FUNDAMENTALS AND DIRECTIVES TO BUILD A ROBOT WITH LMEEC TECHNOLOGY PART IX: ALDEGUNDA 3.0

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ABSTRACT

A robotic pedagogical prototype is shown to disseminate science and technology that directly impacts the connection between university and society and that is a tool that can be used in the areas of education, research and development. The biped robot is conditioned to reproduce routines of movements used in therapies with children with autism.

INTRODUCTION

Since the Edison's Principle of "Always Current", when Mr. Tomas Alva Edison dubbed "The Wizard of Menlo Park", the Founding Father of our Institute (AIEE + IRA = IEEE) developed many devices that greatly influenced life around the world, including the phonograph, the motion picture camera, and the long-lasting, practical electric light bulb. He introduces an intrinsecal and hidden principle kowning as "Always Current" **[1]** to spend and waste the electrical current, this means, the electrical current must always circulates always inside the electrical circuit to guarantee the complete functioning of the circuit of device, this would be called the IEEE zero standard. Opposite Mr. Nicola Tesla Principle that consists in maintain the electrical circuit without current until a switch has been close **[2]**. With this Edison's principle this paper will illustrate how to make the first step to build a robot. But before to start it is necessary to learn what a robot is and what its systems are. Communications World has been changing dramatically with the ocurence of the world wide web in 1993 finally a good part of the population could access a global data network that for a long time was the exclusive use of Universities and of the Department of Defense of the United States of America The possibility of remote control and maintenance operations was seen using the internet and this will be the focus of this project, which takes as a starting point the possibility and scope of using the internet as an easily accessible means to allow control and the maintenance of electronic devices.

IX. Pedagogy and Robots. The teaching of how to make robots is the principle of the design of mechanical structures of bipedal robots, especially when it comes to emulating movements of the human being. Human locomotion has been described as a series of alternating, rhythmic movements of the extremities and the trunk that determine a displacement with respect to the center of gravity. Although the movements to obtain a displacement can be described in general, there are differences in the way of walking of each individual. The cycle of the march can be analyzed since the foot contacts the ground and ends with the contact with the ground of the same foot. There are two components of the gait cycle that are: the support phase and the rocking phase. When the leg is in the support phase is because it is in contact with the ground and when you take off is in the swing phase. The linear distance between a point of contact of the foot and the point of contact after taking a stride is known as step length and is fundamental in the calculations of speed and acceleration that can develop in the cycle of the march. "The control of a robot involves having all the gdl insured. Using engines and rigid structures can perform pre-established routines and emulate a movement similar to that of humans. This approach can be used as a starting point in the construction and control of bipedal robots. The bipeds are programmed to walk slowly keeping their center of mass in balance by means of the movements of the foot when making contact with the ground, this principle is known as ZMP (Zero MomentPout). Problem Statement. The construction of a bipedal robot with a structure in which emulation algorithms of human behavior and capacities can be implemented, is part of a solution to solve the application problem where a biped robot or one of its mechanical parts is required (ex. arms, torso, head, etc.). Researchers and students can acquire a large amount of knowledge of the disciplines related to the design, construction and programming of robotic mechanisms such as mechanics, electronics and computers, in addition these mechanisms are put to work to support teaching of concepts from various disciplines in the area of information technologies. Currently in the Technological Nezahualcóyotl University and Autonomous Metropolitan University there are several projects of biomedical engineering, communications networks, artificial intelligence, etc. that can not be proven in prototypes on a physical level. There are works with humanoid robots that complement therapies with children suffering from an autism spectrum disorder, but few researchers are dedicated to the study of the subject and one of the great difficulties is the cost of the robots they use for practice. Our design aims to contribute with a tool to further develop the study of the interaction of robots and children with autism. Autism. Autism or Autism Spectrum Disorder (ASD), refers to a broad range of conditions characterized by challenges with social skills, repetitive behaviors, speech and nonverbal communication. According to the Centers for Disease Control, autism affects an estimated 1 in 59 children in the United States today.

Restrictions and limitations. To carry out the administration of a project, the relationship between the time dedicated to the realization with the scope and the assigned budget is considered, which usually produces a quality according to the proportion of the other areas. The basic concept that every project manager must handle is the one referring to the triangle of project management. The idea is to be clear from the beginning about the scope of the project, the time required and the budget necessary to complete it. These are the three basic parameters that will have to be dealt with in this project and that, in the end, will determine to a large extent if the project was successful. In this project, the completion time is 12 months, which is the planned time covered by a research in the Master of Science and Information Technology. The estimated budget for acquisition of materials is $ 20,000.00 MXN, this amount can be variable depending on the provider. The expected scope is to cover the objectives in their entirety. The limitations of this project are: Stability: This paper does not address the issue of stability, because a balance analysis has to be done that is not included in this scope. Mechanical scheme: The robot is in a first version in terms of mechanical design, meaning that the design can change in later versions to optimize the movements that can be executed. Electronic scheme: In the part of sensors only those necessary to achieve basic movements of the robot are studied. Leaving the robot's self-control part very limited. Control scheme: The robot does not have a closed control loop, so it is limited to a running cycle without control. Studies have been conducted to apply a control but are still in the development stage. Movements: The movements of the robot do not have an analysis of continue movement, therefore the robot performs movements abruptly. Method. Develop a strategy that facilitates the understanding of the design, construction and manipulation of a robotic prototype. Robots are generally designed and built by robotics engineers, however robots are used in various areas that do not necessarily have to do with this discipline. There is no career that explicitly contains topics of robotics, but there is a great interest in building robots to evaluate different jobs carried out in the careers of Electronic Engineering, Biomedical Engineering and Computer Engineering. The robots are built in an increasingly shorter time and with better characteristics. Designing and assembling robotic mechanisms involves two fundamental aspects: maintaining a precise movement and responding to a sequence of specific instructions, that is, a program. For this, different strategies are followed. In particular, we want to exploit the skills of each student in their area of study in the same project. We start with the contribution of Joseph Marie Jacquard [14] with the idea of separating the mechanical part (hardware) from the part of the realization of a control program (software). Applying the same concepts but in an extended way, we propose to separate the project into three blocks: Mechanical block. This block has the task of configuring different parts between the actuators, to generate a specific movement and at the same time achieve the desired morphology, taking into account the position of all the elements involved such as the battery, electronic cards and wiring, to mention a few. Electronic block. In this block, the most suitable components will be searched to operate the actuators, from the power supply and control part, the signal processing cards, sensors, etc. Always trying to make the components as simple as possible. Control block. The brain of the robot, to make an analogy to the human being. In this part the instructions that are going to be executed by the robot are programmed. Performs the ordering and processing of data from sensors and the manual control system. Separating into three systems, it is intended that biomedical, electronic and computer students use their skills in a better way to contribute to the construction and start-up of a robot. The development of each block used the scientific method, which is a procedure to reach an objective, through hypothesis, experimentation and observation. In the development of the mechanical system a preliminary analysis study will be done to give the best solutions to our problem taking into account all the important requirements. It will continue with prototype design. Once the design meets the requirements, the prototype components are assembled. Finally, the relevant tests are carried out. If an error is detected, the process is reconsidered from the analysis and the steps are repeated in each of the blocks. Putting the bipedal robot into operation. During the development of the project will participate in different forums for dissemination of Science and Technology, will be developed presentations where the public is invited to participate in robotics projects. Students will work with the university to achieve terminal projects or social services in conjunction with this project. One area of application for the biped robot is in helping therapists working with children with autism. Autism is a developmental disorder. It affects communication, imagination, planning and emotional reciprocity. Symptoms, in general, are the inability to social interaction, isolation and stereotypies (uncontrolled movements of some limb). Children with autism present specific skills, such as arming or dismantling blocks or mechanical devices with complex circuits for their ages, musical and pictorial skills and can have excellent photographic memory. Among the therapies that are performed with children with autism are aerobic movements to stimulate control over their extremities. These needs, limitations and abilities if we put them together we can say that a child with autism needs to have therapies of limb movements but there is the problem of not having empathy with a strange human being which makes it difficult for the child to pay attention to the routines, On the other hand, the skills tell us that it has a great liking for robots because they have the advantage of considering their movements predictable compared to a human being, therefore, a robot that reproduces the movements is expected to attract more attention of the child and that the therapy obtains better results. At the 2017 Annual Conference for basic and applied research on the interaction between humans and robots, the Japanese Ryo Suzuki, Jaeryoung Lee and the American Ognjen (Oggi) Rudovic, presented the article "NAO-Dance Therapy for Children with ASD", where they show that the hypothesis of working through a robot with a child with autism has better results compared to the work performed by a child human, however it is not intended to replace the therapist, what you want to provide is support for the development of therapies in the motor system of children. At the end of the construction of the biped robot, the movements and safety measures will be conditioned to emulate the movements that are worked in a motor therapy. The whole system will be put into operation in the different dissemination forums that will be participated by doing pilot tests and adjusting to be used in the field by a therapist. Another of the sequences that will be tested is that the robot teaches the child the parts of human body, especially the robot shows the location of the head, hands and feet. Assignment of degrees of freedom. Each independent movement that an articulation can make with respect to the previous one is called gdl (degree of freedom). The number of gdl of the robot is given by the sum of independent movements the structure can make. Mechanically it is formed by a series of elements joined by articulations. To determine the gdl the robot will have, first you have to decide which articulations of the human body will be represented, then which type of movement the articulation performs to know how many actuators can be represented and thus the gdl are obtained.

Joints of the robot. The starting point is to create an idea of the morphology that the robot will adopt. For this we rely on the structure of the bony system of the human body. The joints that unite the longest bones were identified and they provide an appropriate mechanism to exercise movements similar to human beings. For the project seven points were identified: neck, shoulder, elbow, hip, wrist, knee and ankle. Assuming that the torso is the block that joins the extremities of the body (head, arms, legs), we have the first joints that our robot will emulate. Subsequently, each limb is analyzed. The head has a joint corresponding to the union with the torso (neck). Each arm will have three joints corresponding to the shoulder, elbow and wrist. In each lower limb there will be three joints corresponding to the hip, knee and ankle. In total, the robot will have 13 joints. It should be remembered that a joint may have one or more gdl depending on the movement it performs, however in this work the number of gdl in each joint is limited. Having identified the joints, we elaborated a sketch of the morphology that we intend to build. With the realization of the sketch we have our guide plane in the construction of the robotic mechanism. The first approximation of the design lacks dimensions, as well as a defined task for each of its parts, however we obtain the visualization of a concrete idea of what the final design of the robot will be. This approach is known as the robot's plane model. Assignment of actuators. Actuators are the basis of the mechanical system. Their mission is to generate the movement of the joints of the robot according to the orders that the control unit sends. There are different types of actuators for each work in particular and they are grouped depending on the source of energy that feeds them. More often we can see robotic systems powered by pneumatic, hydraulic or electric energy and the choice depends on the requirements of our system. Types of actuators. The main characteristics to choose the type of actuators that will be used are: power, control, weight, volume, precision, speed and maintenance. Table 2.2 shows the comparison between three types of actuators according to their power supply. Hydraulic actuator. Actuators driven by the pressure generated by the compression of fluids are known as hydraulic. These actuators (which are the oldest) are classified into two major groups: The first is distinguished by the gears that are driven directly by oil under pressure, and the second, generates its rotary movement thanks to the oscillatory action of a piston or firing pin; This type has higher demand due to its greater efficiency. Hydraulic actuators are used in jobs where a large amount of force is required and maintenance is usually slow, so they are discarded for the design of our robot. Pneumatic Actuator. Actuators that are driven by compressed air pressure are called pneumatic actuators. This type of actuator has the advantage of requiring little maintenance and are used mainly in places where it is required to have a hygiene control, but are discarded for our project because you need to have the actuator connected at all times to an air compressor. Electric Actuator. The structure of an electric actuator is simple compared to that of hydraulic and pneumatic actuators, since they only require electrical power to generate a magnetic field and generate movement. There is a large number of standardized models and they are easily available in the market. In addition, they can be combined with gear box adaptations to make them more effective in robotics projects. For this type of actuator very little maintenance is needed.

1. Robot design. When developing a mechanical design, different aspects must be considered to meet the objectives. In this part, the previous study of the number of joints, the gdl, the type of actuators and the material that was chosen to assemble the robot is put into practice.

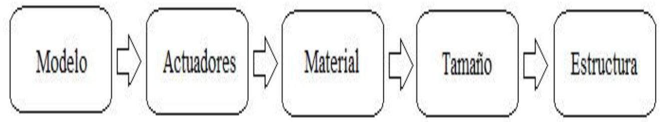
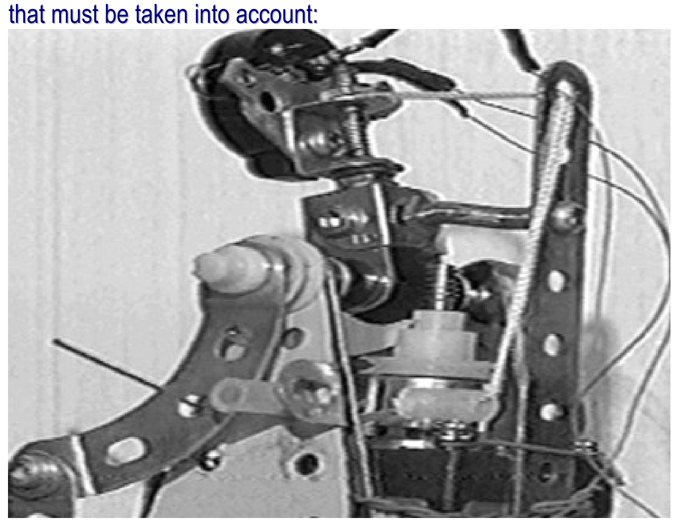


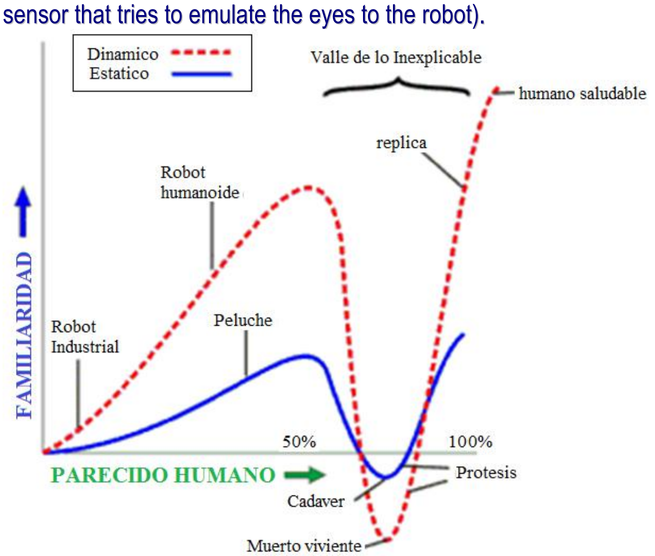
Figure that shows a block diagram of the steps to follow in the mechanical design for a bipedal robot. In the model block, the number of gdl that the robot has was assigned and the first approximation of the design was drawn. In the actuator block it was chosen to use servomotors. In the material block, a study was made of different types of material that can be used to join the servomotors. The dimensions of the torso of the robot and its extremities are defined in the size block. Finally, in the structure block, the configuration of the position of each piece is established to conclude with the mechanical design of the robot.

2. Design size. The proposed design respects the dimensions allowed to build humanoid robots of the "RoboCup Soccer Humanoid League Rules and Setup", which is a world soccer tournament among humanoid robots endorsed by the Institute of Electrical and Electronics Engineering (IEEE). The dimensions correspond to the morphology of the human being at scale and try that the limbs of the robot have adequate proportions. The Mexican Robotics Tournament (TMR) also follows these measures, so it was decided to design according to the IEEE recommendations. The next figure shows the restrictions on the dimensions of the robot that must be taken into account:



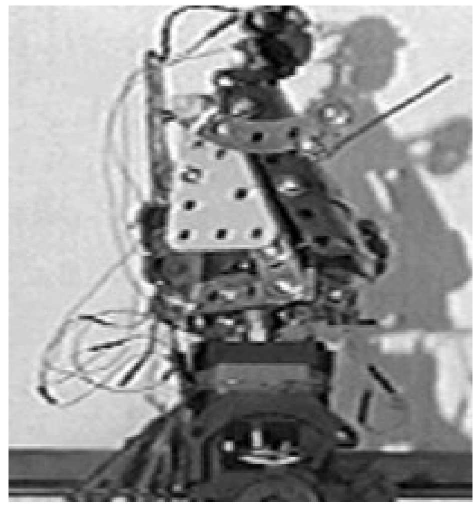
Total height 30 cm ≤ Htop ≥ 60 cm. Each foot must fit in a rectangle of area Htop2 / 13. The robot must enter a cylinder of diameter 0.6 Htop. The sum of the lengths of the two arms and the width of the torso on the shoulder should be less than: 1.4 Htop. The length of the legs Hleg (including the feet) 0.35 • H ≤Hleg≥ 0.7 • H. Head height Hhead including neck 0.05 • H ≤ Hhead≥0.25 • H Must not have a configuration that exceeds 1.5 • H.

3. Appearance of the design. The design considers the final appearance of the robot important. One of the purposes of this robot is to spread Science and Technology through participation in conferences, visits to educational institutions and competitions in different branches. When having contact with a large audience of spectators, especially children and young people, took into account that the more similar a human being has to the robot, the more empathy it will have with the audience. A hypothesis on which we rely to define the appearance of the robot is "The disturbing valley", which was explained by Masahiro Mori in 1970, which states that when anthropomorphic replicas look and act almost like a real human being, they cause a rejection response among human observers. The "valley" in question is an inclination in a proposed graph, which measures the positivity of the reaction of people according to the human likeness of the robot. The theory is summarized with a graph divided into two axes: the horizontal, which represents the degree of familiarity or empathy with the robot; and the vertical, which indicates the level of resemblance to a human. The curves that cross it vary if the robot is static or in motion, since, according to Mori, the animation has an augmentative factor: they increase familiarity, but also the discomfort when they enter this "inexplicable valley". Although Mori's theory tries to explain the psychological implications of the interaction with robots created in the image and likeness of humans, it does not end up providing enough scientific evidence. The author continues saying that "there are many variables involved that can cause us to react in one way or another to these very human robots". As can be observed in the graph of the "disturbing valley" of figure at last, the X axis has a scale of percentage of human appearance from 0% to 100% and the Y axis has a relative scale, where it is about describing the perception family that a person has when they see a robot. There are two graphs, one of them is for robot without movement (static), in this category, for example, a toy with robotic form but without movement, has a medium familiarity but remains below 50% of human resemblance, in Contrast a prothesis has a low familiarity or empathy but not a great human kinship. The graphic that interests us is the one of robot with movement (Dynamic), in this category is where the behavior of the valley of the disturbing thing is appreciated more. In this category are the industrial robots that have a low familiarity but also a low percentage of human resemblance. As a robot becomes similar to a human being has a high degree of empathy with robots, until this kinship causes uncertainty when the appearance and behavior of the robot become too similar to a human, this phenomenon can be seen in science fiction movies where robots simulate have a life of their own and cause panic to human beings. Our work is in the area of humanoid robot and is far from falling into the valley of the disturbing. Approaching the valley of the disturbing would produce reactions of rejection of the audience which would not achieve the goal of generating interest in robotics. The precautions that were considered were; do not use parts that are related to any human prosthesis, do not generate aggressive movements (forcefully and quickly), place the electronics in a place not visible to the public and use sensors that generate familiarity, (for example the ultrasonic sensor that tries to emulate the eyes to the robot).



Finally, the prototype is:

And



CONCLUSIONS.

The construction of two bipedal robots was successfully. Undoubtedly pedagogical robotics plays an important role in the development of students' abilities regardless of their ages, so we cover the basic procedure that marks the literature on the construction of a pedagogical prototype, that is, the Analysis of the problem, in which the environment is investigated and explored to propose the problem to be solved (therapy of movements of children with autism), design, in which possible solutions are sought and the goals to be covered are projected, construction, in which assembles the model with the parts and materials appropriate to the problem, programming, in which the software defines the movements and behaviors of the prototype, tests, in which the prototype is put into operation and the results are analyzed, documentation, which evidence is collected that prove the functionality of the design, presentation, in which the prototype created as alternative solution to the problem. Leaving in the University a robot that has low cost in comparison with the Bioloid robot and where future investigations can be made. Participation in science and technology dissemination forums means that knowledge and proposals to solve society's problems. This is the best work for LMEEC Technology.

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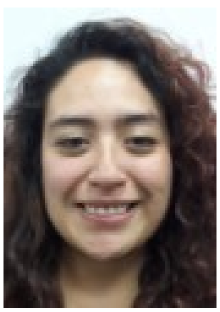

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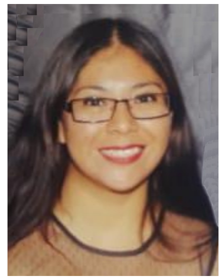

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