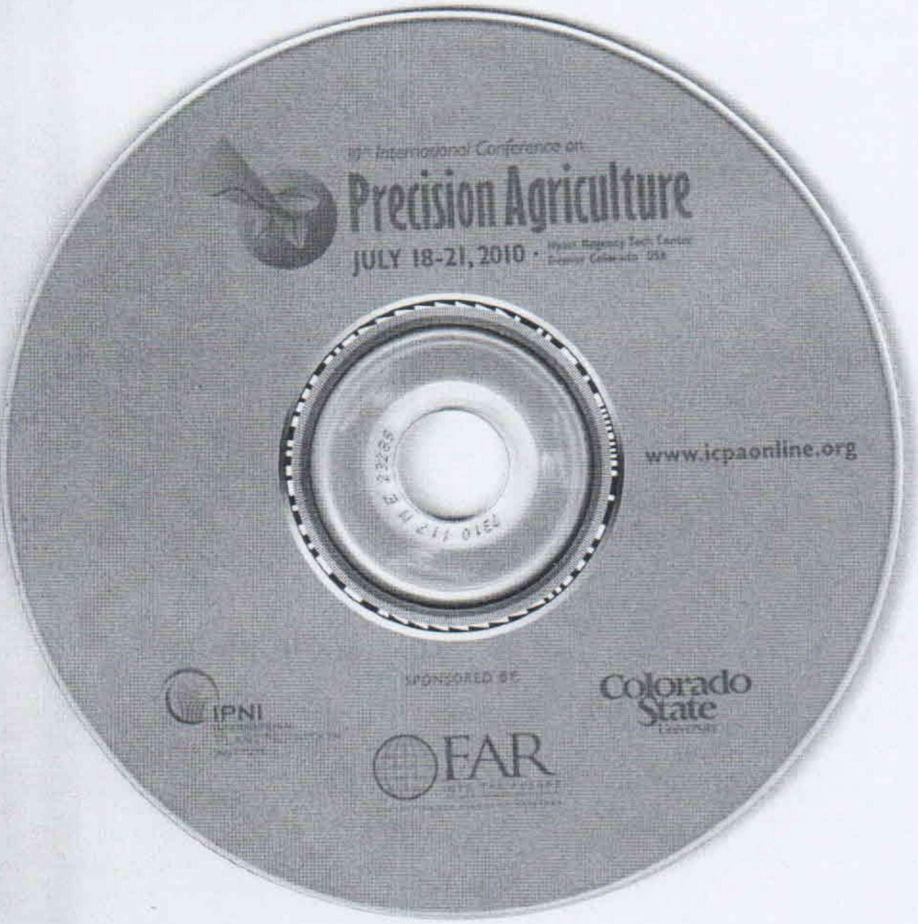
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EMBEDDED SENSING SYSTEM TO CONTROL VARIABLE RATE AGRICULTURAL INPUTS

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ABSTRACT

This paper presents an embedded sensing system for agricultural machines to collect information of the plants and also to control the application of fertilizer with variable rate in corn crop. The aim of use the Crop Circle reflectance sensor was to explore the spectral features of foliar pigment to use the plant as the indicator of availability of nitrogen in soil. The sensing system was built in Uniport 3000 NPK fertilizer applicator of Jacto that presents a distribution system of solid fertilizer which is granulated by means of high uniformity air-flux. The Uniport also presents an electronic controller of fertilization that can be started with manual or automatic control mode through RS-232 serial communication port. Furthermore, the system has the capacibility to send serial data such as the machine displacement speed and the fertilizer application rate. Two dedicated software were developed: one was used to reading and storing the sensor data; and the other one used to sending commands to system controller with desired fertilizer application rate. In order to design the software that sends commands to the system of fertilizer application controller, the machine displacement speed and the system mechanical response time were taken into account to determine the resolution of fertilizer application rate. The results show that the proposed system is able to collect the desired information and achieves the control of fertilizer application with variable rate. Moreover, the proposed system also provides requirements by practical observations for embedded system development in agricultural applications.

Keywords: On-the-go sensor, agricultural machinery, instrumentation, VRT.

INTRODUCTION AND DEVELOPMENT

Management of variability based on maps generally is easier to implement because of the available technologies, such as GPS, remote sensing, yield monitors and soil sampling. But the use of embedded sensors can allow the management of variability with the control of variable rate applicators in real time, moreover, the detection of properties of soil and plant don't require the presence of a global positioning device.

Reflectance sensors use the property of the plants, that they absorb visible light and reflect a portion of infrared light due the structural properties of the plant. The reflected light is detected by sensor and used to make calculations of vegetative biomass which is directly proportional to plant biomass. This work utilised the Crop Circle sensor model ACS-210 of Holland Scientific, which is an active reflectance sensor and provides the Normalized Difference Vegetation Index (NDVI).

The embedded system was set up to allow monitoring and control application of inputs to a variable rate. It was composed of a Crop Circle sensor, a GPS receiver, an Uniport 3000 NPK equipment and a central computer equipped with two dedicated software. Two dedicated software were designed and implemented, one used to the sensing data acquisition and other used to the application control.

The experiment was divided into three steps: collecting, processing and application. The first step was to collect data from embedded sensors. The second step, was to process this collected information to determine the rates of nutrients that would be used. The third step was the application of nitrogen fertilizer based on the data processed (TANGERINO, 2009).

RESULTS AND CONCLUSIONS

The information obtained during data collection was stored in text files. The processing of these information is useful for a clearer visualization of features that can help the user perform an interpretation of the crop. Such as identifying places where is necessary a great amount of fertilizer nitrogen and other parts requiring a small amount.

The system didn't process the information in real-time with steps of data collection and applying input. For a real-time data processing, it is necessary that the system be prepared to relate the indices information collected by the sensors with the rate that should be applied, i.e. able to make agronomic interpretations, which was not the scope of this work.

This experiment showed the necessity of identifying characteristics of agricultural equipment that should be considered for design a control system. For instance, the speed of displacement of the machine is related to the choice of desired sampling rate and resolution of the application system, as higher speed, lower the resolution of the application system and lower the sampling rate. For the control system apply correct rates and in the correct locations should be considered the response times of the equipment (mechanical drive, elapsed time up to the input reach to the ground, etc.) and speed of the machine.

REFERENCES

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