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Determination of Seed Volume in the Seed Tank of Pneumatic Precision Seeder by Using Microcontroller Based Control System

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Abstract: The amount of seed available in the seed tank of Pneumatic Precision Seeder is controlled by the operator. This case increases the operator's task load during the sowing process. Additionally the absence of the operator's carefulness would cause unsowed lines. In this study, the seeds volume in the seed tank could be observed by operator with a display as the percentage of fullness of tank. The measurement is done by a HC-SR04 ultrasonic distance sensor which is plugged to the cap of seed tank. The Arduino Mega 2560 microcontroller is used in the control unit. HC-SR04 ultrasonic distance sensor creates an audio signal at the 40kHz towards seeds. This audio signal reflects from seeds and back to sensor. Arduino Mega 2560 measures the time of audio signal travel and calculates the distance between sensor and seeds in the seed tank. The volume of the seeds in the tank is estimated by comparing this distance with the dimensions of seed tank. The amount of remaining seed in the seed tank is shown as a percentage on the LCD screen placed in front of the operator. The control circuit alerts the operator with audible warning buzzer when the seed volume in the tank is under 10%. In the system the communication between the pneumatic precision seeder and tractor where the display is placed is done by using Bluetooth module HC05.

Keywords: *Arduino, ultrasonic distance sensor, pneumatic precision seeder.*

1. Introduction

"Precision Farming" that is regarded as the continuation of the transition process of manpower to animal power then to the tractor power in agricultural refers to the use of developing technologies of information age in production process that is economic and integrated with environment [1].

The concept of precision agriculture was introduced for the first time in the U.S. in the 1980s and was born from the need to solve environmental problems resulted from agricultural activities such as the use of fertilizers and pesticides. Information technology in recent years with the development of precision agriculture has made rapid progress, especially in developed countries [2].

Precision agriculture is recognized as an appropriate approach for sustainable agriculture [3]. Discussions also about future trends continue while precision farming practices continue to develop [4].

In recent years, advances in microcontroller and sensor technology has made them cheaper than before. Due to technological advances in microcontrollers and sensors, they began to be widely used in agricultural machines. Although microcontrollers and sensors have low prices, the efficiency of these technologies is depends on the software loaded on them. Some of the studies about usage of microcontrollers in precision farming in the literature have been presented.

Koc and Keskin have developed an automatic system for field sprayer. This system is balancing the sprayer boom due to the distance between boom and ground by using a microcontroller and ultrasonic distance meter [5].

Sabanci et al. have developed a system that used for cow scratching in the farms. In their study they developed a control board that is designed to automate the animals scratching machine. In their control circuit of automatic cow scratching machine, motion sensor detects that the animals lean against the brush. PIC 12F675 microcontroller activate brush motor according to the information obtained from the sensors [6].

Bhasha et al. have designed a prototype that monitors the water feeding activity of a sprinkler system. Water feeding to the agricultural field has to be done regularly with continuous monitoring. When power cuts occurs the water feeding system corrupted. And until the farmer is aware of that the feeding system stays at standby mode. This causes an important amount of time and money loss. To avoid that this system control the water feeding status and in any change in the status of the water feeding it informs the farmer with a sms. In this system a microcontroller and a GSM module have been used [7].

Primicerio et al. have designed a system on an aerial vehicle called hexacopter which is capable of flying autonomously to a predetermined point. Their system has a multi-spectral camera for vegetation canopy reflectance recording [8].

Sabanci et al. have studied on baling machines. These machines uses mechanical counters for counting number of finished bales that are make these machines often arise problems. An electronic baling counter for baling machines have been tried to be realized with their study with the help of a magnetic sensor placed on binding unit of the baling machine. In the control unit, PIC 16F628A microcontroller that Microchip firm produced was used. Data of the bale number is seen on 4 digits display that is on the control unit [9].

Dilay et al. have examine the use of the wireless sensor networks

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(WSNs) in precision agriculture in the literature and it is reviewed that various agricultural applications. WSNs can serve many civilian and military areas as well as in the precision agriculture for the management of agricultural processes such as irrigation, fertilizers, pesticides and similar applications. In this way, the amount of production and product quality can be increased with the help of WSNs [10].

Sabanci et al. have realized an accessory on seed drill unit that implement an audio-visual warning control circuit that is needed for ideal insemination with pneumatic seed drill machines. In their system, the magnetic sensor placed in the wheel of pneumatic sowing machine calculates the information of the field and transfers this knowledge to the user. In addition, the magnetic sensors placed in each seed planting discs of pneumatic seed drill machine determines the units that do not work properly and gives audio-visual warning. PIC16F877 microcontroller by Microchip is used in this control circuit. The information of field is seen on LCD screen of control unit and the situation is observed with the LEDs on seed drill units [11].

In pneumatic precision seeders, the volume of the seeds in the tank is an important information for farmers. A non-working unit on the seeder may cause serious problems. If the farmer is not careful, a long line may be uncultivated. When he realized, he has nothing to recover that uncultivated area. Because if 5 of 6 units worked there is no way to sow this single line between others. To avoid that situation an ultrasonic seed volume meter have been developed. During the sowing operation, the status of the volume of the seeds in the tank could be followed by the farmer.

2. Material and Method

In this study there is two module. One of them is in the tractor and second one is on the seeder. In the tractor side there is a screen that displays the seed volumes in the tank. In the seeder side there is a microcontroller (µC) that controls the ultra-sonic distance meters. The microcontroller used in this study is Arduino. The communication between two sides have been done by using Bluetooth modules. The whole system block diagram is presented in Figure 1.

Small-scale computers which are embedded in non-computer devices are called as embedded systems [12, 13]. Embedded systems have more limited resources then regular computer's facilities [14]. For example, in personal computers; processor speed is gigahertz-GHz (109 hertz) and main memory is gigabyte-GB (230 byte) level, in embedded systems; speed is megahertz-MHz (106 hertz) and the memory is kilobyte-kB (103byte) or megabyte-MB (220 byte) levels [15, 16, 17]. Embedded systems contain microcontroller which was designed for few special procedures, instead of a microprocessor [12, 13].

Arduino is physical programming platform which includes input/output cards and Java-based programming language. In Arduino development board which was produced by Atmel, C-based programming is performed with their own software wiring program [18]. Arduino is an application written in the Java programming language which is serving as IDE code editor and compiler, at the same time it can perform installation process of compiled program to the card and it can be run on any platform. Ready-made cards can be purchased for usage of the Arduino which has open hardware and open-source architecture [19].

The Arduino Mega 2560 is a product of Arduino family, which owns Atmega 2560 microcontroller [18]. Arduino Mega 2560 development board is shown in Figure 2. General properties of the Arduino Mega 2560 development board are given in Table 1.

For measuring seed levels in the seed tanks ultrasonic ranging module HC - SR04 was used. It provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit [20]. This module has a trigger pulse input and an echo pulse output. The microcontroller applies a trigger for at least 10us high level signal to trigger pulse input. And the module automatically sends eight 40 kHz and detect whether there is a pulse signal back. If the signal back, through high level , time of high output IO duration on the echo pulse output is the time from sending ultrasonic to returning. This high level time is converted to distance by using velocity of sound. The HC – SR04 module is presented in Figure 3.

Figure 2. Arduino Mega 2560 Development Board.

Figure 3. The tanks ultrasonic ranging module HC-SR04.

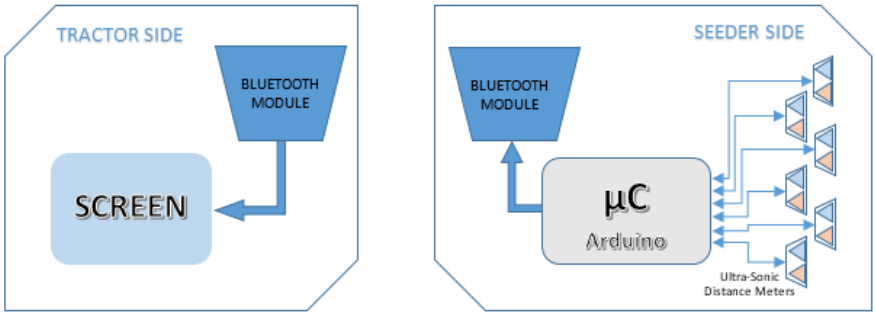

Figure 1. The block diagram of whole system.

Table 1. General properties of the Arduino Mega 256 [17]

GENERAL PROPERTIES	
Microcontroller	ATmega2560
Operating Voltage	5V
Supply Voltage (Recommended)	7-12V
Supply Voltage (Limits)	6-20V
Digital I/O Pins	54 (of 14 PWM output)
Analog Input Pins	16
Output Current (per pin)	40 mA
Output Current (3.3V)	50 mA
Flash Memory	256 KB (8 KB used by bootloader)
SRAM	8 KB
EEPROM	4 KB
Operating Frequency	16 MHz

This module is packaged with a box but it is taken care not to contact the transmitter and receiver sensors to the box. Any contact on them causes a short circuit of sound way. And the measurement became meaningless. The picture of packaged module is presented in Figure 4.

Figure 4. The packaged ultrasonic ranging module HC - SR04.

The communication between seeder side and tractor side is done by using HC-05 Bluetooth module. This module is used for converting serial port to Bluetooth. These modules have two modes: master and slaver device. For configuration this module uses AT command [21].

In the tractor side it is used as master mode. And in the seeder side it is used as slave mode. By using AT command same name and password was assigned to the both of modules as SHTT and 654321 name and password respectively. The HC05 Bluetooth Module is presented in Figure 5.

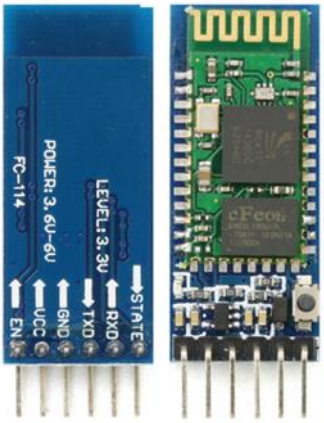

Figure 5. HC05 Bluetooth module.

The NX8048T070_011 touch display belongs to Nextion Company is used for displaying the status of seed tanks. For each tank there is a process bar and a text display to show the seed volume in the tank. This display communicate with the microcontroller trough Bluetooth module by using serial communication. If the seed volume in any tank falls under 10% the display begins to wink red and green. The screen snapshot is presented in Figure 6. This screen is prepared in the Nextion Editor which is presented by the Nextion Company.

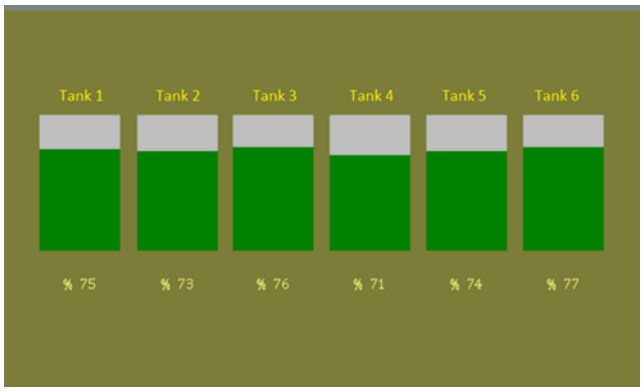

Figure 6. The snapshot of the screen.

3. Results and Conclusions

The developed system have been tested on a Pneumatic Precision Seeder that has 30 dm^3 seed tank (Figure 7). In tests coated corn and beet seed have been used. First of all calibration of system have been done. Then by making the pneumatic precision seeder work the seeds were evacuated from the tank. The seed volume information in all of the tanks have been sent to the display which is in front of the farmer by Bluetooth modules (Figure 8). The success rate of the system is 100%. When the seed volume in any tank below under 10%, the symbols that symbolize each tank blinks red and green. Additionally an audio alert produced by a buzzer have been used.

Figure 8. The boxed Nextion NX8048T070 TFT screen that used as graphical user interface

Figure 7. The montage of ultrasonic distance meter on seed tank

The seed volume in the seed tank continuously controlled by the user with the developed system. And the volume of the seed in the tank is presented simultaneously to the user. By this way the user ergonomics have been ensured. In a situation such as the do not fall of the seed sourced from any mechanical parts, the user can follow the tanks and notice the situation early. If no change of the seed volume in the tank have been observed for a while, it means planting was not been performed. This system can be also used in grain sowing machines.

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