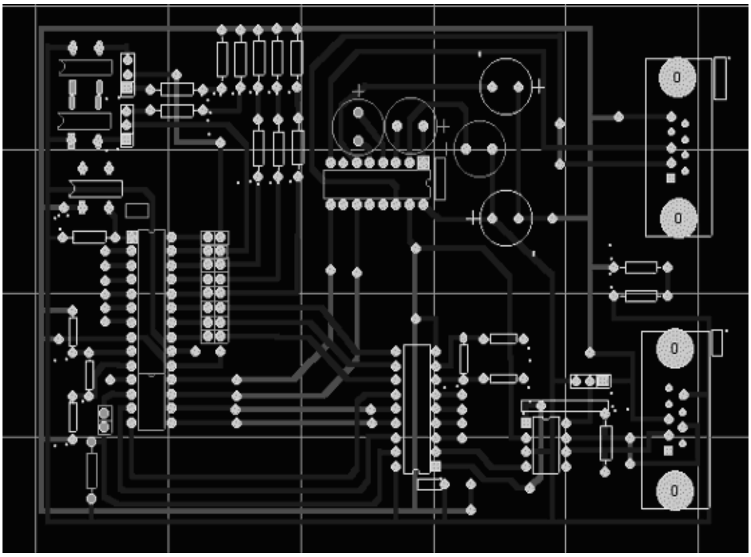
UC5350: it is a Texas Instrument chip that implements Can transceiver.

Moreover the hardware structure consists of two different type of hardware cards:

Sniffer card: It is a particular kind of Can node that is connected to both PC and Can bus, provides monitoring services and allow operator to interface with the whole Can network. Through this card is possible to send a Can frame to the bus and simultaneously to listen and capture possible Can frame from the bus; So it is possible send both command and interrogations to each Can node.

Node Card: It is a general purpose programmable Can node that allow user to design different type of regulation loop for control of sensors and actuators through the Can bus. On each Can node is placed the PIC16F876 microcontroller which implements regulation loops and the comunication with Can bus through the MCP2510 chip.
Moreover microcontroller PIC16F876 stores all the cofiguration parameters on his internal EEPROM.

To design and realize electrical schematic of Node card and Sniffer card we have used the utility Protel 99 SE. This Cad allow users to design layouts and schematic of electric circuits which contain standard components.
The following figure show electrical layouts of Can node:



The blu lines rappresent the bottom layer;
The red lines rappresent th top layer;

SPI bus: the SPI bus is used to implement the comunication with MCP2510, so this kind of comunication protocol is present on all hardware board.

On the sniffer card the Spi bus is used to interface the PC (in which is placed all the monitoring and management software) with the Can bus.

Spi bus is placed on each Can node in order to implement comunication betwen PIC16F876 and MCP2510 chip.

RS232 bus: Each Can node implements comunication with the PC by RS232 protocol in order to allow operator configuring and testing the status of each Can node separately.

The software structure:

In this project are present two different type of software:

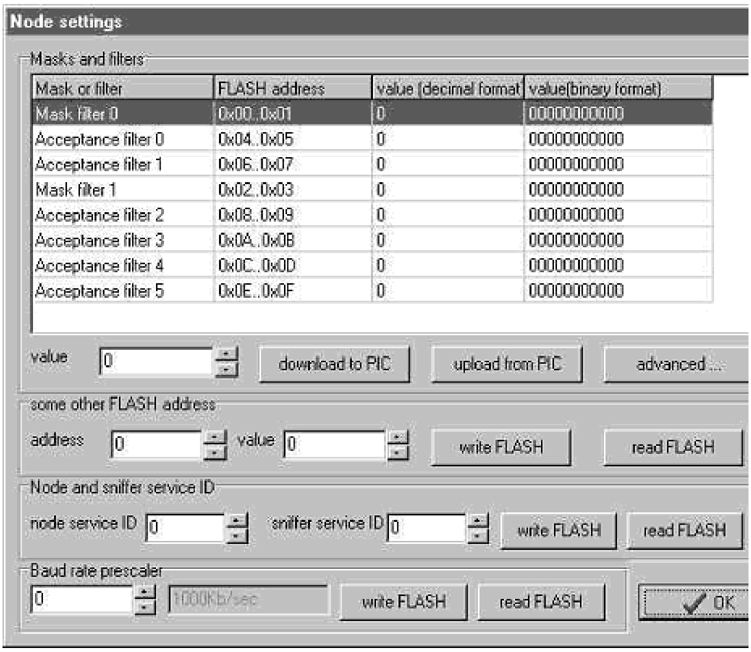
Assembly software: Software developed in assembly to program the PIC16F876 microcontroller that provides all the functionalities of each Can node.

In particular this program allows operator to configure and monitor the Can node through a serial connestion with the PC; Moreover it develops the proper functionalities of the Can node.

Canmania 1.0: Software devoloped in C++ Builder that is installed in the PC and implements all services to interact with Can bus.

The main services of this software are:

Sniffer and Can node configuration : Through proper settings windows it is possible to configure each Can node (included sniffer card) with all configuration parameters like filters, Masks, baud rate prescaler etc.



Stimulation and sniffing: there is a particular table that contains in two different parts all frames to send in the bus and all frames received from the bus; All this structure evolvs and changes his values with time passing; Each frame sent to the bus or captured from the bus appears into the tables with his timestamp reference.

Monitoring: In order to monitor Can node status it is implemented a paticular kind of frame called "service frame"; this frame contains tha address of the Can node selected for testing status, and the address of a particular register the operator wants to test. Only the Can node asked maches the NodeID in the Service frame with his NodeID filter, and responds with a "service answer";

A service answer is sent to sniffer node and contains not only the value of the requested register, but also the values of other seven status registers of the MCP2510 chip for diagnostic purpose.

References:
In order to keep more informations:
Visit www.microchip.com , www.it.com for datasheets and details about components.

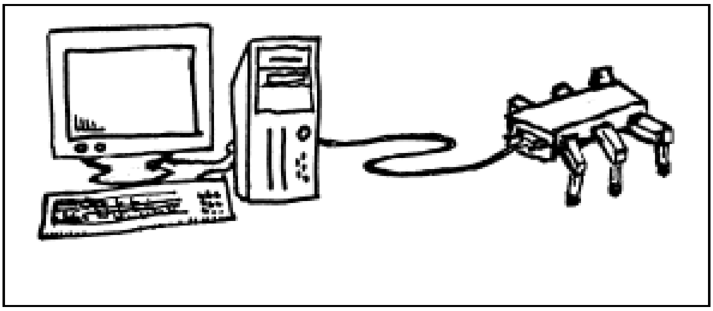
CNNLab: A framework for the control of a bio-inspired hexapod robot

Authors : M. Calabresi, F. Ciancitto, P. Sardo, L. Zagarella.
Tutor: Professor L.Fortuna

Abstract

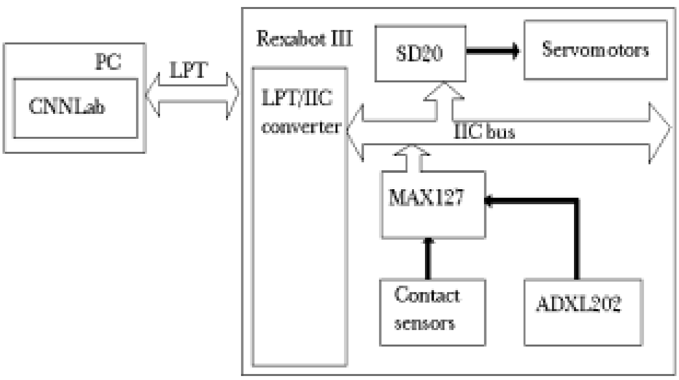
It has been realized a robotic system that mimics the locomotive behaviour of a biological stick insect by using a neural approach. In the previously realized models of hexapod (Rexabot I and II) a Cellular Neural Network (CNN) is used to coordinate the movement of each joint: the dynamic of the system is determined by the number of cells

composing the network and by their connectionism. Up to now the implementation of this network was made with analogical circuitry. This kind of approach exploits the advantages of the connectionism and of the parallelism of the



CNNs and represents a low-cost solution for the joint control and synchronization problems. Unfortunately the lack of versatility and of flexibility of this approach emerges when new solutions, requiring more sophisticated control schemes, are searched.

As an alternative to the preceding models, a new approach consisting of a framework to control a bio-inspired hexapod robot has been used to reach the purpose of creating a useful prototype to experiment different locomotion patterns and more complex types of control: in fact the dynamic of the network is solved by a computer program we designed (CNNLab) that allows, as the main feature, the creation of custom networks (i.e. networks in which there are no limitations for the number of cells to be used and for their connectionism). This program is not only able to simulate the behaviour of a CNN to generate the proper control signals for the locomotion of the robot but also could take into account the information coming up from the sensors, mounted on the robot, as to create an adaptative control (feature that could give many advantages for the locomotion on rough terrain). The hardware part of this project consists of 18 electric servomotors (3 for each leg) of different dimensions climbed on an aluminium frame, an ADXL202 gravity sensor (for the attitude control), 6 optomechanical contact sensors (one for each leg) realized ad hoc for this application an three electric boards: a board containing the SD20 (a pre-programmed PIC working on the I2C bus able to generate the PWM signals to contro



l each of the servomotors), a board containing an A/D converter (MAX127) also working on the I2C bus and an interface board which connects the I2C bus with the parallel port (LPT) of a normal PC.

This framework was made in the attempt of creating a useful environment to implement and test many different kinds of control taking advantage of the flexibility of a computer based approach in order to find new solutions for the bio-inspired robot locomotion problems.

Sim3D A Software for Robotics Simulation

Fargetta Marco, Fisicaro Deborah,
Guarnaccia Liberina, Mazzurco Letizia
University of Catania
DEES-Faculty of Engineering

Extended Abstract

The proposed software is a new tool for robotic simulation, useful to test robot's behaviour on a specific environment.

Thanks to a 3D graphic tool, Sim3D allows to see robot movements during its trajectory into a scenary that user can set. Moreover, it shows some dynamic and kinematic parameters.

SIM3D is used to simulate the dynamic behaviour of a 2 link manipulator installed on a mobile structure with six wheels.

The robot's dimension are fixed but the user can set robot's path by definition of a set of parameters such as: ground's dimension, start and final point, position and dimension of the obstacle, position of object to manipulate, fixed point on which robot must go on.

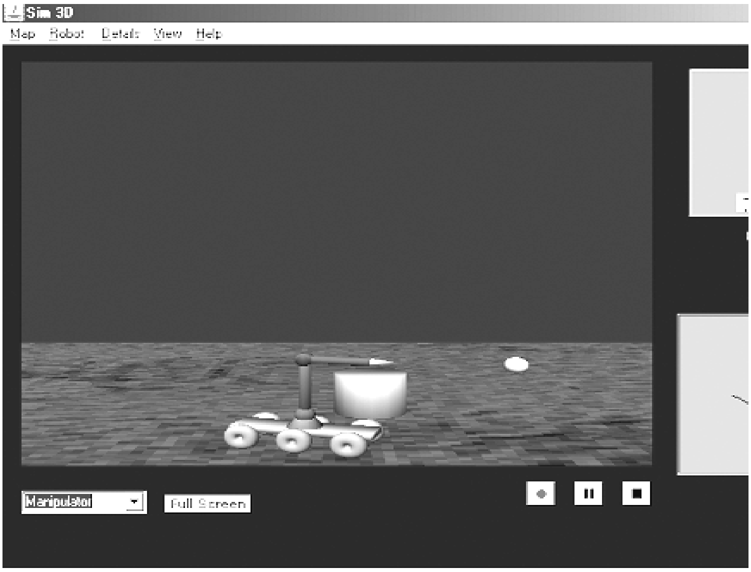
Two different method are being implemented to generate the best trajectory of mobile structure, "Radial potential algorithm" and "Circular potential algorithm"; both identify the target as a field generator with uniform potential that attract the robot, while the obstacles are considered as a generator of forces (proportional to inverse of distance's square) that reject robot.

These forces have a radial configuration for the former method, a perpendicular configuration for the second method.

To build manipulator's trajectory polynomial curve are used.

Sim3D can be used to control the value of position, speed, acceleration and torque for each manipulator's joint, during its trajectory; therefore the user can modify in real time, some features of the considered path, such as obstacles or goal, or any other robot parameter.

For these reasons, Sim3D can be suitable used to design an interface with a real robot.



A tool for the characterisation of Piezoelectric devices

Valeria Caputo, Martina Giuffrida, Davide Stracquadaini
DEES: University of Catania

Introduction.

Piezoelectric materials make possible to realise compact, light and cheap sensors and actuators.

Small dimensions may condition the sensors and actuators performance dealing with frequency response and linearity. Furthermore when the signal input is high (in particular, mechanical stress for sensors and high voltage for actuators), hysteresis phenomenon can be observed.

When the devices have to be precise and the input signal varies within a wide range, the hysteresis phenomenon cannot be neglected. This paper shows a measurement system able to find the hysteresis curves of a bimorphic piezoelectric actuator.

The measurement system.

The capacitive sensor is made up of two capacitors with on plate in common, which is fixed to the extremity of the piezoelectric bar. When the piezoelectric bar deflects, the area of one of the two capacities (for example Cx1) grows up, while the area of the other one (Cx2) decreases.

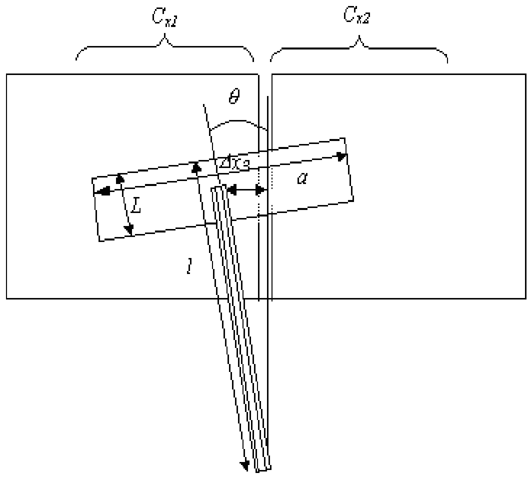


Figure 1. Differential capacitive sensor.

Figure 1 shows the capacitive sensor. The variation of the two capacities Cx1 and Cx2 can be related with q and Dx3.

The difference between the capacities is approximately:

$$C_{x1} - C_{x2} = \frac{2\varepsilon L}{d} \cdot \Delta x_3 \qquad (2.1)$$

The sensing circuit shown in Figure 2 converts this difference into the output voltage V0.

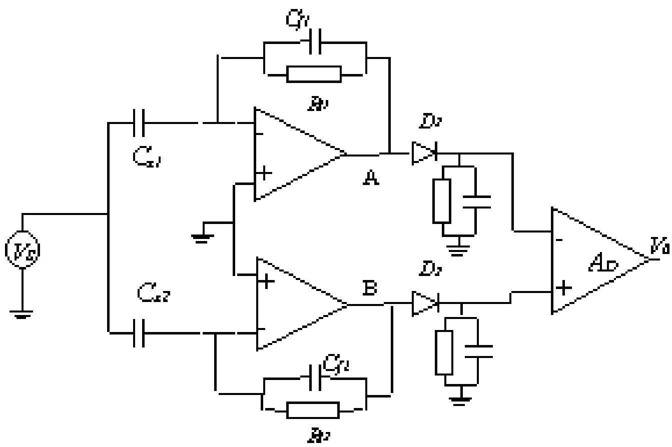


Figure 2. Sensing circuit.

If AD is the gain of the instrumentation amplifier, the relation between the difference

DC and the output voltage is:

$$V_0 = \frac{\Delta C}{C_f} \cdot A_D \cdot V_s \qquad (2.2)$$

The input signal Vs is sinusoidal with a frequency of 100kHz and in the circuit RD=18kW and CD=100nF.

The scheme of the measurement system is shown in Figure 3:

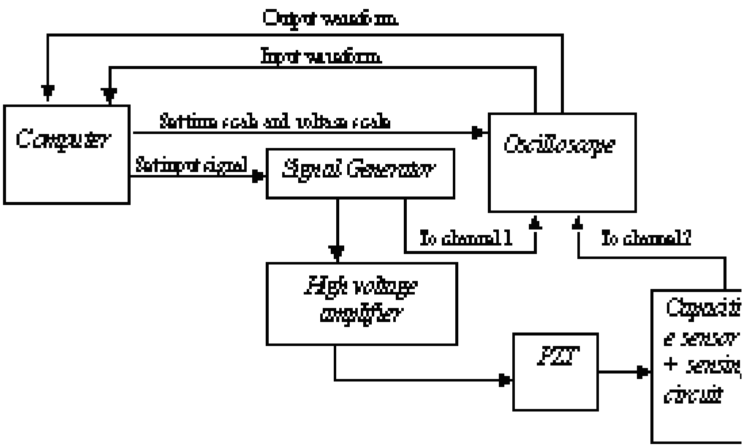


Figure 3. Scheme of the measurement system

Thanks to a software instrument realised with LabViewв it is possible to make the measurement automatic; the function "Acquire" starts the cycle.

Figure 4 shows the LabViewв panel for data acquisition.

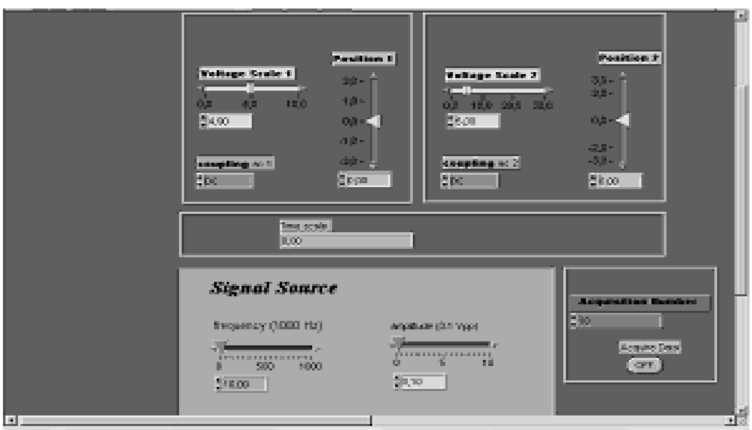


Figure 4. Labview panel for data acquisition

The signal present in the two electrodes of the piezoelectric bar and the one that represents the deformation of the bar are mediated and stored in two files. These data can be visualised with another LabViewв software instrument, which panel is shown in Figure 5.

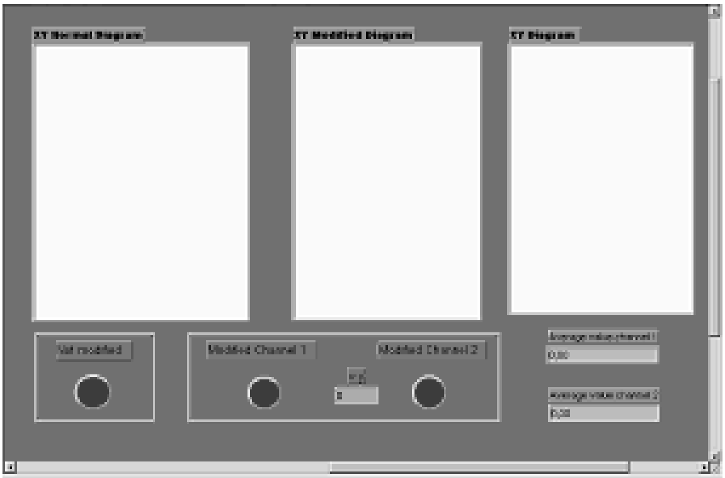


Figure 5 Labview panel of the [illegible] software

The first diagram is relative to the two waveforms in the XY space; in the second diagram the waveforms have been phased, while the third diagram is obtained subtracting the mean value to each signal.

3. Hysteresis diagrams.

The input signals are sinusoidal with variable frequency and amplitude.

Figure 6 and Figure 7 show the obtained results.

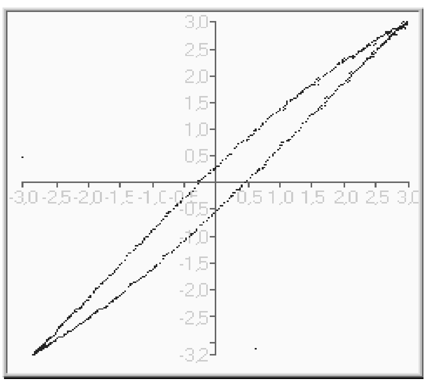


Figure 6. Hysteresis diagram. Frequency=2Hz, Amplitude=450V

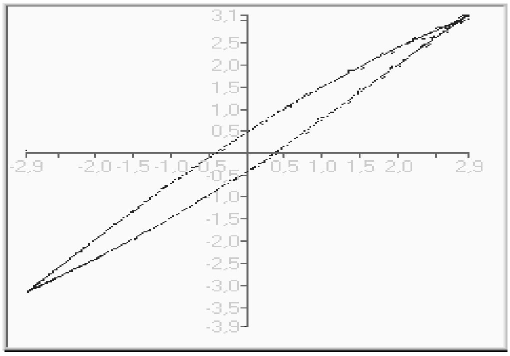


Figure 7. Hysteresis diagram. Frequency=10Hz, Amplitude=450V

4. References

- Raman Pallas, John G. Webstar, "Sensor and Signal Conditioning". Ed. John Wiley & Sons.

- Kouji Mochizuki, Kenzo Watanabe, Takashi Masuda, "A High Accuracy High Speed Signal Processing Circuit of differential Capacitance Trasducer. IEEE Trans. Instrum. Meas. Vol 47 No 5 October 1998.

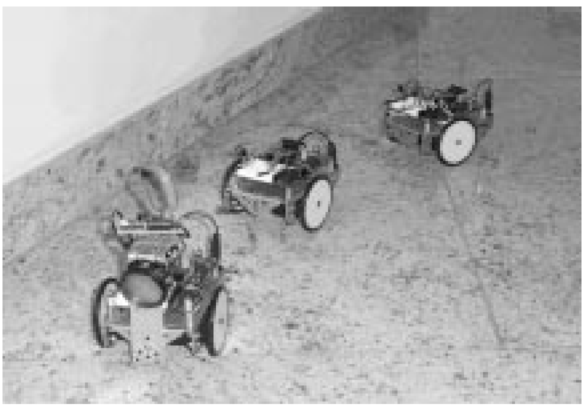
- Joost C. Lotters, Wouter Olthuis, Peter H. Veltink, "A sensitive Differential Capacitance to Voltage Converter for Sensor Application" IEEE Trans. Instrum. Meas. Vol. IM-36, No 4, December 1997

- N.N. Rogacheva, Chang Chen Chou, Schuo Hung Chang, "Elettromechanical Analisys of a Simmetric Piezoelettric/Elastic Laminate Structure: Theory and Experiment. IEEE Trans. On Ultrasonic, ferroelectrics and frequency control, Vol. 45 No 2, March 1998.

Vehicle Chain

Attanasio Rosario, Centorbi Gaetano, Greco Andrea, Macina Gennaro, Mascolo Sebastiano.

Universita degli studi di Catania, Facolta di Ingegneria, D.E.E.S.



Extended Abstract

The object of this paper is to show how a Boe-Bot robot can be used as a faithful

follower. In particular we managed three robots to obtain a vehicular chain using different sensors.

The first robot, called "leader vehicle", is able to detect an obstacle by means of an ultrasonic sensor. The second and the third one have to follow the leader thanks to infrared sensors, maintaining a fixed distance.

An 8-bit microprocessor type Pic 16c57, programmed in PBASIC language, controls everyone.

The ultrasonic sensor works with a different power supply because during the transmission signal it needs two amperes of current. This sensor operates with a transducer that works both by speaker and reciver. The signal, reflected by an obstacle, returns to the transducer and then the microcontroller processes it. The time between the transmission of the signal and the return of the reflected wave is proportional to the distance.

The IR sensors, installed on the shadow vehicles, send a signal between 37.5 and 41.5 kHz in order to detect the previous vehicle at different distances. The maximum of sensitivity is at 38.5 kHz corresponding to a distance of 35 cm (fig. 1).

IR detectors on board detect the signal, reflected by an object.

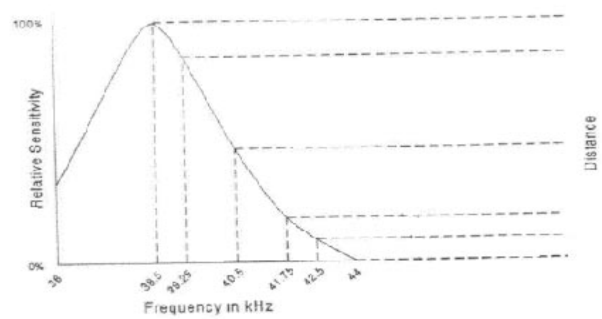


fig1

A speed control of the two servos was used to make the follower robots able to mantein a fixed distance from each other as shown in fig.2.

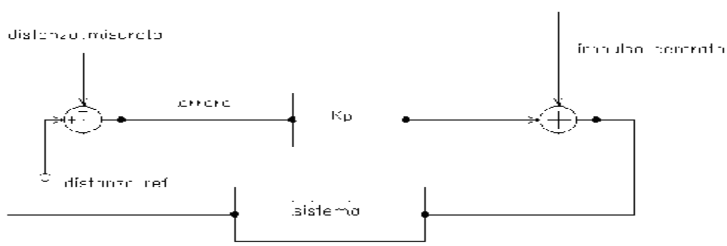


fig2

The error value is obtained as difference between the set point distance and the measuered distance multiplied by Kp. The result is used to adjust the pulse widths sent to the servos.

References
-Parallax Basic Stamp Manual.
Parallax Robotics Student Workbook.

Emulation of a Job Scheduler for a Flow Shop Manufacturing System

Carmelo Floridia
March 25, 2002
University of Catania, Faculty of Engineering
Department of Computer Science and Telecommunications Engineering

Abstract

The present project is an example of application of the computer science in the industrial automation.

The project consists in two parts: an hardware and a software part.

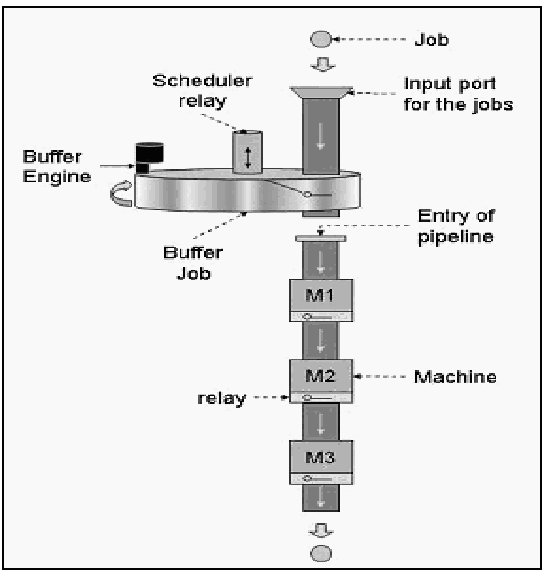
The hardware part is an emulation of a plant of a hypotetic manifacturing factory, in which there are a pipeline with three machines (fig 1).

The software part consist in some programs that do the control and the monitoring of the plant.

The plant have an input port and by this the jobs are forwarded to be processed. The jobs don't go directly in to the pipeline, but they wait in a buffer (fig. 2). The buffer can hold at most 20 jobs. When the buffer contain some job, it is possible to begin the work. The start can be triggered by a local switch or by a program that run in a remote PC (Personal Computer). After the start a sheduler get the jobs from the buffer and forwards theirs in the pipeline.

The forwarding can be made in two way: FIFO (First In First Out) and Minimizing Makespan. The Makespan is defined as the difference between the time in wich the last job exit from the pipeline and the time in wich the first job go in the pipeline. Because the buffer is circular and can rotate in two directions, the search of the next job is made through the shortest path. Every machine is rapresented by a relay that hold a job for a programmable number of

Figure 1. Plant



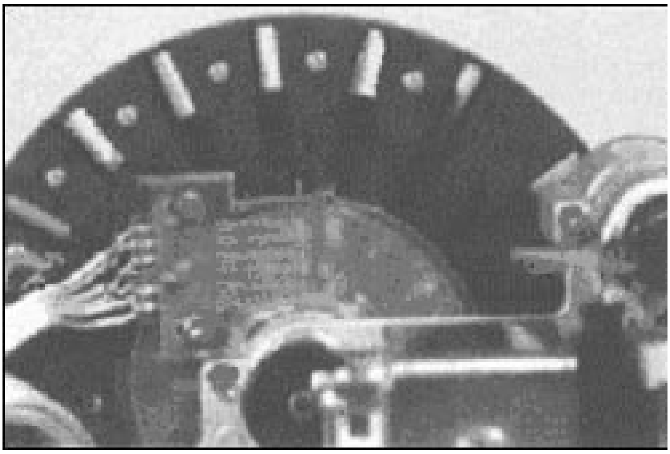


Figure 2. Buffer Jobs.

seconds, and the jobs are rapresented by metallic coins. The coins go from a machine to another by a vertical fall.

The processing system implemented is a Flow Shop, which main features are:

- all jobs pass through all the machine in the same order;
- there is not passing between jobs;
- there is no preemption;
- every machine can get just one job at a time;
- a machine process a job for a known time and the time can different between jobs.

If a machine Mx finish to processing a job but the next machine My is busy by another job yet, the processed job cannot pass to the machine My, and the machine Mx cannot receives another job. In this scenario become critical the jobs forward order.

The control of all activities of the plant is made by a PLC, a Fieldbus and a SCADA.

The PLC (Pragramable Logic Controller) is a particular computer used for realtime application. It can be programmed by several specific language. I have used the Ladder language, which is described in the IEC 61131-3 standard. The PLC have some input and output ports. The input signals are used to raise, through the sensors, some extern event. The output signals are function of the input signals and are used to make some action in the plant through the actuators. An example of input signal of my plant is the signal that shows an incoming job in the buffer. An output signal is the signal that is send to the relay of the buffer to release a job that must be processed.

The PLC is connected, through the Profibus DP fieldbus , to two modules of input-output and to a PC (fig 3).

In the PC is installed an Applicom Card for the transfer control of the data through the Profibus. By programming the Aplicom Card it is possible to make a cyclic transfer like as I/O Module ® Applicom Card ® PLC or PLC ® Aplicom Card ® I/O Module. The signals that concern the buffer are handled directly by the PLC. The Machines, instead, are connected to the I/O Modules. When the PLC want to send some signal to the machine, do it by the Profibus and the Applicom Card.

The PLC code to the machine control is implemented as three threads. They run in pseudoparallelism (the PLC have one processor only) and are syncronized by global variable.

The development tool, that I have used to develop the SCADA (System Control And Data Acquisition), is the Lookout of the National Instruments. In my application the SCADA have the task to monitor the process. For example, it shows the number of jobs that are within the buffer, what jobs the machine are working and what is the residue time of job processing in a machine (fig 4).

The communication between the SCADA and the PLC is possible through the Applicom Card. The card have an OPC server and the SCADA is connected to it as a OPC client. OPC stands for "OLE for Process Control", a standard communication protocol.

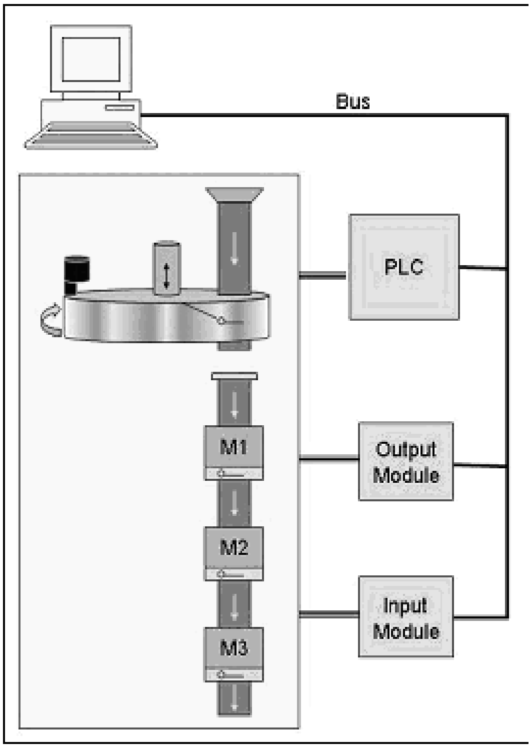


Figure 3. Network

The SCADA give to the user the opportunity to modify the Job Time Table. In this table the rows rapresents the jobs and the columns the machines. Each entry of the table is the time spend by a job in a machine. The table is the input data of a scheduler algorithm (Campbell's Euristic Algorithm) that I have implemented in a program called "Algo", writed in C Language.

When the SCADA user want to begin a process, he can push a button in the graphic interface and the Algo program start. Algo reads from the PLC the number of jobs loaded in the buffer, reads the Job Time Table, compute the optimal job order list and send it to the PLC memory registers. Then, the PLC can send the signals to the buffer to release the jobs in the optimal order.

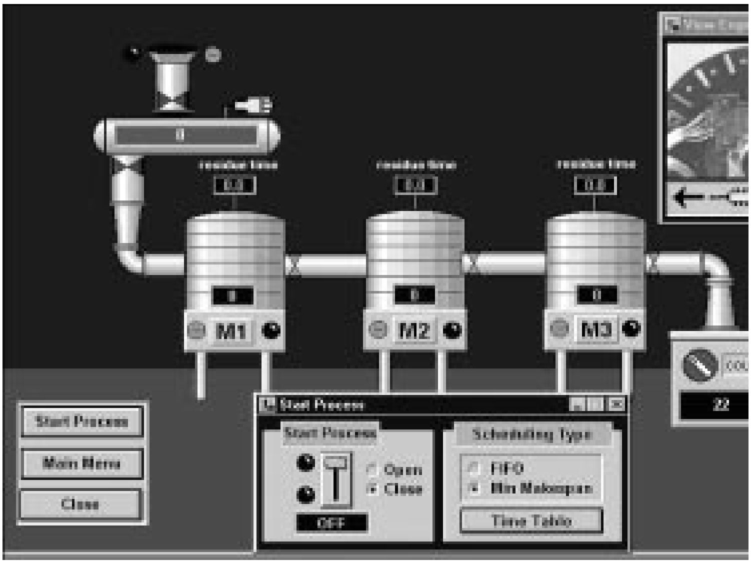


Figure 4. SCADA: User Graphic Interface

Reference
- A.Brandolesi, A.Pozzetti, A.Sianesi, "Gestione della Produzione Industriale", Hoepli.
- P.Chiaccio, "PLC e Automazione Industriale", McGraw Hill.
- OPC Foundation, "OPC Specification", in the site http://www.opcfoundation.org.
- Slide of the course of Industrial Informatic, http://www.diit.unict.it/users/scava/teach.html.

Russian Section

Quality control.

Shapirov Ruslan.
St.Petersburg State University of Aerospace Instrumentation (Russia)

Lots of customers are ready pay more money to buy items of a higher quality.

They interested in accuracy and durability.

A high quality of production can't be guaranteed without the quality of production in general and the quality of each operation in particular. Each of it consist of three kinds of control:

-entrance control;

-exit control;

-operational control.

In previous time in Russia there was only control over materials entering a factory and finish articles. In this case a factory bankrupts because of technological losses. The matter is that in this case a quality rate decrease and this item has to be sold.

On the other hand if a factory produce the items satisfactory from the consumers' point of view, we shouldn't forget that in another country this quality may appear insufficient. That's why it was necessary to create common "world standards of quality". It's called ISO. The last of it is ISO 9002. If a factory not observe the standards then it's items aren't competitive.

My specialty concerns the problem of high quality at Russian factories. I suppose that due to the fact that this specialty is so young, this problem isn't researched in a proper way. I'm interested in researching of this problem at the second year of my education. Then I'll graduate from this institute as a high rate specialist.

DEVELOPMENT OF THE AUTONOMOUS POWER SOURCE FOR AIR AND SPACE CRAFTS

V.B. Karpushin
St.Petersburg State University of Aerospace Instrumentation (Russia)
Department 32 "Information techniques in an electromechanics and robotics".

Generally there are two electrical power systems on flying objects: main, including emergency, and autonomous. The main system is intended for a current supply of all systems of a power and information automatics, life-support of the spacecraft and crew. The power of contemporary main power supply systems for flying objects accounts 1000 kW (at current frequency 400 Hz and voltage up to 400 V). The autonomous system serves for power supply of specific objects, frequently in a mode of short-term or pulse high-level power pick up.

Powerful laser machine can serve as one of such consumers. In this case the rating of power supply should be in the range from 1 to 10 MVA. The laser machine can be used for searching mineral resources, studying the earth entrails, shelf of sea bottom, etc.

The analysis of modern developments in the field of element base reveals, that the most perspective type of the electrical machine for autonomous aircraft and spacecraft systems is noncontact superconducting electrical machine on the base of a synchronous generator. The main advantage of the noncontact electrical machine is absence of the brush contact, that considerably rises service-life and reliability of operation. According to the data of the technical literature the cryogenic synchronous generators have the least specific mass (40-50 g/kVA) as compared to different versions of other generators modifications. As a basic electrical machine for the autonomous power source the cryogenic synchronous generator with a brushless exciter is being developed. The brushless exciter represents the reversed synchronous machine and feeds a field winding via controlled thyristor converter. All construction is located in a single cryostat and has a range of operating temperatures from 30 up to 100 K. Power source rotor speed of rotation is in the range from 24000 up to 12000 rpm. Slotless stator construction enables to make both low-voltage (from 100 V) and high-voltage (up to 40-100 kV) power sources depending on a consumer demands.

The work is carried out with support of the grants RFFR 01-02-17850,00-15-99096, and of the grant of the Ministry of Education of RF 1239.

Method of Parameter Identification for Non-Stationary Process

Jiraphon Srisertpol
srisertpol@hotmail.com
St.Petersburg State University of Aerospace Instrumentation

Abstracts.
The paper introduces a new scheme of the parameter identification for non-stationary process. The proposed technique, used the generalized tuning system of measurement (GTSM)[1] which include the correction parameters of its with the model-reference system and estimate parameters.

Introduction.

The problem of determination a mathematical model for stationary process by observing its input-output data pairs is generally referred to as system identification .The scheme of GTSM give a new method of parameter identification for non-stationary process. This method presents a "good level" learning algorithm, which utilizes for study to character of non-stationary process and estimate parameters of process.

This paper is organized into five sections. In the next section, method of parameter identification are briefly described. Section three described the simulation and its result. Section four gives concluding remarks. Reference are in section five.

METHOD OF PARAMETER IDENTIFICATION

Let's consider non-stationary process described by the following system of state-space model

$$\dot{X}(t) = A_t X(t) + B_t U(t)$$
$$Y(t) = CX(t) \quad , \qquad (1)$$

where $A_t = A_0 + \Delta A(t), B_t = B_0 + \Delta B(t), D_t = D_0 + \Delta D(t)$ $, X \in R^n$

state vector ,

$Y \in R^k$ - input vector ,

$U \in R^m$ - output vector and measurement matrices .

The model- reference system is

$$\dot{X}_M(t) = A_0 X_M(t) + B_0 U(t). \qquad (2)$$

Structure of the generalized tuning object of measurement (GTSM) we shall receive, having entered a vector , to stabilize the dynamic properties of the control system in the equations (1)

$$Z(t) = X(t) - \mu(t). \qquad (3)$$

The equation (1) concerning of the new coordinate will have the expression

$$\dot{Z}(t) = A_0 Z(t) + B_0 U(t) - \dot{\mu}(t) + \Delta A X(t) + \Delta B U(t) + \qquad (4)$$

Let's choose the equation of the compensating channel in the following form

$$\dot{\mu}(t) = N_0 \mu(t) + \Delta N X(t) + \Delta R U(t), \qquad (5)$$

where the matrices are tuning with adjusted coefficient and .
The equation (5) and equation (6) then becomes

$$\dot{Z}(t) = A_0 Z(t) + B_0 U(t) + \delta_A X(t) + \delta_B U(t), \qquad (6)$$

where $\delta_A = \Delta A - \Delta N, \delta_B = \Delta B - \Delta R, \delta_D = \Delta D - \Delta M,$

The performance of parities $\lim_{t \to \infty} \delta_A(t) = 0, \lim_{t \to \infty} \delta_B(t) = 0$ is the purpose of adaptive identification and simultaneously parametrical corrections of dynamic property of the non-stationary process. The scheme of parameter identification using GSTM is shown figure 1.

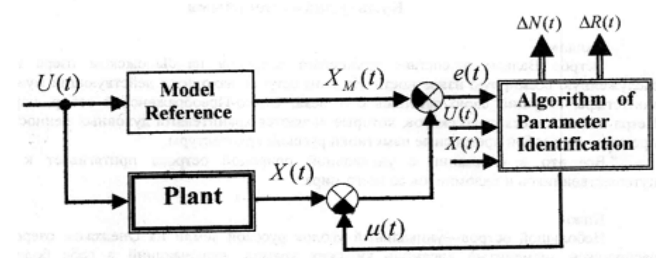


Fig.1 Scheme of parameter identification

3. SIMULATION RESULT :

An example of the system is described by the following state-space equations ,

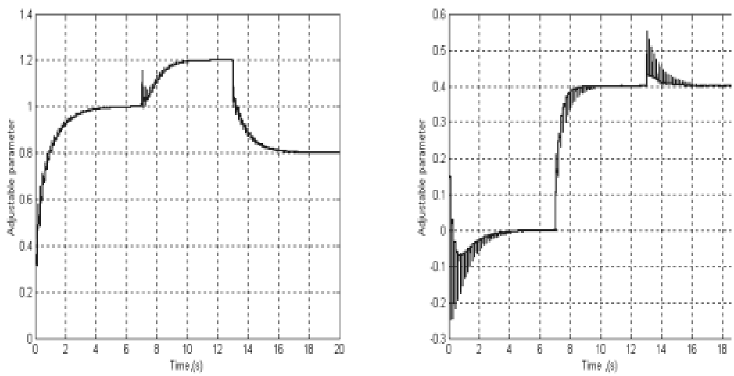
$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -a_0(t) & -a_1(t) \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 0 \\ b_1(t) \end{bmatrix} U \ , \qquad Y = \begin{bmatrix} 1 & 1 \end{bmatrix} X \qquad (7)$$

The value of is set to 4 initially, is changed to 3.8 after 7 seconds and is changed to 4.2 after 13 seconds. The value of is set to 3 initially, is changed to 2.6 after 7 seconds and . The input signal square signal amplitude 2 and frequency 2 rad/sec.

Give model-reference plant

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -5 & -3 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 3 \end{bmatrix} U \ , \qquad Y = \begin{bmatrix} 1 & 1 \end{bmatrix} X \ , \qquad (8)$$

The simulate response of adjustable parameters is shown in Figure 2. Consider results that we used with the speed gradient algorithm for compensate parameter via vector and estimate parameters of process(,) appropriately.



a) b)

Fig.2 The processes of parameter identification

a) adjustable parameter .

b) adjustable parameter .

4. CONCLUSION : For system identification ,this method can achieve a good performance when system is non-stationary. Thus this results permit to estimate its and correction parameters . Further study could be developed the method for system with incomplete state vector of plant and with non-stationary process.

5. REFERENCES :

1. M.S. Katkov,J. Srisertpol , M.M.Azarov // The Synthesis of The Indirect Adaptive Control System.// 5th International Federation of Automatic Control (IFAC) Symposium

"Nonlinear Control Systems", St.Petersburg Russia ,4-6 July 2001. P.376-379.

2. M.S.Katkov ,Continuous adaptive control system with identificator , Moscow 1992, 385 P.(in russian)

3. M.S.Katkov //The synthesis of adaptive measuring devices of the dynamical characteristics and parameters of the object// M: Measuring technica ,1994 № 9 P.19-23.(in russian)

4. Thipkin Y.Z. , Information in theory of identification, :Nauka,1995 (in russian).

Spain Section

POPULATION BALANCE EQUATION: A TOOL FOR DYNAMIC MODELING OF PARTICULATE PROCESSES

Marta Duenas Diez
Telemark University College
Kjolnes Ring 56, P.O. Box 203, 3901 - Porsgrunn (Norway)
Marta.D.Diez@hit.no

Abstract

Particulate processes are often encountered in industry. The polydispersity of some key properties characterizes particulate processes and makes them ill-suited to be modeled within the framework of conventional conservation equations only. In the mid 60s a tool called Population Balance Equation was developed to quantify the dynamics of particulate processes. This paper aims to give an introduction to the Population Balance Equation and review its state of the art.

Introduction

Particulate processes are encountered in many applications and are widely used in the production of valuable industrial products. Crystallization, biochemical processes, polymerization, leaching, comminution, and aerosols are just some examples of particulate processes. Such processes differ considerably from one another but they all are characterized by the presence of a continuous phase and a dispersed phase comprised of entities with a distribution of properties, such as size, chemical composition, etc. The entities typically interact with one another as well as with the continuous phase. Such interactions may vary from entity to entity. Therefore, the polydispersity of particulate processes affects significantly the behavior of such systems, thus affecting the quality of the final products. Moreover, the polydispersity makes particulate processes ill-suited to be modeled within the framework of conventional conservation equations only.

This paper deals with the Population Balance Equation, a tool to quantify the dynamics of particulate processes, which was developed in the mid 60s and since then has experienced wide acceptance and use in the field of particulate processes. This paper describes the formulation of the Population Balance Equation, and reviews the strenghts, the weaknesses and the status of this approach.

Formulation

The Population Balance Equation was originally derived in 1964, when two groups of researchers studying crystal nucleation and growth recognized that many problems involving change in particulate systems could not be handled within the framework of the conventional conservation equations only, see Hulburt & Katz (1964) and Randolph (1964) . They proposed the use of an equation for the continuity of particulate numbers, termed population balance equation, as a basis for describing the behavior of such systems. This balance is developed from the general conservation equation

Accumulation = Input - Output + Net Generation (1)

applied to the number of entities having a specified set of n properties zi i = 1,2...n. The properties zi to be considered for the number balance will depend on the application. Typical examples are the entity's size diameter, entity's chemical composition, entity's age... In equation 1, all the terms represent number of entities with the specified property in a given interval, each term being related to certain transport, generation or destruction processes. Thus the accumulation term is the change of number of entities in a given property interval by accumulation in the system, the input and output terms are related to convective flow, the generation term includes both generation and destruction by continuous or discrete processes. Examples of continuous processes are chemical reaction or precipitation. Discrete generation processes are those giving birth or death of entities in a given property interval such as nucleation (birth), agglomeration (birth) or breakage (death).

The derivation of the Population Balance Equation is equivalent to the development of the conventional equations of change, i.e. the number balance shown in equation 1 is applied to a volume element of the system Dx Dy Dz fixed in the space, the resulting equation is divided by the volume element and the limit as Dx Dy Dz go to zero is taken. By doing this, the microscopic Population Balance Equation is obtained

$$\frac{\partial \Psi}{\partial t} = -\frac{\partial (v_x \Psi)}{\partial x} - \frac{\partial (v_y \Psi)}{\partial y} - \frac{\partial (v_z \Psi)}{\partial x} - \sum_{i=1}^{n} \frac{\partial (v_{\zeta_i} \Psi)}{\partial \zeta_i} + B - D \qquad (2)$$

where Y(t, x, y, z, z1, z2, ..., zn) is the number density distribution, vj j = x, y, z is the velocity of propagation of entities along the spatial coordinate axes x, y, z , whereas vzj is the velocity of property coordinate axes zi, D is the rate of death of entities and B is the rate of birth of entities. Therefore, the partial derivative with respect to time represents the accumulation term, the partial derivatives with respect to the spatial coordinate axes represent the convective transport term, the partial derivatives with respect to the property coordinate axes represent the continuous generation term and D and B give the discrete generation term. For more details about the derivation of the Population Balance Equation, the reader is referred to the original work by Hulburt & Katz (1964) and Randolph (1964).

It is therefore not surprising that equation 2 shows an obvious resemblance with the conventional equations of transport. For example, the equation of continuity is given by (Bird, Stewart & Lightfoot, 2002)

$$\frac{\partial \rho}{\partial t} + \frac{\partial (v_x \rho)}{\partial x} + \frac{\partial (v_y \rho)}{\partial y} + \frac{\partial (v_z \rho)}{\partial x} = 0 \qquad (3)$$

Nevertheless, note some important differences between the conventional equations of transport and the Population Balance Equation. First, the discrete generation term does not have a counterpart in the conventional equations of transport. But, more importantly, the Population Balance Equation is a functional equation not a scalar equation. The latter explains why the Population Balance is typically more difficult to solve mathematically than the conventional equations of transport.

There are many examples in physical modeling where the spatial variation might be neglected, and where the interest lies in studying the global behavior of the system. This led to the development of the macroscopic balances in transpor phenomena theory.

Similarly, there are many instances in the field of particulate processes in which the macroscopic behavior is of main interest. Therefore, a macroscopic version of the Population Balance Equation was developed

$$\frac{1}{V}\frac{d\left(V\overline{\psi}\right)}{dt}=\frac{1}{V}\left(Q_{in}\overline{\psi}_{in}-Q_{out}\overline{\psi}_{out}\right)-\sum_{i=1}^{n}\frac{\partial\left(v_{\zeta_i}\overline{\psi}\right)}{\partial\zeta_i}+\overline{B}-\overline{D} \qquad (4)$$

where (t, z1, z2, ..., zn) is the geometrically averaged number distribution, i.e. it represents the number of entities in the given property interval per unit volume. In equation 4, the derivative with respect to time represents the accumulation term, the first two terms on the r.h.s represent the convective transport term, the derivative terms with respect to the property coordinate represent the net continuous generation term and the averaged birth rate minus the averaged death rate represent the net discrete generation term.

The macroscopic Population Balance Equation is the version that has been most widely used in practical applications, and the version that has attracted most attention.

Pros and cons of the Population Balance Equation

The secret of the success of the Population Balance Equation for dynamic modeling of particulate processes lies in its ability to describe systematically the polydispersity of such processes. Moreover, the Population Balance Equation is able to describe mathematically a wide range of complex events affecting such processes. Some good examples of complex events that can be accounted for in the Population Balance Equations are the nucleation phenomena taking place in crystallization, the disintegration of particles in comminution, the aggregation event in polymerization, etc. Finally, another advantage of this tool comes from its general character and wide application. Any advance that might be obtained for one certain application can easily be extended to other applications. For a good review of applications, the reader is referred to Ramkrishna (2000).

However, the application of the Population Balance Equation presents also certain drawbacks. The main problem is that the resulting formulations may be mathematically challenging. The macroscopic balance equation, when all terms are used, typically yields to an integrodifferential equation. Analytical solution of integrodifferential equations is in most cases impossible. Fortunately, extensive research has been devoted to the solution of Population Balance Equations. The method of moments, as developed by Hulburt & Katz (1964), is the most widely used method to reduce integro-differential equations into a set of Ordinary Differential Equations (ODEs), but it is not always applicable because this method may lead to an open set of equations. Examples of numerical solution methods proposed in the literature (Ramkrishna, 1985; Ramkrishna, 2000) are: the method of weighted residuals, the method of self-preserving distributions, Monte Carlo simulation techniques, the size interval-by-size marching method and discretization via fixed/moving pivot techniques. Discretization techniques are widely used and might lead to a system of Differential and Algebraic Equations (DAEs). An example about the use and solution of a Population Balance Equation yielding a DAE system can be found in Duenas Diez, Ausland, Fjeld & Lie (2002).

State of the Art

In the last decade, the focus has been displaced from finding solution methods to using explicitely the Population Balance Equation models for control purporses. The first notable attempt was the controllability analysis suggested in Semino and Ray (1995) and applied to emulsion polymerization Semino and Ray (1995b). Chiu & Christofides (1999, 2000) successfully applied nonlinear output feedback controllers to a crystallization process. Model predictive control, which is a control framework that has spread in the process industry during the last decades, has also received a great deal of attention in the field of particulate processes in the last decade. Eaton & Rawlings (1990) used nonlinear programming to solve the nonlinear model predictive control formulation of a batch crystallizer. Nonlinear model predictive control was also used in Crowley, Meadows, Kostoulas & Doyle (2000) to optimize the performance of a semibatch emulsion polymerization reactor. Linear model predictive control has been proposed for the stabilization of oscillating microbial cultures in bioreactors Zhu, Zamamiri, Henson & Hjortso (2000).

Conclusion

This paper gives an introduction to the Population Balance Equation, a tool for dynamic modeling of particulate processes which has received a great deal of acceptance due to its ability to describe the polydispersity and the complex events often encountered in particulate processes. The derivation of the Population Balance Equation is similar to the derivation of the equations of transport, but leads to functional equations which are difficult to solve. Indeed, the search for ways of overcoming the mathematical complexity of the resulting formulations focused during several decades all the attention and research effort. Nowadays several solution aproaches, both analytical and numerical, are available, and the main focus is to integrate the Population Balace Equation models with process control.

References

Bird, R.B., Stewart W.E. & Lightfoot, E.N. (2002), Transport Phenomena, John Wiley & Sons, Inc. 2nd Edition.

Chiu, T. & Christo…des, P. (1999), 'Nonlinear control of particulate processes', AIChE Journal 45(6), 1279-1297.

Chiu, T. & Christo…des, P. (2000), 'Robust control of particulate processes using uncertain population balances',AIChE Journal 46(2), 266-280.

Crowley, T. J., Meadows, E. S., Kostoulas, E. & Doyle, F. J. (2000), 'Control of particle size distribution described by a population balance model of semibatch emulsion polymerization', Journal of Process Control 10, 419-432.

Duenas-Diez, M., Ausland, G., Fjeld, M. & Lie, B. (2002), 'Simulation of a hydrometallurgical leaching reactor modeled as a DAE system', Modeling, Identification and Control, In press.

Eaton, J. W. & Rawlings, J. B. (1990), 'Feedback control of chemical processes using on-line optimization techniques', Computers and Chemical Engineering 14(4), 469-479.

Hulburt, H. M. & Katz, S. (1964), 'Some problems in particle technology - A statistical mechanical formulation', Chemical Engineering Science 19, 555-574.

Kalani, A. & Christo…des, P. D. (2000), 'Modeling and control of a titania aerosol reactor', Aerosol Science and Technology 32, 369-391.

Ramkrishna, D. (1985), 'The status of population balances', Reviews in Chemical Engineering 3, 49-95.

Ramkrishna, D. (2000), Population Balances. Theory and applications to particulate systems in engineering, Academic Press.

Randolph, A. (1964), 'A population balance for countable entities', The Canadian Journal of Chemical engineering 42, 280-281.

Semino, D. & Ray, W. (1995a), 'Control of systems described by population balance equations - i. controllability analysis', Chemical Engineering Science 50(11), 1805-1824.

Semino, D. & Ray, W. (1995b), 'Control of systems described by population balance equations - II. emulsion polymerization with constrained control action', Journal of Chemical Engineering 50(11), 1825-1839.

Zhu, G.-Y., Zamamiri, A., Henson, M. A. & Hjortso, M. A. (2000), 'Model predictive control of continuous yeast bioreactors using cell population balance models', Chemical Engineering Science 55, 6155-6167.

SIMULTANEOUS IDENTIFICATION OF THE STRUCTURE AND THE PARAMETERS OF A TRANSFER FUNCTION USING A GENETIC ALGORITHM

Angel Martin Martinez, Universidad de Valladolid

INTRODUCTION

When designing a control system for a process, it is often necessary to develop a dynamic model of the process that is to be controlled. This model is useful both for calculating the parameters of the controller, and for evaluating its performance in a simulation.

There are different types of model that can represent the dynamic behaviour of a process. Some examples are pulse responses, step responses and transfer functions. The latter is frequently used, as it has several advantages:

- It is a very compact representation, that is, it has fewer parameters than other types of models as pulse or step response.
- Several parameters related to the dynamics if the process can be analytically calculated from a transfer function.

Transfer functions used for designing controllers are usually obtained from the fitting of experimental data. Several optimisation methods (i.e. Least Squares) are used for this purpose. With these methods, it is necessary to make a supposition about the structure of the transfer function (i.e., suppose that it is of first order), and later calculate its parameters with the optimisation algorithm. If the fitting is not satisfactory, another transfer function structure is supposed ant the minimization process is repeated.

In this work, a method for the simultaneous identification of transfer functions structure and parameters, based on a genetic algorithm, has been developed. This method thus avoids the need of supposing the structure of the transfer function.

TRANSFER FUNCTION CODING

Transfer functions are made up with the following elements: poles, zeros, delays and static gains. These elements can be represented in a genetic code with two numbers, the first corresponding to the type of element, and the second to its value.

To implement this representation, strings of 35 bits has been used. The latter 32 bits store the value of the parameter, using the standard Pascal representation of float numbers. The first 3 bits store an integer that represents the type of the parameter, with the following correspondences:

0: first order zero.
1: first order pole.
2: second order zero.
3: second order pole.
4: gain.
5: delay.

6,7 : parameter not used.

For example, the following genetic code stores the decimal values 1 | 0,8853:

001|00100101100101001110110111010101

And this code would be translated in a transfer function as a pole z + 0,8853.

It should be noted that first and second order zeros and poles are considered different types of parameters. With this representation, it is ensured that the genetic code can represent complex zeros and poles. As a gene only stores the numeric value of a parameter, in this cases the numeric value of the following gene is taken, regardless of its type, so a pole or zero in the form $z2 + a \cdot z + b$ can be constructed.

REPRODUCTION

The reproduction method must allow that transfer functions with different number and type of parameters can be tried. Thus, it has not been used a genetic code of predefined length, but a genetic code whose length can change during reproduction.

The reproduction method is as follows:

- A gene of the first parent, and a different gene of the second parent, are randomly chosen.
- A random number between 1 and 35, representing a intermediate position in the gene's string, is chosen.
- The first child inherits the genetic code of the first parent until this separating point, and the genetic code of the second parent from it. The second child inherits the remaining genetic code.

In the following example, two parents with four genes are taken, and its genetic code is recombined, with the division point placed on the 17th element of the second gene of the first parent, and the third gene of the second parent, so two child with three and five genes are obtained:

Parent 1:

00100100101100101001110110111010101
0010010010101110|0101110010100111101 001001001001110110111010110010101 01
00010100111011001001001011111010101

Parent 2:

00100010100111010010110110111010101
0010010001010011101101110010111010 1 0010011101101110|0010110010100101 01
00100111010101010010110010100111011

Child 1:

00100100101100101001110110111010101
0010010010101110001011001010010101 00100111010101010010110010100111011

Child 2:

00100010100111010010110110111010101
00100100010100111011011100101110101 00100111011011100101110010100111 01
00100100100111011011101011001010101 00010100111011001001001011111010101

OBJECTIVE FUNCTION

An objective function with two terms has been used. The first term is the sum of the squares of the difference between experimental and calculated values, and the second term is proportional to the number of parameters of the transfer function:

$$Objective = \sum (error)^2 + K \cdot NumParam$$

With this objective function, the algorithm tries to minimize the prediction errors, using transfer functions as simple as possible.

If the transfer function is not realizable (it has more zeros than poles), unstable, or has a too small gain, a very high value is given to the objective function.

GENETIC ALGORITHM PARAMETERS

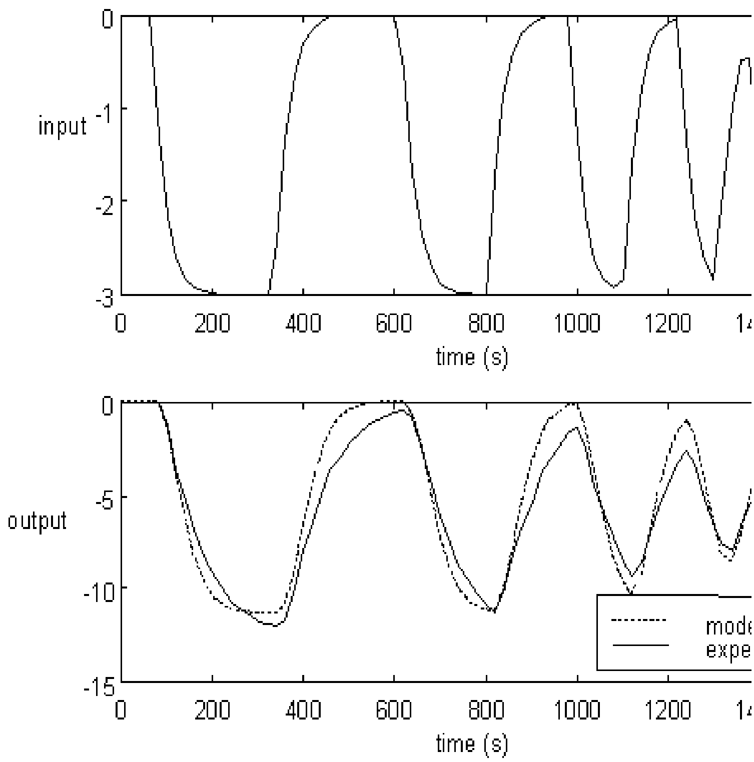
A genetic algorithm with the following parameters has been used: sigma scaling, crossover probability 0,85, mutation probability 0,01, and elitism. A population of 500 individuals was evolved during 100 generations. It should be emphasized that the population must be large, because a significant fraction of the transfer functions randomly generated during the start-up of the algorithm are not valid (because they are unstable, unrealisable, ...), and there must be enough valid transfer functions to ensure the genetic diversity.

RESULTS

The method has been applied to the identification of the dynamic model for the control of the level of a deposit with a variable - speed pump. The obtained transfer function is:

$$F(z) = \frac{z^2 + 1{,}32 \cdot z + 0{,}40}{z^3 + 0{,}19 \cdot z^2 + 0{,}024 \cdot z - 0{,}56}$$

In the picture, experimental and predicted values are compared:



INFORMATION

ISA district 12 student's committee

Alex Bobovitch (NWDZNIT, Russia), chairman bob@aanet.ru
Professor Orazio Mirabella (UC, Italy) omirabel@iit.unict.it
Professor Valery Elkin (SUAI, Russia) bob@aanet.ru
Harvey Makin (RTC, Ireland) hmakin@cit.ie
Professor Alex Sinyakov (SUAI, Russia san_k11@aanet.ru
Professor Paolo Pinceti (GU, Italy) pinceti@die.unige.it
Miguel A. Garcia (VU, Spain) miguel@autom.uva.es
Professor Jesus M. Zamarreno (VU, Spain) jm@autom.uva.es
Jaroslaw Smieja (STU, Poland) jsmieja@ia.polsl.gliwice.pl

The 5-th district 12 students competition (SC'2002) results
(from the minutes N18 of the Jury's competition meeting, March 25,2002)

1.To award the First Diploma to Valladolid University, Spain section as the winner of the SC'2002 . (170 points).

2.To award the Second Diploma to the Silesian Technical University, Poland section as the winner of the SC'2002 (143 points).

3. To award the Third Diploma to the Cork Institute of Technology, Ireland section as the winner of the SC'2002 (130 points).

4. To award the First Diploma to Luis Zamarreno (Valladolid University, Spain) as the winner of the SC'2002 (47 points).

5. To award the Second Diploma to Angel Martin (Valladolid University, Spain) as the winner of the SC'2002 (43 points).

6. To award the Third Diploma to Alejandro Merino and Almudena Rueda (Valladolid University, Spain) as the winner of the SC'2002 (40 points)

7. To award the Forth Diploma to Colin Lehane (Cork Institute of Technology< Ireland) as the winner of the SC'2002 (38 points).

8. To award the Fifth diplomas to Sebastian Budzan, Tomasz Kedzierski, Boleslaw Bak (Silesian Technical University, Poland) and Agliozzo Carmelo (Catania University, Italy) (37 points).

9. To award the certificates to all students – participants of SC'2002 and students advisers.

10. To publish the SC'2002 results at students EuroXchange.

11. To organize the 6-th district 12students competition (SC'2003)at January, 2003.

Chairman *A.Sinyakov, professor*

District 12 Students home page: HTTP:// WWW.AANET.RU/ISA