Mechatronics in Mexican Agriculture Current Status and Perspectives

Jaime Cuauhtemoc Negrete

Private researcher graduate in Agrarian Autonomous Antonio Narro University
México

Abstract *In Mexico the pressure for food is increasing, as in other countries, so there is no way to make use of modern technologies for providing food for the growing population, these technologies are precision agriculture , automation and robotics, which were based on Mechatronics, which is an integrative discipline in the areas of mechanics, electronics and computer science which aims to provide better products, processes and systems. As the aim of this paper review the status of the applications of mechatronic in Mexican agriculture and perspectives for the future.*

Keywords
Agriculture,México,Mechatronics.Automatization,Greenhouse.

I. INTRODUCTION

Mechatronics new agricultural revolution in agriculture. The first revolution in agriculture in the twentieth century was the Green Revolution, beginning in the 40s as a solution to world hunger, making genetic improvements in seed and innovating with the use of synthetic fertilizers, crops such as corn, wheat, sorghum and soybeans among others. The Green Revolution refers to a model implemented in agriculture in order to obtain higher yields, after the industrial revolution with the requirement of food production to support industrialization and the presence of both scarcity and climate events, pests and diseases. As the population continues to grow exponentially it is necessary to implement other agricultural revolution in the XXI century revolution .This is agricultural mechatronics or agri mechatronics . In Mexico the pressure for food is increasing, as in other countries, so there is no way to make use of modern technologies for providing food for the growing population, these technologies are precision agriculture , precision livestock, automation and robotics, which were based on Mechatronics, which is an integrative discipline in the areas of mechanics, electronics and computer science which aims to provide better products, processes and systems. Mechatronics is not, therefore, a new branch of engineering, but a recently developed concept that emphasizes the need for integration and intensive interaction between different areas of engineering. Whereas they Mechatronics is the synergistic combination of precision mechanical engineering, electronics, automatic control and computer systems for the design of products and processes, which seeks to create more complex machinery to facilitate the activities of human beings through electronic processes.

Bio-mechatronics is an innovative way of mechanization within the scope of the rural engineering that goes beyond the conventional concepts of mechanization and is based on the synergy obtained with the combination of different technological areas; agricultural mechanization engineering, instrumentation, control systems and technology (artificial intelligence and information technology).Barreiro 2002

But in our country and some other you have another concept of bio-mechatronics that define the integration of electromechanical machines with the human body, in principle, for therapeutic uses, as would robotic prostheses directly connected to the patient's nervous system that can restore mobility or give you never had. Given the above difference in the concepts of bio-mechatronics the agri-mechatronic or agricultural mechatronics term is proposed. Applications in agriculture and animal production are numerous; They are a reality today; Automatic guided tractor electronic

control failures planters, automated control trans planters transplant failure, electronically controlled dose of fertilizer using GPS maps as fertility, pruning robot for vineyards, agricultural robots (Agrobot, robot mower Lawnmower and others), robot for graft ,sheep shearer robot, robot milker , meat cutter robot, robot shepherd, robots for harvesting fruits and vegetables, robots that eliminate weeds are already replacing agrochemicals, sensors for early detection of diseases in plants and animals, cotton picker robot is already in development in China.Mulan,2008. The country needs these technologies to rapidly increase food production. This is possible because it has the infrastructure and human capital in sufficient quantity, one study estimates that in Mexico every year around 2,500 students graduate mechatronics of more than 150 schools that offer this specialty, at all three levels (bachelor's, master and Ph.D.)Anonymous 2014.So the new agricultural revolution in Mexico is feasible as long as the conditions for it by promoting the research in institutions devoted to teaching and research in mechatronics towards applications in agriculture and livestock. As the aim of this paper review the status of the applications of mechatronic in Mexican agriculture and prospects for the future.

II. MATERIALS AND METHODS

For data collection searched in printed data bases , Internet, magazines scientific, professional and postgraduate university thesis, newspaper articles, etc.

III. RESULTS AND DISCUSSION

In Mexico applications to agricultural mechatronics are they have focused mainly on greenhouse automation, next the work done in the country are described.

Proposed the design and implementation of an Integral Intelligent System called JAPIEST , with is focused on the prevention, diagnosis an control of diseases that affect tomatoes (Lycorpesicum esculentum).Plants and farmed inside hydroponic greenhouses, whose particular conditions of temperature, humidity and nutrient consumption can influence directly the surge of plague or diseases. Based on an integrated development environment involving, Java,MySQL,RULE and some interconnecting modules, an expert system is help growers with some helpful advices from experts in different domain. Based on JAPIEST , could be possible to provide automated hydroponics greenhouses with cooperation and autonomy capabilities in order to share information and knowledge for the maintenance of healthy crop production cycles. Some extensions can be targeted on the on-line- supervision and management of: (i)main production,(ii)recollection,(iii)packaging and (iv) delivering. More over , the integral project also considers to feed nutrients automatically, and to control the environmental variables of the Automated Hydroponic Greenhouses. Lopez -Morales 2008

Torres 2010.Design,construction and testing the prototype of an automatic machine to prepare compost from organic household solid wastes, the prototype has the capacity to process 3 kg of organic household solid wastes daily, which is the approximate amount of this kind of wastes generated each day by a typical family of five members , the waste processing is continuous , and composing lasts 30 3ays,sice the wastes are introduced into the composer ,until they come out of it, as a product with acceptable biological stability, with could be applied directly as amendment to the cultivated soil. As part of the design of this automatic composter, calculation were made for its dimensioning ,plans of the prototype were drawn up, the technical specifications and assembly diagrams for the construction were determined, besides the source program and circuit diagram.

Diaz.2011.Perform the control and automation of a greenhouse, said environmental control in the greenhouse is based on various control systems, such as; pH control in the solution required for each type of plant, control the pumping system, the control of

irrigation, the humidity control in adequate hydration depending on the type of plant, the level control in water storage and the temperature control and control of greenhouse illumination ,and automation was done with a programmable logic controller (PLC), which establishes control in the final control elements by means of signals channeled to the sensors and transmitters decoded by simulate the natural ecosystem.

Lugo 2011 . Made a prototype based on the integration of three technologies; computing, communications and electronics in order to automate the irrigation's control for closed or open systems. Soil information was provided (sand content percentage , clay, organic matter and bulk density) and crop´s as well(type ,duration, root growth functions).With this information a water balance was developed, with results in the decision to irrigate or not, any of the crops. When , as a result of the abatement of water in the soil function in conjunction with water balance, is determined to be watering, the software sends output signal by the RS232 serial port of a computer to an electronic device to operate the irrigation physical devices and supplementary(e.g. electro valves, fans, lamps,)-A bidirectional communication subsystem PC-GSM-Cell modem was integrated, with allows turning on/off device, using remote commands from a cell phone, as well as sending alarm and warnings that indicate the system status through test messages and emails via mobile phone. The automation system was designed in modules, with allows in to adapt to various applications amenable to automation and control.

Carrillo and Vásquez . 2008 . Work aimed to automate systems for temperature, humidity relative, irrigation and soil moisture of a greenhouse. For this they will use the S7-200 PLC because with this you can take control of all the variables simultaneously. For control of temperature and relative humidity using the theory of reasoning approximately, which it is an introductory part of fuzzy control. This allows the two variables they interact in a single control, and an function of another.

Cepeda .2010 .Design, analyze and implement of a intelligent greenhouse developed by the Tecnologico of Monterrey, Mexico City Campus, which seeks to propose on innovative model to improve the quality and quantity of hydroponic crops in the region. Its focus is based on a sustainable development approach considering a robust design that integrates reliable, simple, efficient, ecologic and low-cost system with the aim of achieving the automation and control of the microenvironment in support of the farmer. The application of control techniques using fuzzy logic governing the greenhouses environmental variables helps to create a microclimate ensuring the optimum crops growth. The use of renewable energies (solar and/or wind) provided the greenhouses with some sense of autonomy and gives it an ecologic conscious together with an hydroponic irrigation system oriented to the efficient use of water. Initially its low cost and automation make this greenhouse accessible and a true farming solution to increase the farmers and Mexican field productivity.

Rios 2012.Proposes an alternative solution to protected agriculture for control pests in a greenhouses controlling the physical access in an automated of the greenhouses , with an access and exit protocols. By some phytosanitaries measures, it reduces the presence of parasites and improves safety and exclusion. A FPGA based access systems was designed, deployed and installed through inputs and output peripherals , such as sensors and actuators in order to detect phytosanitaries measures based on concrete decisions. Disinfection of footwear, hand washing, and proper attire are conditions that the users must comply in order to enter into the greenhouses: identification and authentication is based on Radio Frequency (RFID). The FPGA architecture (arrangement of field-

programmable gate) used at a low cost connectivity allows various sensors and actuators for the detection of various conditions to which the user has to submit to meet the protocol specifies that the system developed : This architecture allows the parallel, therefore, several processes are running at the same time, which will enable / disable different machines states taking appropriate decisions to establish the state in which the input and output protocols are. These are the advantages of using a parallel architecture in relation to a microcontroller. The development of the system can be installed at any greenhouse containing water and electricity.The confidence level of an automated access control system for greenhouse based on FPGA is 97.4% compared to manual access. This demonstrates the effectiveness of the system being able to diminish the presence of major insects cause major damage to tomato crops, this due to the implementation of mechatronic systems based on FPGA technology to keep track of users and radio frequency identification (RFID).

Guadarrama .2014 . Proposed for the automation of a greenhouse climate considering the variables of temperature, humidity, PH, CO2 and lighting; it was designed so DeviceNet communication network suitable for work at low level, ie field level without further disruption to the lower ranks of low voltage and milliamp measurement sensors delivering. The heating system used is based food Biogas.Was use a MicroLogix 1500 PLC.

Llamas 2004.Presents calculus of a two freedom degree robotic arm, equipped with a video camera for recording desired images of plants. Images will be sent to a computer for its analysis. Because greenhouses agriculture requires control of informed related with a number of parameters in order to keep the environment under optimal condition for the crops. Images of the plants supplies many useful information for evaluating the state of development of the crop.

Mechatronics history in Mexico began in the early 90s, when several institutions of higher education offer some courses in mechatronics. With regard to companies is difficult to know precisely the date on which the incorporation process or mechatronic products began, however it is known that the automotive industry pioneered and today remains at the head, it is expected that the aviation sector continues gaining strength and this is another pillar in the development of mechatronics in industry. In 1994 starts this educational option Universidad Anahuac del Sur, later in 1997 UPIITA (UPIITA) IPN offers a degree in Mechatronics Engineering in Mexico. Mechatronics in Mexico has grown explosively, never before seen in the country, unmatched by any other discipline, both in the public and private academic environment, but not so in the industrial environment, which remains broadly as an unknown engineering. Mexico shows an emerging development in mechatronics, as its most significant advances focus on prototype robots and arms carried out in various institutions of higher education, technology development in the country is focused on the design of machines, tools, processes and systems as well as maintenance and support.Galindo 2015

In Mexico and even in the world is necesary to emphasize the benefits of inovation that would bring the proper use the synergies of technologies and disciplines involved in mechatronics.The ideal setting for growing snergies in the solution of the social needs presented in engineering projects.Cuervo 2015.

In Mexico the institutions of research and education in mechatronics only University of Quintana Roo has a line of research aimed at the agricultural sector, which includes the development, modeling and implementation of mechatronic systems for applications in the region such as agribusiness (sugar mills, automation of greenhouses, beekeeping, forestry, agriculture), hospitality, processing industry and environmental applications.UQRoo.2015 and the Tecnologico de Monterrey in the cathedra of agronics whose research is focused on this chair are the generation of technology for automation of greenhouses, design and implementation of

mechatronic systems to improve the efficiency of agricultural processes and the development of systems based on the use of renewable energies , dedicated to meeting the energy demands of agricultural field. Together, these lines of research aimed at improving the efficiency and profitability of agricultural processes by generating products of technological innovation.ITESM 2015.

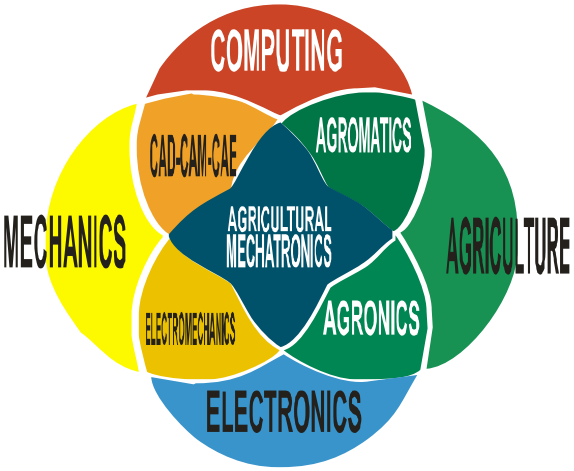

Fig. 1 Diagram with the sciences which cooperate to agricultural mechatronics.

Agricultural mechatronics need of some sciences as shown in Figure 1 including ; the Agromatics which is the application of the principles and techniques of computer science and computer theories and laws of operation and management of the agro intended to serve as operational support in diagnosing problems and in the design and evaluation of alternative solutions .FCA-UNL 2015, and the agrónics so including the use of telecommunications, computer services, mechanics and electronics, applied together to agriculture and livestock. Ureña 2013.

Innovative Agricultural Mechatronics give to support precision agriculture in the small farm holdings of the developing and the underdeveloped countries.It should essentially evolve as a branch of agricultural engineering.Precision agriculture powered by agricultural mechatronics is playing a key role in optimizing agricultural productivity in the developed countries.To prevent food crisis in the years to come,suitable technology to support precision agriculture has to be developed in the developing and the underdeveloped countries.Agricultural scientists ,extension professionals and engineers from all branches of engineering have to join hands to develop more site specific,fuel efficient,cost effective,environment friendly technology suitable for small farm holdings.Agricultural mechatronics will be very much in demand in the developing and the underdeveloped countries in future because precision agriculture is in infancy stage in most of these countries.Since precision agriculture is an approach which optimizes productivity on a sustainable basis, it has immense potential for growth in the developing and underdeveloped countries.Benji 2015.

IV. Conclusions

In Mexico it is possible to increase the productivity of agriculture , if the decision to guide and formed human capital and training are taken at all three levels; Bachelor, Masters and PhD, to the research and application of agricultural mechatronics, results in developed countries so it evidence Mexico can not be left behind in this regard, besides that is the only way to increase food production , applying mechatronics in precision agriculture and agricultural and livestock robotics. So previously treated the perspectives for the agricultural mechatronics in the country are very big.

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