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Introduction of GPS System for Use in Agriculture (A: Review)

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ABSTRACT

The overall aim of this article was to further develop and implement a GPS guidance system for use in agriculture. The guidance system utilized the use of GPS signals from two separate receivers to calculate the field position of the machine relative to a starting point. It used this information to ensure the position of the machine was not only in line with a predetermined heading, but also at the right offset from the starting point. The article was undertaken to continue current research in the hope that an effective system would one day be ready for commercial retail for a price well below that of current packages.

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INTRODUCTION

The Global Positioning System (GPS) has become a part of modern-day life. Whether we know it or not, we all use GPS in our daily routines. Since its launch in the 1970's by the U.S. Department of Defence [7] the use of GPS has become immense. It is used to guide aircraft around the world, track emergency devices and guide us around our own countries in the form of in-car navigation. Due to its ability to position vehicles, GPS has been adapted into the agricultural industry in the form of accurate, straight-line guidance systems. These systems have been in development for many years now, with accuracy down to an amazing ±2cm. [13]. However, such mainstream guidance systems are extremely expensive to install (upwards of $80 000) and thus there stands the opportunity for a new cheaper, but still accurate, method of guidance. Enter carrier phase GPS. This system provides agriculture with the ability to have ±2cm GPS accuracy for a fraction of the cost of mainstream systems. It does so because the system does not provide an absolute position in the world - it guides via calculation of displacement from a starting point [1]. A guidance program using this system has already been developed by Professor Billings-ley, but requires further enhancement to make it commercially viable in the agricultural industry. Currently, the software can guide any machine in a perfectly straight line for however long is necessary, but it cannot provide parallel swathing (see figure 1), or guide autonomous of the operator. At the start of this year the system was operational but required user input to steer the machine via an arrow on a computer screen, or a light bar depending on its configuration. It used two Garmin GPS35 receivers, and was able to produce position and guidance data at a rate of 1Hz.

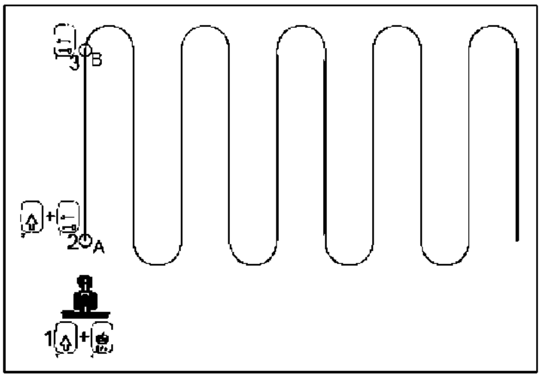

Fig. 1: An example of parallel swathing.

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Research, testing and development is necessary to quantify the performance of this system, improve it for commercial use and compare its abilities with other systems on the market. New advances in technology have provided an ability to upgrade the receivers on the system to produce position and guidance data at 5Hz. The Garmin GPS1 8-5 receiver is an example of such new technology. The GPS 18-5 can output position data at a rate of 5Hz and is thus inherently more accurate than the GPS 35 receiver. Testing of the hardware will be undertaken to quantify the gains in accuracy provided by the new hardware. The software that 'talks' to the GPS35 receivers' needs to be modified to communicate with the GPS 18-5's as some of the receivable information has changed between the models. The software requires the GPS satellite position record (almanac) that can be downloaded from the GPS 18-5 receiver to calculate the location of every satellite in the sky. This is required as the GPS software requires the locations down to six decimal places and the 18-5 receiver only transmits this data as integers. The almanac data must be downloaded, converted and stored ready for use by the guidance program and code must be written to do this. Code must also be written to compare the software satellite location calculations to those coming from the GPS 18-5 receiver. Code must also be added to provide the user with the ability to accurately offset over a required swath width. Increases in productivity and usability will be quantified through the testing of the updated guidance system.

GPS consists of a constellation of 24 satellites and their ground based monitoring stations [13]. These satellites are arranged so that there is between four to ten satellites visible at any location on the Earth at any point in time (as four is the minimum amount of satellites required for accurate positioning). On the 17th July, 1995, worldwide coverage by the GPS system was confirmed - 24 fully operations satellites were operating in orbit [5].

Segments of GPS:

There are three main segments to the GPS system: the space segment, the control segment and the user segment. The space segment consists of the satellite constellation mentioned previously and shown in Figure 2. A GPS satellite transmits a signal made up of five different components: two sine waves (carrier frequencies), two digital codes and a navigation message. The carrier frequencies and the digital codes are used to calculate the distances between the GPS satellites and the receiver; the navigation message contains data about the position of the satellite as a function of time [5].

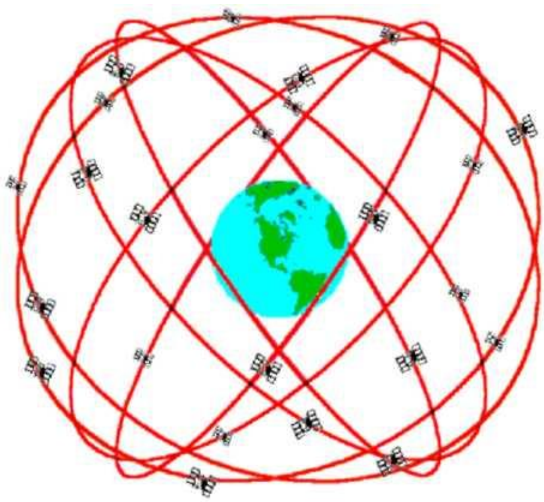

Fig. 2: GPS Constellation.

The control segment of the GPS system is a network of ground-based tracking stations, control stations and a master control station (MCS) (see figure 2) situated at Colorado Springs, Colorado, U.S. This segment is used to track the satellites to determine and predict their locations, the behaviour of their on-board atomic clocks, the satellite almanac and other items. The coordinates of the tracking stations are known extremely accurately and each is equipped with a accurate GPS receiver. The data collected through these receivers is transmitted to the MCS where it is analyzed and data such as the satellite positions, clock parameters and almanac are modified. This is then transmitted back to the satellites through a control station to ensure the accuracy and integrity of the GPS system [5]. to civilian users, anyone with a GPS receiver and antenna can use the GPS signal to calculate their position on the planet to within 8.5m. The system is currently available to all users without charge, which is why it has become so readily adopted into industries such as aviation and agriculture.

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GPS - The Basic Idea:

The basic idea behind GPS is quite simple. If we know the distances between a GPS receiver on Earth, and three satellites in the atmosphere, and also the locations of those satellites, then we can compute the location of the receiver using triangulation [13]. That is all well and good, but how do we go about calculating the distances between the receiver and the satellites?

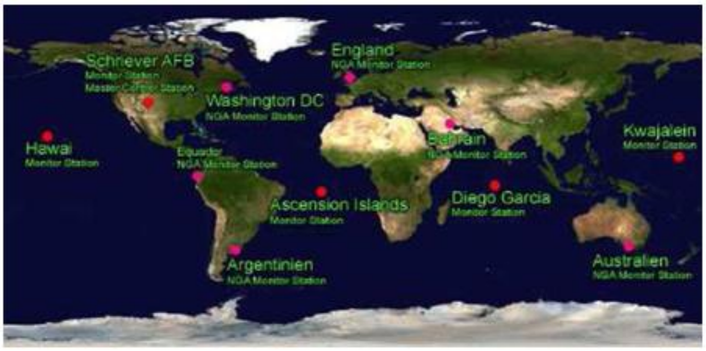

Fig. 3: Location of GPS MCS and other.

Each satellite transmits a different code signal to the next. One part of this signal consists of positioning data of the satellite relative to time. This data updates the almanac (record of satellite positions) in the receiver and allows the receiver to pinpoint the location of every satellite it is talking to [5]. Another part of this signal is a pseudo random code (Figure 3) and it 'plays' from the satellite and in the receiver. Each piece of equipment starts 'playing' this sequence from the same point in time thus, due to the distance between them, a short delay will occur in the comparison of the signals. The receiver calculates the delay between its signal and the received signal and then multiplies this difference by the speed of light to calculate the distance to the satellite [13]. Each satellite has a unique Pseudu Random Coda.

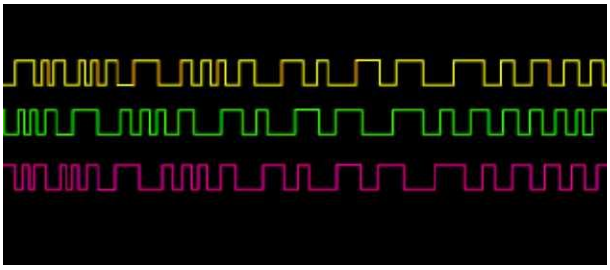

Fig. 4: Pseudo Random Code Transmitted by GPS Satellite.

Once we have calculated the distances from the receiver to three different satellites, we can calculate our position on the planet. By imagining that the three satellites are the center of three spheres, each with a radius of the distance between the receiver and the satellite, we can narrow down our location to simply two points in space. It would be useful to have a fourth satellite to finalize our position, however it is easier to simply reject one of the answers as it is too far from earth or moving at an extreme velocity [13]. This concept is shown in Figure 5.

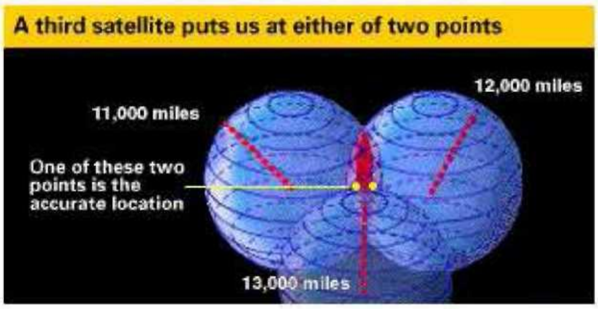

Fig. 5: Triangulation from Satellites.

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The calculation of position not only relies on good satellite positioning data, but also the accuracy of the clocks in the satellites and the receivers. The timing in the satellites is kept accurate by atomic clocks based upon Rubidium and Cesium [8]. Due to the cost of atomic clocks (between $50 000 to $100 000) it would not be conceivable to place them in receivers. Thus receiver's clocks cannot be as accurate as the satellites' and this is a big problem because if the timing of a receiver is off by even a thousandth of a second, it translates to an error of over 300km [13]. Luckily, a method was developed to provide receivers with near-atomic accuracy. This method works in both 3-dimensions and 2-dimensions so for less confusion, we will work in 2-dimensions for the moment. As the ranges between the receiver and the satellites are calculated from time, we can simplify things by talking in terms of time.

RESULTS AND DISCUSSION

Through analysis, modification and testing of the current software, improvement and testing of the new software, and development of a mechanical drive interface, it is hoped that a fully working prototype will be complete by the end of this article.

REFERENCES

[1] Billingsley, J., 2006. A Sideways Look at GPS, Billinglsey, John. http://www.skyrule.com/usq/ current 2006.
[2] Broida, R., 2003. How to Do Everything with Your GPS (How to Do Everything), McGraw-Hill/Osborne Media, New York, U.S.
[3] Bruce Wiebusch, 2001. Design News, Reed Business Information. http://www.designnews.com/article/CA181389.html current 2001.
[4] Dana, P.H., 2006. Global Positioning System Overview, University of Texas.
[5] Deere & Company, 2006. Turnable MFWD Fenders, Deere & Company.
[6] Deere & Company, 2006a. John Deere Introduces Swath Control Pro on 4720 and 4920 Sprayers, Deere & Company.
[7] Deere & Company, 2006b. Stellar Support, Deere & Company. http://stellarsupport.deere.com/en_US/ current 2006.
[8] Dye, S., D.F. Baylin, 1997. The GPS Manual. Principles and Applications, Baylin Publications, Boulder, CO, USA.
[9] feature/wheels_and_tires/6000_7020sf/6015_6020_fenders_turnable_mfwd.html current 2006.
[10] http://salesmanual.deere.com/sales/salesmanual/en_NA/tractors/2006/
[11] http://www.colorado.edu/geography/gcraft/notes/gps/gif/orbits.gif current 2006.
[12] http://www.deere.com/en_US/newsroom/2006/releases/farmersandranchers/ 060303_swathcontrolpro.html current 2006.
[13] Trimble, 2002. AgGPS Autopilot System, Trimble Navigation Limited, Sunnyvale, CA.