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Applying the use of Systemic View and Mobile Robotics in Engineering Education

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***Abstract*— This research aims to present the LOGBOT project, an educational wheeled mobile robot based on systemic view concept to help teacher's present concepts to students in Engineering education. The LOGBOT robot has the ability for autonomous navigation in indoor environments, and remotely operated either from a computer station, which sends commands wirelessly to the robot. With this proposal, teachers will be able to achieve more autonomy in the use of these resources. The main result of this research is that the engineering student gains the ability to develop advanced strategies in design and construction of robotics, all involving the environmental and social issues.**

***Index Terms*—Engineering Education, Systemic View, Mobile Robotics**

I. Introduction

THE LOGBOT (acronym to Logistic Robot for Educational Purposes) is proposed in this paper as a methodology in systemic view for engineering education. The wheeled mobile robot (WMR) is a system example that illustrates the use of systemic view in project design. The Systemic View allows people make their understanding of social systems explicit and improve them in the same way that people can use engineering principles to make explicit their understanding of electronic, computing and mechanical systems [1].

The objective of LOGBOT project is to motivate the creativity in engineering student and helps him to understand the properties of each element forming part of a system, and mainly comprise the integration of these elements of a system as a whole, as well to identify possible interactions between this system with other systems [2]. A system is a dynamic and complex whole, interacting as a structured functional unit; energy, material and information flow among the different elements that compose the system [3], [4].

In engineering education, the main approach in the design of projects is the analytical view, which is concerned with the relationship between the component parts of the system, while the systemic view is concerned with the relationship of the system with the other systems, such as objects, people and the environment that encompasses all [4], [5].

The design and construction a system like a mobile robot is a multidisciplinary activity that encompasses several areas of knowledge, whose result is the integration of functions of each element that is part of a system. Robotics has a main function to replace humans in dangerous or repetitive tasks [15], [16], [25], so their inclusion as social and environmental technology is a current frontier of robotics development, because the trend is that the robots are also social beings [4], [5], [6], [13].

The wheeled mobile robot called LOGBOT has a traction type differential movement – with two wheels and an impeller to maintain the stability of its structure with the surface. This robot has two models of navigation: autonomous and telemetry.

In autonomous control mode – Autonomous Guided Vehicle, the LOGBOT has the ability to navigate in indoor environments with the use of the corridor wall as your reference trajectory to be traveled [33].

In the control by telemetry mode – Remotely Operated Vehicle, communication with the LOGBOT control station operator is made by radio frequency at a distance of one kilometer to outdoors, and one hundred meters indoors [34].

This paper is organized as follows. Section 1 introduces the reader to the limits of current robots and the motivation behind creating LOGBOT. Section 2 further explains the significance and objective of this work. Section 3 is dedicated to the systemic view concept as a methodology in engineering education. Section 4 discusses the design of the LOGBOT as a whole, the mechanics, physical, hardware, software, navigation and networking are presented. Section 5 and 6 are dedicated to the results & discussions and conclusion respectively.

II. Project Significance and Objective

The knowledge becomes more complex and available every day and many engineering students have the following questions: "How to build something?", "What should I learn?", "How can I build a robot?" It generates demand for new educational methodologies for the engineering student to assimilate, integrate and apply the amount of information in their formation [6]–[9], [12].

This paper proposes the use of LOGBOT project as a method of transmission of knowledge in engineering education, with use of systemic view as supplement to analytical view in the design of a mobile robot, which can be built by any undergraduate student of engineering.

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A. *The Systemic and Analytic Approaches*

The systemic view is a type of mind modeling that does improved plan and organization of systems design, objectively seeing wholes, all involving the environmental and social variables. Interrelationships and detect patterns and learn to restructure these interrelationships in a more harmonious [10]. The analytical view focuses on the separating the individual parts of system are being studied, but not the interaction of this system with other systems [5].

The analytical view and the systemic view are complementary strategies in an attempt to understand the functioning of complex systems. The first allows targeting the problem to make it tractable, both terms of analytical or numerical. The second demand has specific tools that allow the integration of the parties, even if it does not have a clear understanding of how it all works [20]–[22].

B. *Robotics and Cybernetics in Engineering Degree*

The current frontier of robotics research is the development of service robotics platforms to work in agriculture [23], environmental monitoring [16] and space [24]. This means there is an emergency review of the most basic concepts and principles in robotics design, because this discipline are massively multi-disciplinary and naturally awaken creativity and interest by the student to explore and understand other disciplines of undergraduate engineering, thus increasing their productivity and permanence in the career of a researcher.

All these concepts and approaches are based on cybernetics [18] [19], whose emergence of inserting it again as a basic discipline in the curriculum of engineering degrees in the last 20 years, is already happening in some universities around the world. For example, the University of Reading, U.K., the discipline of cybernetics is part of School of Systems Engineering, in conjunction with computer science and with electronic engineering [12]. In the Amazonian Federal Rural University (UFRA), Brazil, the cybernetics is a major part content of the "Cyberphysical Systems" discipline of Cyberspatial Institute (ICIBE), in the curriculum of their courses – Environmental Engineering and Renewable Energy, and the Surveying and Cartographic Engineering [8], [29].

C. *LOGBOT Objectives and Contributions*

The main objective of the project LOGBOT is that the engineering student, in addition to using the analytical view approach, also uses the systemic view in their robotics projects. The contribution of this work is to encourage engineering students to start or enhance their research or knowledge in robotics and cybernetics.

Over the last 10 years, a number of initiatives based on interdisciplinary projects, with a focus on robotics and cybernetics have been undertaken that have succeeded in increasing and maintaining a healthy numbers of undergraduates in Computer Engineering from institutions – Amazonian Superior Studies Institute (IESAM) and Federal University of Pará (UFPA), both located in Brazil. The details of these results are discussed in section 5 below.

III. SYSTEMIC VIEW IN ENGINEERING EDUCATION

The Systemic View has its foundation in the field of system dynamics, founded in 1956 by MIT professor Jay Wright Forrester. Professor Forrester recognized the need for a better way of testing new ideas about social systems; in the same way we can test ideas in engineering [2]. Two books of the foundation stones of systemic view is Cybernetics or Control and Communications in the Animal and Machine," by The MIT Professor Norbert Wiener, first published in 1948 [4], and "General Systems Theory" by Ludwig von Bertalanffy, first published in 1968 [3].

Since the beginning 21st century, systemic view is a strong basis for the development of Cyberphysical Systems (CPS), the current technological challenger. A CPS is an integration of computation with physical processes, is about intersection, not the union, of the physical and the cyber. The term "Cyber-physical systems" emerged around 2006, when Dr. D. Helen Gill at the National Science Foundation (NSF) in the United States coined it [11].

The analytical views is concerned with the relationship of parts of a single system, while the systemic view, and also worry about the parts of a system, is also concerned with the relationship of this system with other systems, in particular, environmental and social systems. The fig. 1 shows a map of systemic view concept.

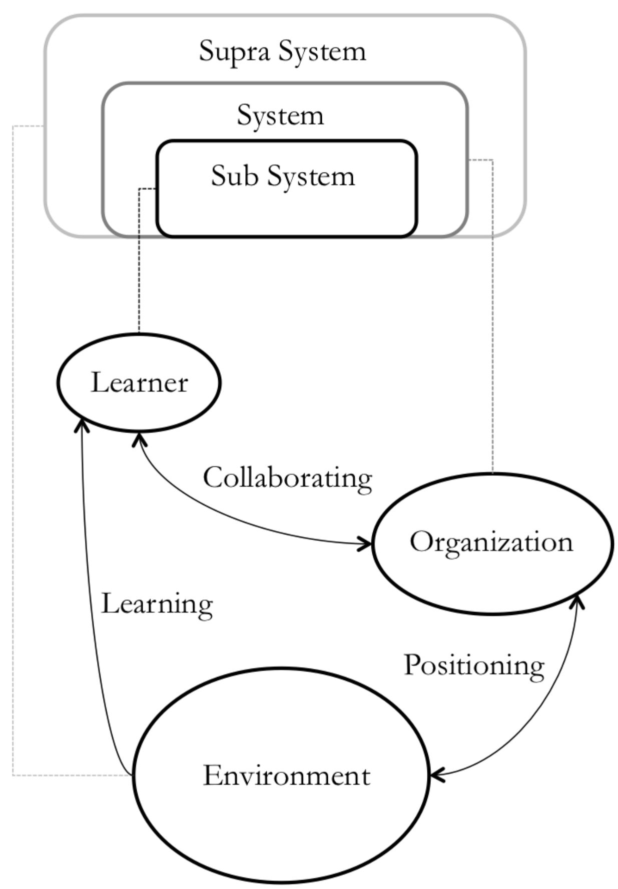

Fig. 1. Systemic View Map. Every issue or project is seen systematically can be understood as having three levels of activity, which is a three-level hierarchy: supra system, system and sub system.

The systemic view is a process of understanding and transforming complex situations – these may include social, ecological and industrial dynamics; environmental complexity; and the epistemological relationship "transmission/learning" of knowledge in education, because there is a systemic interaction in the teaching, the student is part of the learning process, is also element of teaching and learning [6],[7], [8].

Think systemically requires a new way of looking at the world, human, and therefore also requires a change of attitude by the student, a posture that provides focus and expands the understanding that the individual is not solely responsible for carrying a symptom, but there are relationships that keep this symptom [6], [8], [20]. The approach of systemic view is fundamentally different from that of traditional forms of analysis.

The analytical view focuses on the separating the individual elements of what is being studied; in fact, the word "analysis" actually comes from the root meaning "to break into constituent parts". The systemic view, in contrast, focuses on how the thing being studied interacts with the other constituents of the system – a set of elements that interact to produce behavior – of which it is a part. This means that instead of isolating smaller and smaller parts of the system being studied, systemic view works by expanding its view to take into account larger and larger numbers of interactions as an issue is being studied.

This leads in sometimes strikingly different conclusions than those generated by traditional forms of analysis, especially when what is being studied is dynamically complex or has a great deal of feedback from other sources, internal or external. This makes the student understands that all human action is an environmental and social action [10], [28].

The character of systemic view makes it extremely effective on the most difficult types of problems to solve: those involving complex issues, a normal activity in engineering, those that depend a great deal dependence on the past or on the actions of others, and those stemming from ineffective coordination among those involved. Examples of areas in which systems thinking have proven its value include:

→ Complex problems that involve helping many actors see the "big picture" and not just their part of it;
→ Recurring problems or those that have been made worse by past attempts to fix them;
→ Issues where an action affects (or is affected by) the environment surrounding the issue, either the natural environment or the competitive environment;
→ Problems whose solutions are not obvious.

The ability to hold these three levels of hierarchy in mind at the same time while considering an issue and identifying the way in which changes at one level affect changes at the other levels is known as systemic view.

The Sub-systems are parts of the system that are to interact in an interdependent manner so that the system reaches equilibrium and express its purpose in Supra-system. The parties are also the only way that the system can learn about the environment that embraces, they are the power plant to give life to the system. All the dynamics that exist within the system must have coherence (context or sense wholeness), if they want to be a legitimate part of this system.

The environment in most situations is the Supra-system and covers everything that is not included in the system for their purpose. The system as a whole has properties that are different than the sums of their (interconnected) parts.

IV. LOGBOT PROJECT

In the design of a mobile robot, the student must identify the elements that become part of the robot (analytical) and that their actions on the environment variables (systemic) respectively. The table 1 shows this interrelationship [35].

TABLE I
ROBOT/ENVIRONMENTAL ELEMENTS INTERRELATIONSHIP

Element (Sub system)	Robot Function (System)	Environmental Action (Supra system)
Mechanical Structure	Element responsible for supporting the parts of the robot as a whole	The robot's body dimension as an actor that occupies the environment embraces it.
Motors	Mobility and strength of movement	Change of position and orientation of the robot in the environment
Batteries	Energy for electro-mechanical and electronic components	Autonomy displacement in space that embraces it.
Hardware	Sensors, Actuators, Microcontrollers and Control Circuits.	Percepts and interacts with the environment
Software	Algorithm and math models that's govern the Robot as a whole.	Decisions of interact basis on Physics properties of the robot and the environment that embraces it.
Networking	Receipts/Sent commands and sensor data	Communication with others actors of the environment, as a computer control station, people and other robots.

The LOGBOT is presented in fig. 2. This educational project of Federal University of Pará, Brazil (UFPA) is an example that illustrates the use of systemic view in a design of complex system as a wheeled mobile robot, by involving subsystems that follow the coherence properties of a robotic system.

The fig. 2 should be viewed as a whole, because besides the robot, there is also the environment that embraces it. The robot acts upon the environment, because the environment acts on the robot. The robot is the integration of parts, whose functions are to form a robot as a whole and interact with the environment that embraces it [16], [23], [34].

Fig. 2. The LOGBOT Project – A Wheeled Mobile Robot for Educational Purposes, on corridor in Electrical Engineer Build at Federal University of Pará, 2009.

The language of mathematics embraces and represents the entire interrelationship [14]. The understanding of a mathematical formula becomes better when it is aware of three levels of activity and hierarchy in the concept of systemic view. The kinematic model relates the speed of the motors (actuator subsystem) at speeds of a referential fixed to the robot, commonly originating from its center of mass [17]. The first mathematical notation on the kinematics of the robot in the environment that encompasses it is given by:

$$q = \begin{bmatrix} Position \\ ------- \\ Orientation \end{bmatrix} \quad (1)$$

The variable q represents the configuration of a wheeled mobile robot on the environment, q receives information about the robot position and orientation in the environment that encompasses it [15]. The fig. 3 shows the robot space configuration in the environmental variables.

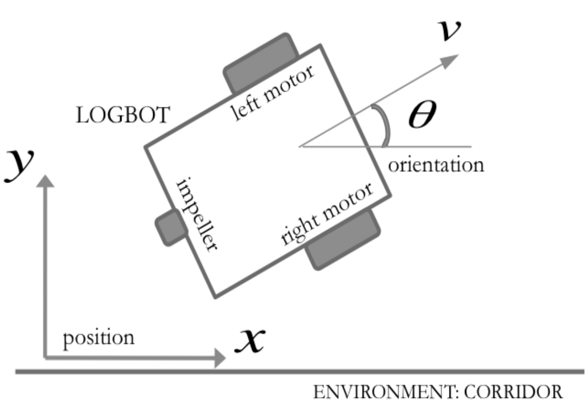

Fig. 3. The LOGBOT is a system in your space configuration; the supra-system in this case is the corridor. The wall is used for reference of trajectory of the WMR in autonomous mode; the impeller, motors and wheels are sub-systems with mobility functions.

The v is the linear velocity of WMR as a whole, x and y are the Cartesian position of WMR in relation to a fixed reference on the environment (wall of corridor) and q represents its orientation with respect to this fixed reference [17]. The LOGBOT has three degrees of freedom (DOF) – position and orientation, and can be specified by:

$$q = \begin{bmatrix} x(t) \\ y(t) \\ --- \\ \theta(t) \end{bmatrix} \quad (2)$$

Where $x(t), y(t), \theta(t)$ are the components of the linear velocity of the robot in function of time it acts on the environment, which comprises. The kinematic model that involves the complete sub-system, system and supra-system is:

$$\dot{q}(t) = G(q)u(t) \quad (3)$$

Where $\dot{q}(t)$ is the change of position and orientation of the robot on the environment (**variable related to the supra-system**); and $u(t)$ is the control vector, whose components are the angular velocities of the robot traction motors (**variable related to the sub-system**), both all the time during which the robot operates on the environment; The matrix $G(q)$ represents all the possible moves that the robot can do (**variable related to the system**) [35], the matrix $G(q)$ is square when the control vector has dimension equal to the number of degrees of freedom. However, for most WMR this matrix is not square, since the gears of the operation is smaller than the number of DOF of the system. This restriction of movement is non-holonomic and is given by [34]:

$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} \cos\theta & 0 \\ sen\theta & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} v \\ \omega \end{bmatrix} \quad (4)$$

The translation velocity v, and the angular velocity ω of the rigid body of the robot as a whole are given by:

$$\begin{bmatrix} v \\ \omega \end{bmatrix} = \begin{bmatrix} \frac{D}{2} & \frac{D}{2} \\ \frac{D}{T} & -\frac{D}{T} \end{bmatrix} \begin{bmatrix} \omega_R \\ \omega_L \end{bmatrix} \quad (5)$$

In (5) D is the wheel diameter (14.8cm), T the distance between the wheels (32.0 cm), ω_L and ω_R are the angular velocities of the left and right wheels respectively. The resulting speed of the robot as a whole is given by:

$$\omega = \frac{\omega_{RPM}}{60_{Seconds}} = \frac{78}{60} = 1.3Hz \quad (6)$$

$$v = \omega \times \pi \times D = 0.60 meters / seconds \quad (7)$$

In (6) ω is the angular velocity of engine output revolutions per minute, and with maximum efficiency (load). In (7) v is the maximum linear speed that the rigid body of the LOGBOT as a whole can be achieved. In the LOGBOT case, the naval aluminum structure and high-torque motors are essential for its use in outdoor environments such as on lawns whose soil has adversity when compared to flat ground and indoors in buildings. The choice of these parts (**sub-system**) was made to make the LOGBOT (**system**) compatible with your work environment, which outdoor areas of cities immersed in forests (**supra-system**). The table 2 shows these definitions [35].

TABLE II
THE CONNECTION PARTS AND SYSTEMS FOR THE LOGBOT

Properties of Robot (System)	Characteristics of Properties (Analytic View)	Demands between parts of System and other Systems (Systemic View)
Environmental System	Outdoor / Indoor Terrestrial Agricultural Environments.	The structure of the robot's body should be made with material resistant to the adversities of nature, such as agricultural environments. The motors must have enough strong torque to overcome rough terrain.
Robot type	Wheeled Differential Mobile Robot.	2 Degrees of Freedom (DOF). This type of robot has limited movement in the surrounding environment, this leads to a finite number of tasks it can perform and that the planning of tasks the robot must be compatible with your movements.
Control Model	Autonomous and Teleoperated.	Defining the sensors and actuators and developing algorithms, physical and mathematical models of the robot and its interaction with the environment and other systems.
Sensors	Ultrasonic Array	Percepts the walls, obstacles and any object, important resource for decision making.
Actuators	DC Motors and High Bright LEDS.	Response to the environment percepts, that leads to interaction within the environment and other systems.
Interactions with other systems	Communication with the computer control station, Rough terrain, objects, plants, animals, people and other robots.	
Mission	Educational Robot with classical models of control.	

The fig 4 and fig 5 shows LOGBOT mechanical structure and frame respectively, and its composed of naval aluminum and acrylic (3mm in both layers), has dimensions of (30cm X 40cm X 40 cm), and has two independent wheels on the left and right of its front, and a third wheel (impeller) support at the rear center. Has two 115 RPM/12V DC (Direct Current) motors as actuators with output torque of 44Kgf.cm, which are fixed in their structure and their axes aligned with the axes of the wheels.

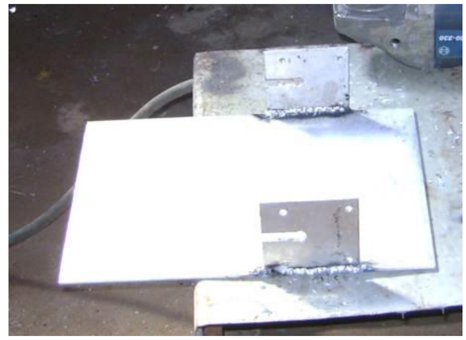

Fig. 4. The LOGBOT basic mechanical structure and it's composed of naval aluminum and has dimensions of (30cm X 40cm).

Fig. 5. The LOGBOT frame, has dimensions of (30cm X 40cm X 40cm), and has two independent wheels on the left and right of its front, and a third wheel (impeller) support at the rear center.

The identification of the PWM switching frequency must be much higher than the inverse of the time constant of the electric DC motor T_a, which is given by dividing the internal resistance of the motor R through its inductance L in ohms:

$$\frac{1}{T_a} = \frac{R}{L} = \frac{0,5}{0,052} = 9,61Hz \tag{8}$$

The PWM control for the power of the motor conforms to the relation (9), and the identified frequency is shown at (10):

$$f_{PWM} \geq 5 \times f_{MOTOR} \tag{9}$$

$$f_{PWM} = 12kHz \tag{10}$$

The fig.6 shows the integration model of the all parts of the LOGBOT. The motors are powered by a battery Lead-acid DC 12V/7A.h. A second battery Nickel-Metal Hydride (NiMH) DC 12/2.3A.h is used to feed only the Electronic Microcontroller, which is well protected interference from any noise generated the motors that move the robot.

The embedded computer involves all actions relation between the Sub-System (**sensors, actuators and network**), system (**the robot as a whole**) and Supra-System (**the environment that encompasses the robot**). The processor core contains PIC18F458 sensing interfaces like analog to digital (A/D), acting interface by pulse width modulation (PWM) and network interface technology using wireless Zigbee (IEEE 802.15.4).

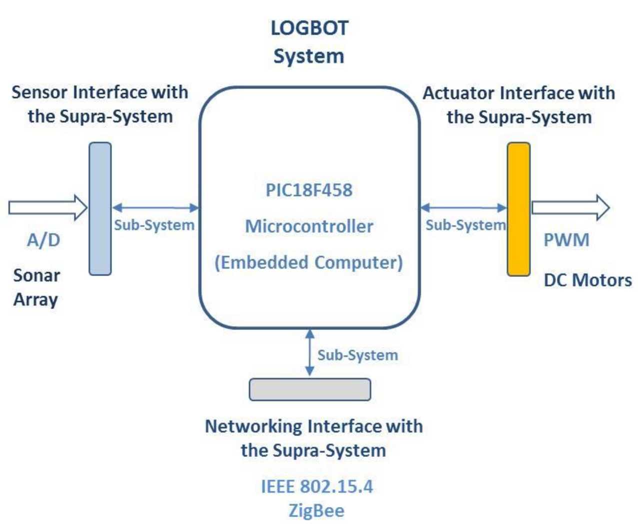

Fig. 6. The LOGBOT hardware integration with systemic levels.

The fig7 shows the drive serves to control the speed differential and traction motors. The core processing is a microcontroller *Microchip* PIC18F458, which it's, for each motor signal drive (stop or turn in a sense) and another type signal PWM (Pulse Width Modulation) that defines the speed of translation. To perform switching of these signals is used an H-bridge LMD18200T on each motor. The PWM signal applied to each motor is what differentiates the speed each wheel, as well as the movements of the robot as a whole.

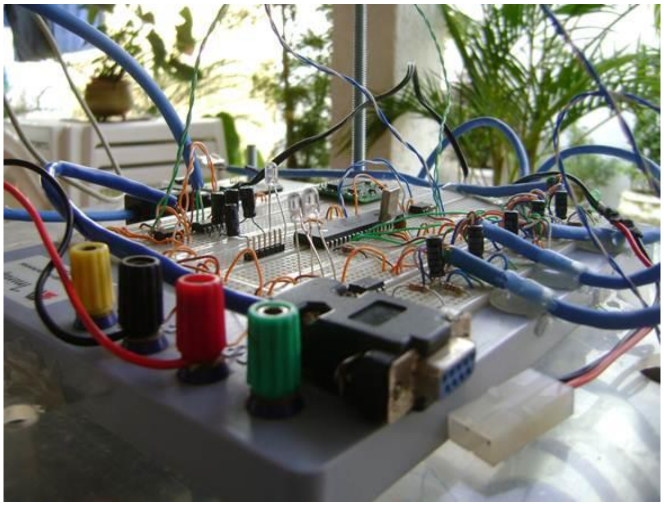

Fig. 7. The LOGBOT electronical circuit in a prot-on-board with the PIC18F458 core processing and the interface of ultrasonic sensors array.

The ultrasonic array sensor comprises five EZ1 sonars, whose output provides an analog voltage of 10mV per unit inch, with a measuring range between 6 and 255 inches (15.24cm to 647.7cm). The unique sensorial resource of LOGBOT is the ultrasound array, whose functions are: use the left wall as your reference for the generation of paths to be traveled and overcome obstacles in the environment that embraces it.

The communication between the robot and the computer is made through two transceivers Zigbee, which operate in the radio frequency of 2.4 GHz in bidirectional mode with bandwidth to 250kbps. The electronic architecture of the robot is modular, which allows the growth of sensory devices like interoceptive and exteroceptive sensors, which increases his power of perception, belief and interaction with the environment [15], [16].

The mobile robot LOGBOT achieved satisfactory results in testing modes: autonomous and teleoperated. The focus of this paper is present methodologies of use the systemic an analytic view for begin and improve the projects of mobile robots. All project and videos that show LOGBOT in action are available on the page: (http://www.ciberfisica.org/logbot).

V. Discussion and Results

When building a robot with the use of systemic view, the first system to be analyzed is the Supra-System (**Environment**), because the properties of the environment and their hardships will react directly the actions of the robot, then the System (**the robot as a whole**) and Sub-System (**elements that make up the robot**) and the control algorithms should support all the environmental properties [13].

This helps to: develop strategies in the design and construction of educational robots, robotics platform and reconfigurable robotics studies, selection and requirements

TABLE III
INTERRELATION OF ACTIVITY PROFESSIONAL ACADEMIC AND STUDENT LIFE GRADUATES OF COMPUTER ENGINEERING, ENTRY 2003/2004 (UFPA / IESAM)

Skills and Abilities	Graduate	Job Market
Control System and Automation (Robotics)	90%	10%
Digital and Network Systems (Applied Telecom)	30%	70%
Computer Systems (Software Development)	10%	90%
Manager Systems (Data Base Management)	10%	90%
Other Knowledge's (Computer Graphics, Game Development)	10%	90%

analysis in the development of control algorithms and machine learning [23], [24].

As an example of the significance of this knowledge, with respect to aspects of professional advancement of students from Computer Engineering degree, in Table 3 presents a survey of the sequence these studies.

The table 3 shows the inter-relationship of the activities and the subsequent quest for academic professional life. This sample was obtained at the Amazonian Institute of Superior Studies - IESAM and the Federal University of Para – UFPA, through monitoring of their students who graduated from Computer Engineering, 2003/2004 entry. Observe that this course was created recently in northern Brazil (2001) and, therefore, it is possible to have a current profile search option for professional activities or academic job market in your present moment.

In this study it is observed that those students who opted for the area of Control Systems and Automation Robotics, with work focused on acquiring skills in robotics, sought to keep in Postgraduate programs offered by universities.

This shows the great importance by the search for qualification, for here is considered that these students understood the purpose of the real meaning of their knowledge learned. That is, a systemic knowledge can interact at any level of learning. The table 4 presents the 10 robots developed between the years 2005 and 2012 in northern Brasil [25]–[35], some projects based in this research are presented:

A. ROVCAM

This undergraduate project is an underwater remotely operated vehicle (ROV) presented in fig. 8, with the objective of accomplishing the inspection of submerged structures through the image acquisition. This work is part of project "Aquatic Inspection in Waters of High Turbidity" at IESAM.

Your supra-system is the rivers that feed hydroelectric plants in the Amazon. This requires that its structure is resistant to water to great depths, and the motors are strong enough to the submarine overcome the currents and other natural adversities. The sensor is a high definition video camera to capture images of the hydroelectric plant underwater structure. The actuators are six thrusters with high cycle to move in the aquatic environment, and four aquatic spots of high brightness to open vision in turbid [25].

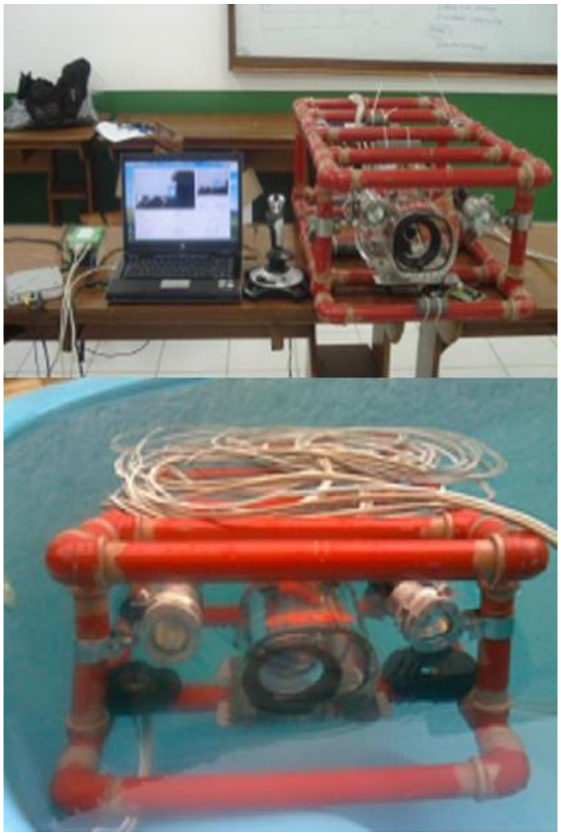

Fig. 8. ROVCAM – underwater wired remotely operated vehicle and your computer control station.

This robot has 6 degrees of freedom (DOF) and allowing you to make complex maneuvers and maintain stability in the zero depth defined by the controller. ROVCAM's mission is to replace the diver (human) inspection of the containment grids in power plants, as this is a dangerous and strenuous activity.

B. SELVABOT

The aim of this undergraduate project is to design a versatile robot intended for assistance and monitoring applications. SELVABOT version-1 is a mobile robot used to be operated in hazardous areas remotely through Bluetooth wireless communications, and presented in fig. 9.

The structure was built to withstand impact and temperatures up to 150 ° C, this because the supra-system of this robot is the industrial type commonly, so it can be used for rescue work, image registration, and target identification, ventilation ducts for air conditioning or oil leakage, among other situations difficult to access by humans. The structure of the robotic system is made of aluminum shipbuilding, which is internally lined with a blanket in order to protect your electronics [26].

Fig. 9. SELVABOT – Inspection Mobile Robot Version 1

In this first version were tested action of temperature on the structure of the robot, it was observed that its operation remains stable up to temperatures of 150 ° C for 10 minutes remaining attached. Its action sensory are temperature sensors and the use of LM35 temperature sensor with analog output of 10mV / 1° C and dynamic range of reading from -55 ° C to 150 ° C. The other sensor is a video camera to capture the type of images. The temperature data and images are sent via Bluetooth to a mobile smartphone or via Zigbee to a computer control station.

C. AEROSONDE

This graduate project in Electrical Engineering is a study about aircraft flight control systems, that covers the design of LQG/LTR (*Linear Quadratic Gaussian Control Design with Loop Transfer Recover*) and fuzzy controllers, to develop an autopilot tested in simulations with a non-linear model of the unmanned aerial vehicle (UAV), Aerosonde. The fig. 10 presents the simulation of Aerosonde [27].

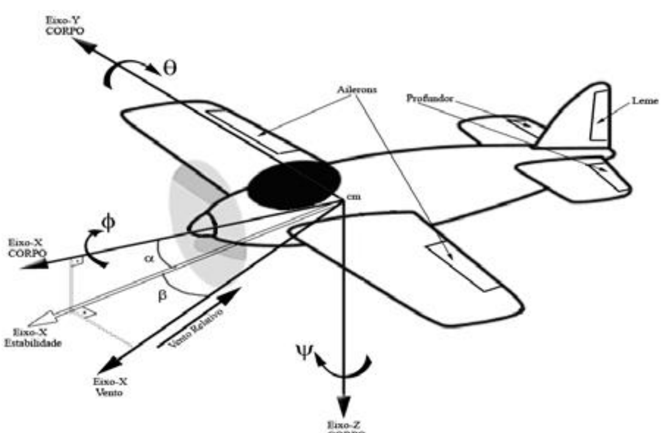

Fig. 10. AEROSONDE – Simulation of the UAV Control System

Further-more, a navigation system is designed for the planning and tracking of a pre-established flight route in two simulations, one with meteorological disturbances and parameter variations of the model, and another, in ideal conditions.

D. GETFOREST

This is non-conventional robot platform presented in fig 10.

TABLE IV
MAJOR PROJECTS IN ROBOTICS DEVELOPED BY STUDENTS OF COMPUTER ENGINEERING OF IESAM/UFPA, FROM 2005 TO 2010.

Robot Project	Type/Mission	Institution	Year
ROVCAM	Submarine Teleoperated	IESAM	2005
SELVABOT-1	Terrestrial Teleoperated Outdoor and Indoor	IESAM	2007
TROPINHA	Terrestrial Teleoperated Indoor	UFPA	2007
ROBONIC	Terrestrial Teleoperated Indoor	UFPA	2008
ASPIRABOT	Line-Follower and Sonar Avoid Obstacles Autonomous Indoor	IESAM	2008
ALFAUNO	Line-Follower Autonomous Indoor	IESAM	2009
PROTOS	Line-Follower Autonomous Indoor	UFPA	2009
AEROSONDE	Aerial Unmanned Autonomous Simulated Outdoor	UFPA	2008
LOGBOT	Autonomous Guided Vehicle Indoor and Remotely Operated Vehicle Outdoor	UFPA	2009
GETFOREST	Non-Conventional Robot For Forecast and indoor/outdoor Environmental Monitoring	UFRA	2010

Fig. 9. GETFOREST – A non-conventional robot for Environmental Monitoring in Maiandeua Island.

Robots of this type commonly little or not move, but they have all the properties and requirements shown in tables 1 and 2, except the motors [29]. The GETFOREST has – an embedded computer is a Microchip PIC18F252 8 bits microcontroller; SHT75 digital sensor of temperature and humidity; The Zigbee module is the wireless interface channel of communication. The Supra-system of these robots is usually forests or agricultural areas where surveying accuracy is an important factor for safety and increase productivity of the field. In these cases the robot must always be at a fixed point to the form data acquisition historic of the field for reliability assessment of climate behavior [28].

These projects were developed through undergraduate interdisciplinary project of the disciplines, or as a dissertation project in graduate programs focusing on computer or electrical engineering. From the third period of undergraduate computer engineering, the student already has the framework of knowledge and ability to initiate the integration of their expertise in the design of a mobile robot.

VI. Conclusion

Robotics is an inherently multidisciplinary field that promotes teamwork, technical competency, innovation and lifelong learning, and can be used according to their student's intellectual and cultural levels. This work claims that the architectural treatment to build these resources together with a model-driven development process will help the development educational engineering process through the systems thinking and mobile robotics. So, several process steps as well as a better use of this resource by the teacher, comes to enable the effective tool for improving the recruitment and retention of students in stem fields.

At this stage, the LOGBOT is a prototype and is a low cost project, whose focus is teaching the study and application of mobile robots based on knowledge of the whole, from the simultaneous interaction between the natural and social resources of so as to analyze the same or interference with the ability to identify links of particular facts of the systems as a whole.

Every human action is an environmental action and as a man, a robot acts on the environment and the environment acts on the robot. Therefore knowledge of the environment (**supra-system**) is important in the selection of parts (**sub-system**) in the design of a robot (**system**) or any system.

The LOGBOT was designed and built with the use of a systemic view in a graduate thesis in electrical engineering, whose research on energy systems [35]. With the use of systemic view, the engineering student acquires experiential knowledge to build real robotics systems. All this involves the theoretical abstraction of the parts, and the integration of these parts that result in the entire system and its relation to the environment and their adversities. All project and videos are available on the page (http://www.ciberfisica.org/logbot) [19].

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