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Research Article

Autonomous Guidance in Agricultural Machines for Mexican Agriculture; A Technology to Increase Agricultural Productivity

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Abstract

Agricultural growth reduces poverty risky, the intensity of poverty and income disparity for society in general. On the contrary, the lack of dynamism in agricultural growth and lack of improvements in the productivity of land and work are a threat to consideration in terms of rural poverty. Autonomous Guidance in agricultural machines is vital in increasing production, since it allows to increase the cultivated area, improving cultivation techniques, lower costs and dignify human work, to carry out such technology the small farmer needs economic energy sources, practical, easy maintenance and operation, and whose working capacity and costs are appropriate to the size of the property. Being the purpose of this paper to review the application of the Autonomous Guidance in agricultural machines to Mexican agriculture to analyze your current situation and your perspectives to increase agricultural productivity and reduce the Mexican rural poverty. In Mexico, the application is practically minimal. It does not have the dynamism that it is taking in other countries, it is necessary to promote it to increase the productivity of small farmers.

Keywords: *Agriculture; México; Internet of Things; Agricultural Technology; Rural Poverty*

Introduction

Agricultural growth reduces poverty risky, the intensity of poverty and income disparity for society in general. On the contrary, the lack of dynamism in agricultural development and absence of improvements in the productivity of land and work are a threat to consideration in terms of rural poverty. Therefore, it is vital for the relief of rural poverty to solve the challenges facing the agricultural sector, including the increase the productivity of the workforce and ensure that agriculture small scale and the segment of rainfed crops are more competitive (World Bank 2009).

The automatic guidance of agriculture vehicles is a key technology in precision agriculture and widely used in agriculture production [1]. There are a number of field operations that can be executed by autonomous vehicles, giving more benefits than conventional machines, a number of autonomous platforms that could be seen in the future. These autonomous platforms would be used for cultivation and seeding, weeding, scouting, application of fertilizers and chemicals, irrigation and harvesting. Two good examples of this process are field scouting and mechanical weeding [2]. Generally, a modern agriculture vehicle automatic guidance system consists of 4 units: A detecting unit that measures the position and orientation of the vehicle; a control unit, as the core of the guidance system, which makes the plan of the path and carries out the path tracking; an executing unit that makes the turn of the wheels according to the command of the control unit; and a monitoring unit, or a field computer as it is called generally, which works as the interface between human and machine. There are 2 main problems to be solved in the agriculture vehicle guidance system. The first one is the measurement of the agriculture vehicle's working conditions, such as its position, heading, speed and wheel angle, among which the most important is the position measurement. There are 2 kinds of position measurement methods: One is the relative method, such as measuring the vehicle's position relative to a guidance baseline based on machine vision; the other is the absolute method, such as measuring the vehicle's absolute position on the earth based on the Global Navigation Satellite System. As the agriculture vehicle automatic guidance system is working in the field, the complicated and non-structured environment makes none of the measurement methods working well all the time. So the multi-sensor data fusion is brought into sharp focus by researchers. By combining measuring data from different sensors with some data fusing methods, such as Kalman filter, particle filter, H∞ filter, and intelligent methods, the measurement accuracy is improved. The integrated navigation systems are mainly GPS/INS, GPS/DR and INS/CNS. The second problem is agriculture modeling and path tracking control methods. Most of the path tracking control algorithms use kinematics models. The two-wheel model is the most frequently used model, in which an agriculture vehicle is regarded as a two-wheel vehicle and its pose is described by its geographical coordinates, heading, wheel angle and speed. Dynamics models based on the Newton second law are another kind of model commonly used [1].

Summarizing, the only way to reverse the situation of extreme poverty in rural areas in Mexico is through new technologies, in the world there is a revolution in the application of this technology in agricultural and livestock production, livestock, this being the purpose of this paper to review the application of the autonomous guidance of agricultural machines to Mexican agriculture to analyze your current situation and your perspectives to increase agricultural productivity and reduce the Mexican rural poverty.

Materials and Methods

A through search was made on the use of the internet in agriculture, using the databases of universities, research centers, scientific journals, the use of the same internet being relevant.

Literature Review

Aditya [3]	An IoT controlled Agri-Rover for automatic seeding was developed, based on the development of IoT control system and conceptual design of Agri-Rover,	India
Kvíz [4]	Evaluates agricultural operator´s stress, mental strain and generally fighting with driving difficulties during operating agricultural machinery sets by means of a heart rate indicator. Different drivers driving different tractors with implements were chosen and evaluated during different field jobs, namely soil tillage and sowing.	Czech republic
Bettio [5]	Comparing the autopilot system with manual pilot in open curve (T1) and closed curve (T2), in the wheat sowing operation. The tests were performed with a set (tractor + seeder) equipped with integrated hydraulic autopilot and enabled to the RTX Center Point® correction signal.	Brazil
Blackmore [2]	Proposes some system requirements for a small autonomous tractor that includes some physical attributes as well as behavioural traits in certain conditions or contexts. The tractor should be physically small, lightweight, reliable, have good real time communication facilities and be managed easily, especially under fleet management.	Denmark
Santos [6]	Evaluate the variability of quantitative losses of peanut mechanized digging with use the autopilot, using the Statistical Process Control.	Brazil
Seido [7]	Proposed system there is a soil-engaging sensing arm to follow a furrow made in previous pass and first driver	Iran
Santos (2017)	Evaluated the main errors arising from peanut sowing operation performed with an auto-steer guidance system by an RTX signal, using the Statistical Process Control techniques	Brazil

Santos (2018)	Analyse the quality of peanut sowing using automatic routing in two paths, curved and rectilinear, based on the error of parallelism and execution error, through statistical process control	Brazil
Yin [8]	Develop an autonomous navigation system that automatically guided a rice transplanter working along predetermined paths in the field. The rice transplanter used in this research was commercially available and originally manually-operated. An automatic manipulating system was developed instead of manual functions including steering, stop, going forward and reverse.	China
Wang [9]	Explore a precise and efficient in-field coordination method to realize flow-shop scheduling for farm machinery fleet equipped with RTK-GNSS based auto-steering system. The new method is based on three-dimensional coordinate system (XYZ), within which the concept of field, operation strip, and operation task were defined.	China
Yin [8]	Develop an electrohydraulic steering control system used for automatically guided agricultural tractors.	China
Nagasaka [10]	Developed a new Global Positioning System (GPS) guided rice transplanter. We developed GPS and IMU guided rice transplanter in previous researches. Those were guided with GPS position data and inertia measurement unit (IMU) direction data	Japan
Czechlowski [11]	Presents the application of a high precision positioning system ASG-EUPOS and its service NAWGEO for agricultural machines positioning. A measurement set was mounted on a cereal combine harvester and consisted of a GNSS antenna and receiver with a GSM modem for RTK corrections transfer.	Poland
Baio [12]	Compare the accuracy achieved by an auto guidance system driving the passes of a sugar cane planter machine over the field versus the manual system, compare the operational field capacity and compare the operational efficiency.	Brazil
Nagasaka [13]	Development of an automated rice transplanter guided by a global positioning system and an inertia measurement unit using the controller area network bus.	Japon
Huizi [14]	Put forward the detection algorithms of the operation routes of the corn harvester and the judgement of the end of the corn field by analyzing the different color features of the visual navigation image	China
Zhiqiang [15]	Novel test method based on virtual reality for binocular vision based guidance system was presented. A virtual system was built with this method. The virtual test system is composed of the modules of test scene, physics engine of tractor, and control of path tracking. The test scene module consists of crop rows, road and four-wheel tractor, which provides image data for pathway detection and road roughness for the tractor. Models of the test scene were created with 3ds Max and Multigen-Creator as modeling tools and with Vege Prime as visual simulation tool.	China
Shuang [16]	An automatic navigation path searching method of agricultural machinery based on GNSS (global navigation satellite system) was proposed.	China
Wanzhi [17]	Improve the precision of navigation control system for agricultural vehicle, an intelligent method of path tracking based on linear time-varying model predictive control is proposed.	China
Aghkhani [18]	Was developed an interchangeable system, with fairly low cost, and moderate technological requirements, constructed and tested which can be installed on most agricultural tractors, and other off-road, self-propelled machineries.	Iran

Bell T [19]	Automatic Tractor Guidance using carrier-phase differential GPS	USA
Bettio [5]	Compare errors in sowing operation in two tractor steering systems: manual pilot and autopilot.	Brazil
Abidine	explored the effectiveness of an autoguidance system based on a real-time kinematic global positioning system (RTK GPS) accurate to the centimeter (about halfinch) in agricultural production	USA
Yangjie [20]	puts forward a method of SINS/GNSS position velocity loose combination navigation by the data fusion, through EKF, of SINS and GNSS. And the feasibility of this method is verified by experiments.	China
Fernandes [21]	Comparative analysis of systems of direction in the operation of spraying by land.	Brazil
Baldo [22]	Speed and direction control between two agricultural vehicles.	Brazil
Oliveira [23]	Evaluate the performance of the use of some auto-guidance systems in sugarcane and citrus. In sugarcane the objective was to evaluate the accuracy of autoguidance system in the furrows opening. In citrus the target was to evaluate the accuracy of auto-guidance systems in the opening furrows for transplanting and to analyze the operational and economical performance of an auto-guidance system compared	Brazil
Santos [6]	Quality of mechanized agricultural operations in peanut cultivation using automatic steering	Brazil
Goehl [24]	Precision seeding and controlled traffic use in agricultural machines: case study	Brazil
Fu [25]	The method for support agricultural priority drivers manually operated steering are proposed, and the electro-hydraulic automatic steering scheme is designed.	China
Baio [12]	Evaluate the accuracy, the cane loss and the operational field efficiency achieved by an auto-guidance system used to guide a sugar cane harvester over the field when compared to a manually-guided machine	Brazil
Pajares [26]	Provides guidelines for selecting machine-vision systems for optimum performance, considering the adverse conditions on these outdoor environments with high variability on the illumination, irregular terrain conditions or different plant growth states, among others.	Spain
Kim [27]	Develop a tracking sensor system using five laser distance measurement sensors, for Automated guidance systems (AGSs) for mobile farm machinery	Korea
Parmar [28]	A comprehensible computer program is developed in Visual Basic studio to determine the tractor parameters for an automated steering system.	India
Perez [29]	Assessed differential signal error from a Dedicated Base Station, OmniSTAR VBS, European Geostationary Navigation Overlay System, European reference frame-IP for internet protocol (EUREF-IP) and radio navigation satellite aided technique (RASANT). These signals were utilized in guidance assisting systems for agricultural applications, such as tillage, harvesting, planting and spraying, in which GPS receivers were used under dynamic conditions.	Spain

Table 1: *Autonomous Guidance agricultural machines use in World Agriculture.*

Autonomous guidance in agricultural machines in Mexican agriculture

In Mexico there is only one work related to the automatic guiding of agricultural machines, that of Yam-Tzec [30], which evaluated lateral error for which the ideal trajectory of the tractor was drawn, considering it as a punctual mass, for which an automatic guidance system was used Trimble® EZ-Guide 250 installed in the Massey Ferguson 592T unit. As a result, the ideal trajectory was obtained, using vectorial equations; In addition, it was observed that in a straight line, when the speed increased from 5 to 9 km · h^{-1}, the path error means increased from 2.0 to 7.0 cm. For the case of central pivot, having the same increase in speed, the behavior of the means was 6.1 to 7.8 cm, with significant differences between treatments ($P \leq 0.05$) [31-36].

Conclusion

From the literature review, the results. show that in Mexico, the application of to Autonomous Guidance in agricultural machines to agriculture is practically minimal. It does not have the dynamism that it is taking in other countries, it is necessary to promote it to increase the productivity of small farmers. There are Human capital to apply the agricultural Autonomous Guidance to agriculture is guaranteed only has to be emphasized that is carried out motivating students and graduates to focus on agricultural and livestock production.

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