EXCELLENT PUBLISHERS

Int.J.Curr.Microbiol.App.Sci (2019) *8*(5): 1177-1187

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 8 Number 05 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.805.134

A Monitoring System for Detecting Choking of Boots of a Seed Drill

Rajeev Kumar[1*], Hifjur Raheman[2], Sukanya Barua[3], Mukesh Kumar Choudhary[1] and Indra Mani[1]

[1]Division of Agricultural Engineering, [3]Division of Agricultural Extension, IARI New Delhi-110012, India
[2]Agricultural and food engineering department, IIT kharagpur, West Bengal-721302, India

**Corresponding author*

Keywords

Monitoring system; Direct incidence IR sensor, Seed drill; Choking of boot, Microcontroller, Alerting system

Article Info

Accepted:
12 April 2019
Available Online:
10 May 2019

A B S T R A C T

Choking of seed drill during sowing of wheat generally occurs due to excessive soil moisture, weeds or agricultural residue present in the field. The developed monitoring system for detecting the choking of boot comprised three units: sensing unit, processing unit and alert unit. A direct incidence infrared (IR) emitter and IR receiver were selected for detecting choking of boots of a seed drill. A microcontroller board was used to process the detected choking output signals of these sensors and to produce signals, using the uploaded programing code in the microcontroller board, to alert the tractor operator about choking of boot of the seed drill. IR emitter and receiver were fixed opposite to each other 180° apart at the bottom end of the seed tube. The alert unit comprised audible (continuous buzzer) and visual (red LEDs) outputs and was fixed on the dashboard of a tractor. The performance of the developed system for a tractor drawn 9×200 mm seed drill was evaluated in the laboratory as well as in the field with wheat seeds at different seed rates. The developed system detected choking, independent of seed rate in all the boots of the seed drill. However, there was a time gap observed between choking actually occurred and sensed by the developed monitoring system. This was due to height at which the emitter and receiver were fixed from the bottom of the boot. The system produced both audible and visual signals successfully to alert the operator about choking of the boots in the field.

Introduction

Sowing is one of the important energy input agriculture operations in which proper placement of seed in the soil for optimum growth and proper plant population is very much desired (Gursoy, 2014). This is achieved by using seed drill/planter powered by tractor, power tiller, animal or human being. With increase in mechanization level in India and non-availability of animal power, tractor and power tillers are gaining popularity as power sources for carrying out different farming operations. Hence, use of tractor drawn seed drills is gaining popularity for sowing different crops. In India, mechanization level for sowing wheat is 45% as compared to 12%, 5% and 5% for paddy, cotton and corn, respectively (Goyle, 2013). Attempts are required to increase the mechanization level in sowing, so that subsequent operations of implements or machines become easier. The seed drill is usually mounted to the three-point linkage of the tractor, which is behind the tractor operator. During operation, its metering mechanism meters the seeds by taking a drive from ground wheel. The germination of seed depends on the output of seed drill whether seeds are dropped into the furrow or not. As the seed drill is pulled by a tractor and the furrows in which seeds are dropped are immediately covered with soil by the furrow closer, the tractor operator has no chance to know whether seeds are dropped from the outlet of the metering mechanism into the furrow or not (Raheman and Singh, 2003). Hence, to increase mechanization level in sowing, this problem is required to be overcome.

While operating a seed drill, choking of boots of seed drill due to two main causes, machine and field parameter. Machine parameter could be improper design boots of furrow opener. Field parameter include presence of agricultural residue/weeds, higher soil moisture content during sowing, bigger size clods, and undulation of field. Despite these factors, the desired population of seeds for getting more yields is possible, if operator gets information on whether seeds are dropped into the furrow or not. With the increase use of electronics in agriculture, attempts are required to be made to detect the boots choking of a seed drill and give this information to operator, to know the seed dropped in the furrow or not(McCarty & Meyer, 1983). Therefore, keeping the above points in view, the present study has been undertaken to design and develop a monitoring system to alert the operator regarding boot choking of a seed drill for proper sowing to get the desired plant population.

Considering the importance of seed quantity required for getting desired plant population to have optimum yield, boot choking detection of a seed drill are highly essential. Many a researchers have tried to detect the flow of seeds in the delivery tube of a planter by using detection technology such as visual LED sensor, capacitive type sensors, microwave sensor, piezoelectric sensor, ultrasonic sensor, infrared technology, image processing (Steffen, 1976; Grimm and Paulson, 1978; Bell, 1979; Merlo, 1981; Amburn, 1980; Friend, 1987; Bachman, 1988; Lan *et al.*, 1999; Grift *et al.*, 2001; Watabe *et al.*, 2001; Karayel *et al.*, 2006; Changqing, 2010; Navid *et al.*, 2011; Wang and He, 2011; Yongfang *et al.*, 2011 and Okopnik and Falate, 2014). Among these, infrared technology was found better because of higher accuracy, smaller size, lesser power consumption, lower cost and easier to control the input/output signals. Moreover, this technology can be utilized in adverse field conditions. The infrared sensors technology tried for detection of flow of seeds mostly used LED/photodiode for emitting the light; phototransistors/IR receiver for receiving the radiation (Steffen, 1976; Bell, 1979; Friend, 1987; Watabe *et al.*, 2001; Wang and He, 2011 and Okopnik and Falate, 2014). Al-Mallahi and Kataoka, 2013, used an off-the-shelf digital fibre sensor to detect the flow of seeds. It consisted of light transmitter, receiver as well as an amplifier connected by fibre cables. It was a direct incidence ray sensing system in which array of emitters and receivers were present on either side of seed flow. But the developed boot monitoring system presented in this study is a direct incidence detection system, which used only one IR emitters and one receiver to detect the boot choking.

Materials and Methods

This section includes development of sensors circuit boards and monitoring system for detecting boot choking in a tractor drawn multi-row seed drill. The procedures followed to evaluate the developed monitoring system for multi-row seed metering mechanisms.

Development of a Direct Incidence IR Sensor

There are two type of IR sensor, one is indirect incidence infrared sensor and another direct incidence. In indirect incidence both the emitter and receiver are placed side by side. When an opaque object is place in front of emitter and receiver, emitted radiation of emitter reflects back and incidence on receiver consequently output voltage of sensor change (HIGH to LOW)as proportional to intensity of incidence radiation on receiver. In direct incidence infrared sensor, emitter and receiver is fixed 180˚ apart (i.e. opposite to each other). When an opaque object is place in between emitter and receiver, emitted radiation of emitter reflected back consequently output voltage of sensor change (LOW to High). Same concept of direct incidence infrared sensor has been used in this study. An IR LED and receiver were mounted rigidly in 25.4 cm diameter pipe such a way that emitted radiation directly were incident to the receiver which is shown in Figure 1a. When boot of seed drill was choked accumulated seed inside the pipe as opaque object in between emitter and receiver, emitted radiation of emitter either reflected back or observed by accumulated seed in the pipe consequently output voltage of sensor was gone high to low which is shown in Figure 1b.

The following components were used to develop the one direct incidence IR sensor for detecting choking of one boot of a tractor:

(i) IR receiver (5mm silicon PIN Photodiode, wavelength of Peak sensitivity = 940, view angle 80º) (ii) IR LED (Angle of half sensitivity: +/- 15°, Peak wavelength: 940nm) (iii) LM-358M (Op-Amp) (iv) 2 x 150 Ω Resistance (v) 1 x 10 kΩ Resistance (vi) 1 x 10 kΩ Variable Resistance (Potentiometer/Preset) (vii) 5 Volt power source (viii) General purpose PCB or bread board.

The circuit diagram of the developed IR sensor for detecting choking of boot is given in Figure 2. R2 and IR LED were the source of IR light and it was received by the IR receiver. When IR ray falling on the IR receiver was interrupted because of the accumulation of seed between IR emitter and IR receiver, the LM358 IC compared the signal before and after accumulation of seeds between emitter and receiver with a specified voltage level depending on the setting of the potentiometer. The comparator gave the output signal after comparing these signals and these signals were then fed to the microcontroller board as well as to the red LED1 (Fig. 2).

Development of a monitoring system for a tractor drawn Seed Drill

The schematic diagram of the developed monitoring system for detecting boot choking in a 9 row 9×200 mm tractor drawn seed drill is shown in Figure 3. One sensor (Fig. 3) for each boot of a seed drill has been used which is nomenclature as IR_sensor_1 to 9 in Figure 4. Red and black lines indicate the positive and ground wires of power supply, respectively and blue line is for taking the output of IR sensors to the input of microcontroller board. The double pole double through (DPDT) switch was used for making the cont. buzzer ON or OFF (Fig. 3). These sensor circuits were connected to IR LEDs and receivers which were fixed to each of the boots of the 9 row seed drill along the line of seed flow. This system comprised of four units. The first and most important unit was PCB circuit board in which 9 direct incidence IR sensor circuits were fabricated (Fig. 4b) for detecting choking of boots of a 9 row seed drill, second unit was Arduino Mega 2560 microcontroller board for processing the output of sensors using the uploaded programming code to control its input and output and alerting the operator by producing audible sounds, third unit was IR LED and receiver which were rigidly fixed to the 25.4 mm diameter pipe welded just above the boot of seed drill along the seed flow line which is shown in Figure 4a and fourth unit was alerting unit comprising of 9 red LEDs with 9 number of 200 ohm resistor and one cont. buzzer which was fixed to the PCB board for mounting it on the dash board of the tractor in front of the operator for alert to operator for efficient sowing operation. Thus it allowed the operator to know whether there was any choking in any of the 9 boots of the seed drill. A DC to DC power converter, from 12 V, 7 ampere hour battery power to 5 V DC power, supplied the power to the PCB board, alert unit and detecting unit. Fabricated sensors in the PCB board are shown in Figure 4c. All four units were connected through electric wires.

Flow chart of programing coding for controlling the input/output of microcontroller

The programming code was developed in Arduino IDE and uploaded to Arduino Mega 2560 microcontroller board. The flow chart of uploaded programming code in the developed monitoring system for controlling the output signals of sensors is shown in Figure 5. At first the input (output of sensor) and output pins (input of alert unit) of the microcontroller board and global variable were defined and initialized. The decision boxes of the program flow chart were used to take decision based on digital value (1 and 0) which was dgital Read of sensors for indicating either choking of boot of seed drill or not, based on the output of IR sensor. The uploaded programming code was used for generating the output of monitoring system to detect the choking of boots of a seed drill. If any one or more digital Read of sensors read the binary value 0 then it printed 0 and cont. buzze was ON, else it printed 1 and cont. buzzer was OFF. After choking of boot of a seed drill, it was detected by direct incidence IR sensors fixed at the boot. If seeds accumulated inside the boot, the IR receiver would not get any rays falling on it and the signal would be processed in the microcontroller to give both audible (buzzer ON) and visual output (LED ON) and print 0. If no accumulation of seeds in the boot, buzzer would be OFF, red LED OFF and print 1.

Results and Discussion

The developed monitoring system fitted to a 9×200 mm tractor drawn seed drill was evaluated both in the laboratory (in the stationary condition) as well as in the field with wheat seeds.

Performance evaluation of the developed monitoring system fixed to a 9 row tractor drawn seed drill in the laboratory

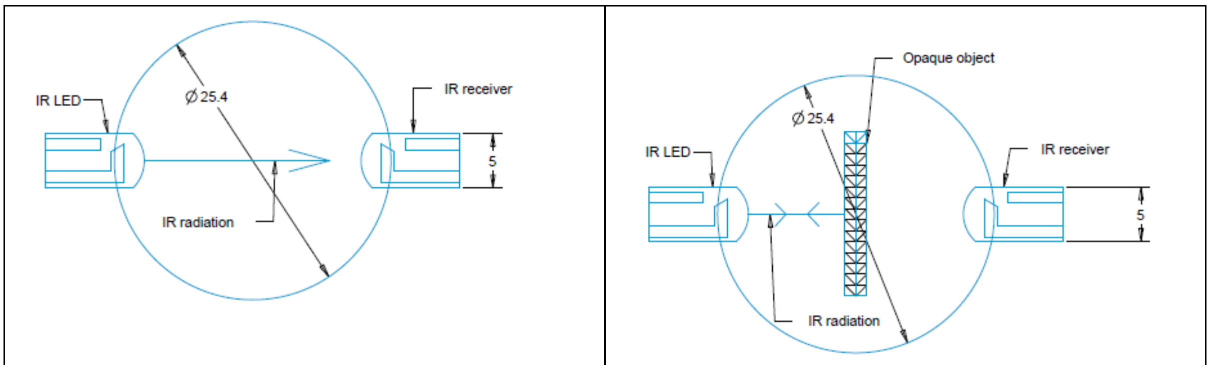
In the laboratory evaluation, seed drill was raised from the ground to keep trays for collecting dropped seeds from each furrow openers. The fluted roller metering mechanism was rotated with 0.37 kW, 1500 rpm DC motor. Speed of this motor was reduced in two stages. In the first stage, speed of motor was reduced from 1500 rpm to 100 rpm by attaching a gear box with a reduction ratio of 15:1 and in the second stage, speed of DC motor was reduced with the help of speed controller from 100 rpm to either 27, 35, or 44 rpm to get a desired seed rate at recommended travel speed 3, 4, 5 km/h (IS 6813). The developed system was rigorously evaluated at different combinations of speeds of fluted roller (27, 35 and 44 rpm) and exposure length of flutes (4.9 mm to 6.8 mm) to obtain seed rates of 80, 100 and 120 kg/ha. Output of the developed monitoring system for detecting choking of boots in a 9 row seed drill based on visual and audible alerts was verified by closing the outlets of boots of seed drill one by one manually and corresponding visual and audible indications obtained were verified to decide the workability of the monitoring system. During blockage of outlets, seeds were accumulated inside the boot from the lower end thereby causing obstruction of emitted IR radiation between IR LED and receiver fitted in the boot. Only two of them boot no. 1 and 7 are shown in Figure 6 and 7, respectively. When boot number 1 was blocked (Fig. 6a), the corresponding red LED in the alerting/display board became ON (Fig. 6b) and cont. buzzer produced sound to alert the operator about the choking of boot no. 1. Similarly, when boot number 7 was blocked (Fig. 7a), the corresponding red LED in the display board became ON (Fig. 7b) along with production of sound by the cont. buzzer. When there was no choking of boots, all the red LEDs should be OFF and the same was verified too. The developed monitoring system for detection of choking of boot of seed drill, digital Read(programming language) of program gave a binary output '0' (Low voltage, cont. buzzer ON, red LED ON) and when the sensor did not detect choking of boot of seed drill, digital Read of program gave a binary output '1' (high voltage, cont. buzzer OFF, red LED OFF).Hence, from these observations, it was concluded that the developed monitoring system was capable of detecting boot choking in a multi-row seed drill. The data recorded during the evaluation of monitoring system with the help of personal computer (PC) were at an average frequency of 600 data per minute (60000 ms) from serial monitor of Arduino IDE. The program execution delay period was taken as 100 ms. Output of monitoring system as the binary value (0 and 1) for detecting choking of boots in a 9 row seed drill was verified by closing the outlets of boots for approximately 30 second one by one manually and corresponding binary value were recorded. A sample plot of detecting choking by the developed monitoring system in boot 1 to 9 at a seed rate of 100 kg/ha and fluted roller rpm of 35 is shown in Figure 8, where binary values are indicated in Y-axis and time is indicated in X-axis. However, it was also observed that there was a time gap between choking actually occurred and it was sensed by the sensor. On an average, a delay of 2403 ms was observed for all the boots between the time at which choking of boot was done manually and the time at which it was detected by the system. This delay in sensing choking was varying from 1510 ms to 3556 ms and was due to the height (15 mm from the bottom of the boot) at which the IR sensor was fixed. When blocking was made manually at the bottom of the boot, the seeds were accumulated inside the boot and it took some time to fill the boot with seeds to reach the position where the IR LED and receiver were fixed to detect choking and this time was dependent on seed flow rate. Higher the flow rate, lesser time was required to block the sensor and vice versa. It can also be seen that detection of choking by the developed system was faster (i.e. lesser delay time) both at higher seed rate and higher rpm of fluted roller as compared to when the seed rate was lesser and at lower rpm. Hence, it was concluded that delay in detecting choking of boots by the developed monitoring system was dependent on seed rate and rpm of fluted roller.

Performance evaluation of the developed monitoring system fixed to a 9 row tractor drawn seed drill in the field

Performance of the developed monitoring system for detecting choking of boots of a 9 row tractor drawn seed drill was evaluated at different seed rates by changing the exposure length of fluted roller in actual field condition. Indication of its output was given in both audible sounds by cont. buzzer and visual indication by the glowing of red LED corresponding to that furrow opener. When any one or more boots of a seed drill was choked due to excessive moisture in soil or agricultural residue and weeds present in the field, seeds were not dropped into the furrows and they accumulated inside the pipe. Thereby the sensor fixed to this boot got blocked and accordingly output of the sensors was given in both visual and audible forms to alert the operator. In Figure 9 and 10, 7th and 3rd numbered boots of seed drill were choked during sowing operation in the field due excessive moisture and agricultural residue in the field.

The number 7th furrow opener got choked first as indicated by the assigned 7th numbered red LED ON (Fig. 9b) and then 3rd numbered boot got choked afterwards indicated by both 7th as well as 3rd numbered assigned red LEDs On (Fig. 10b). These visual indications were associated with sound by making the cont. buzzer ON.

Fig.1 Concept used in development of choking detection sensor in the seed drill



a. Without choking condition | b. With choking condion

Fig.2 Circuit diagram of developed direct incidence IR sensor

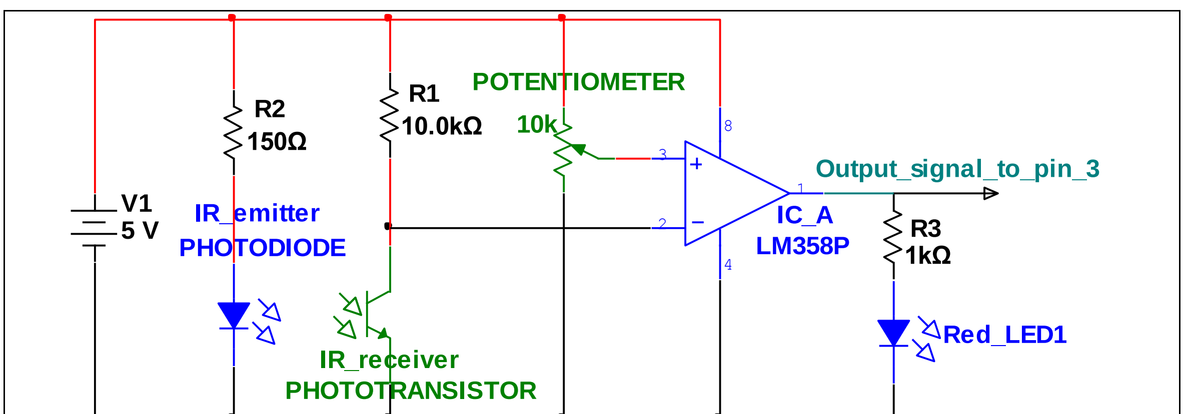


Fig.3 Schematic diagram of the monitoring system for detecting boot choking of a seed drill

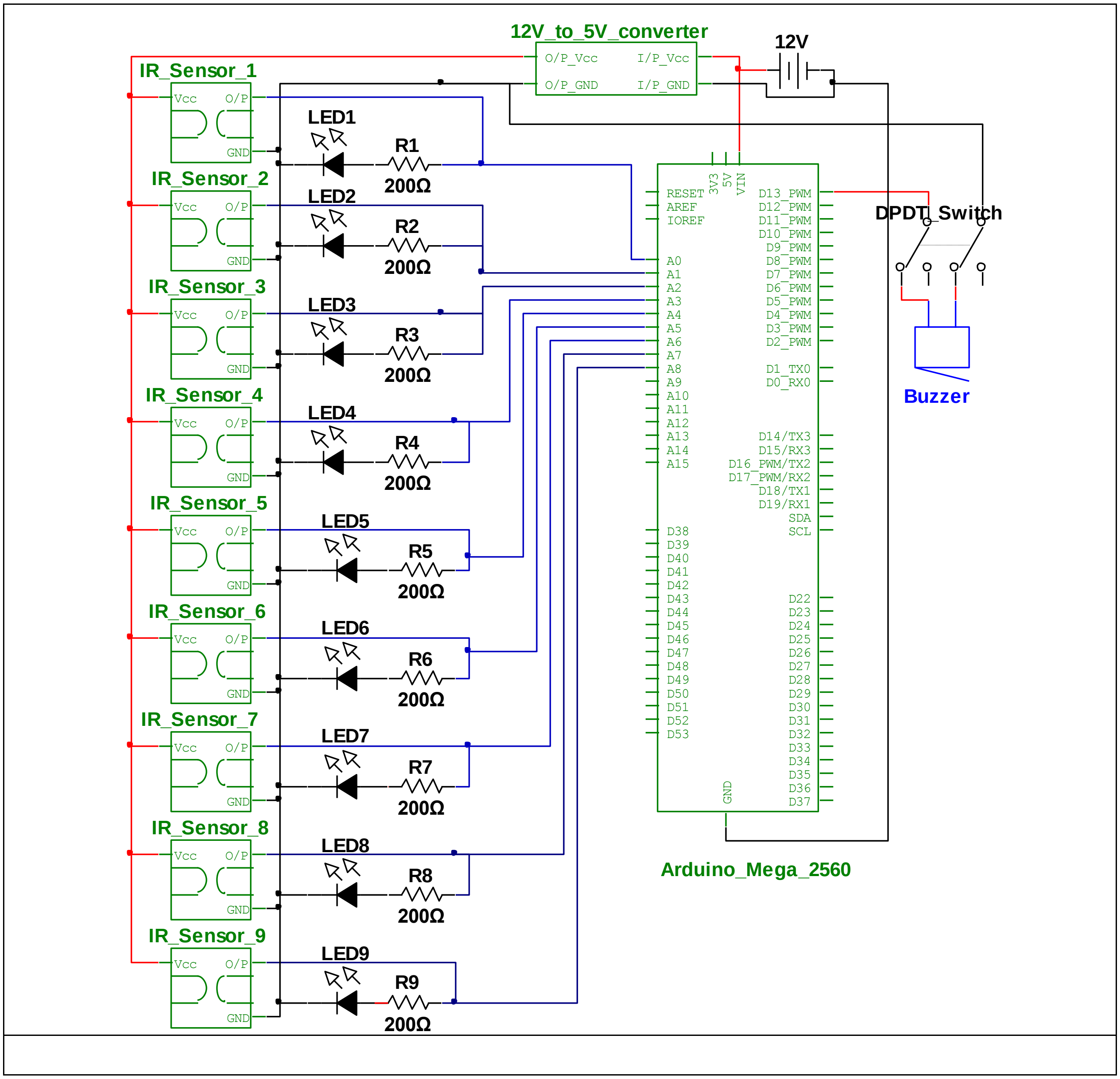
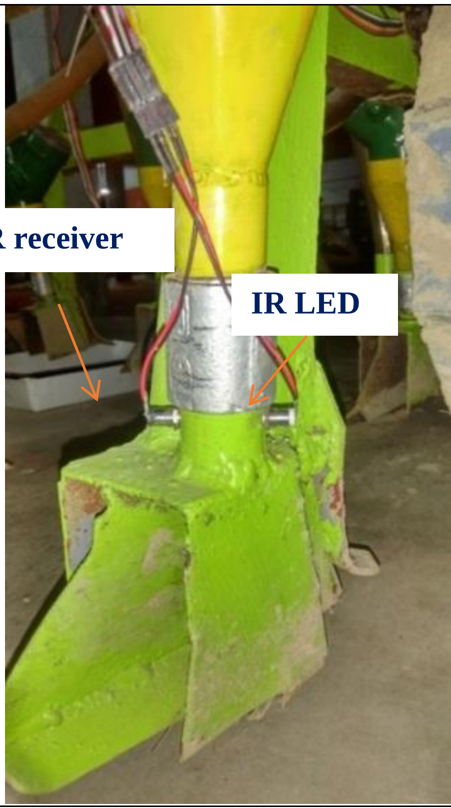
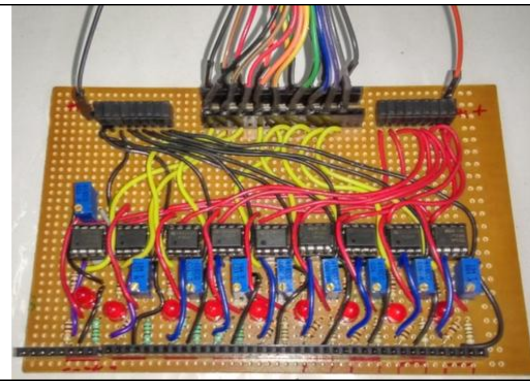


Fig.4 Mounting of IR LED and receiver for detecting boot choking of a seed drill



a. IR LED and Receiver fixed in the boot



b. Fabricated PCB board

c. Alerting Unit

Fig.5 Program flow chart for monitoring boot choking of a seed drill

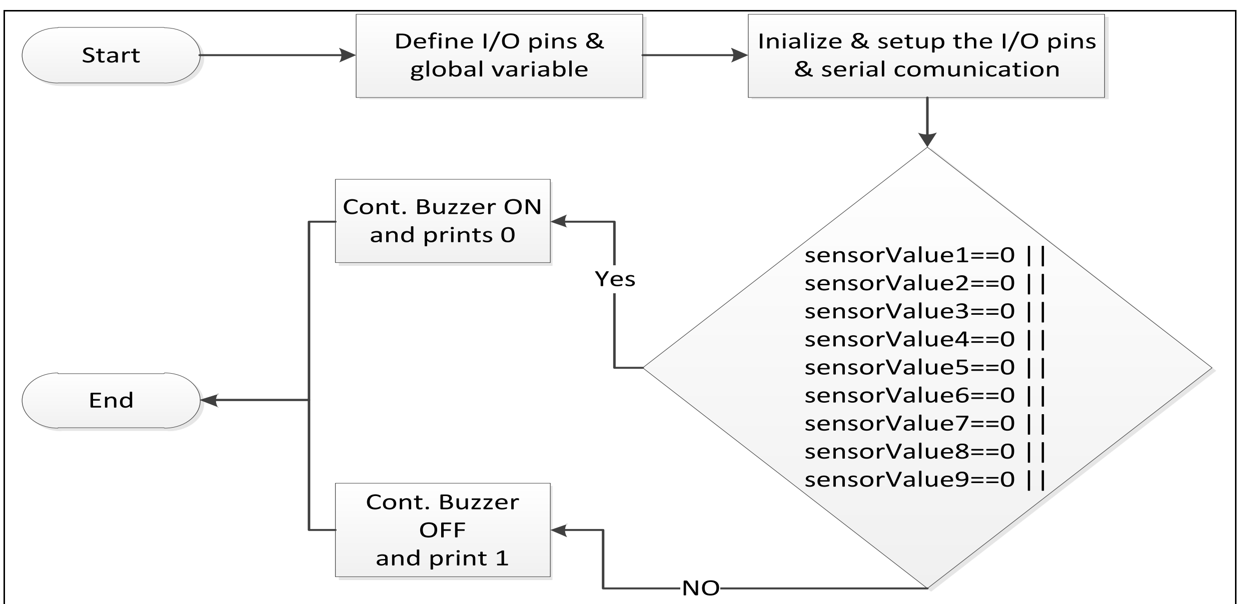
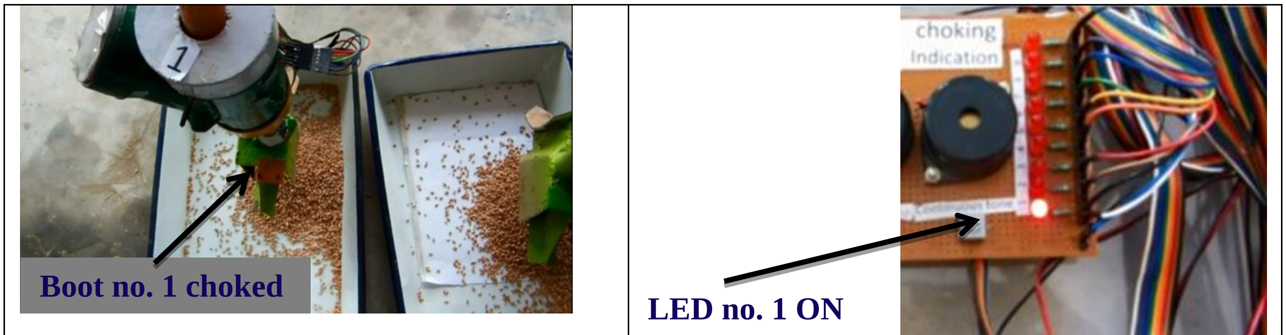
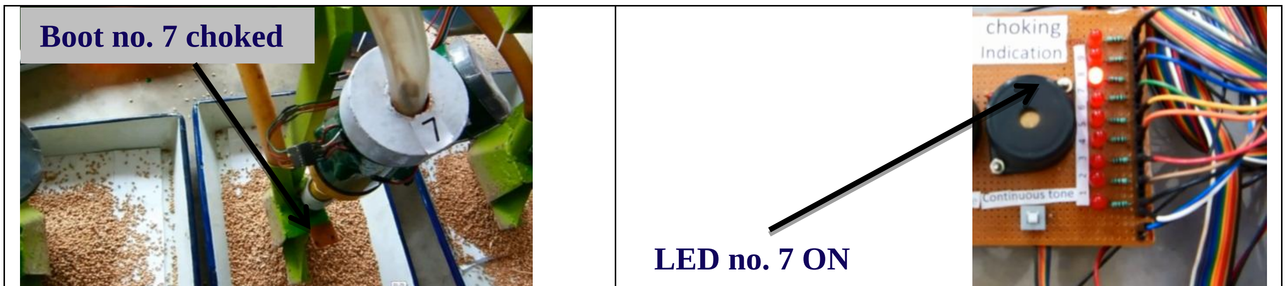


Fig.6 Visual output of the monitoring system when boot no. 1 was choked



(a) Choking of boot no. 1 | (b) Visual indication for choking in boot no.1

Fig.7 Visual output of the monitoring system when boot no. 7 was choked



(a) Choking of boot no. 7 | (b) Visual indication for choking of boot no. 7

Fig.8 A sample plot of detection of choking in a tractor drawn seed drill by the developed embedded system at a seed rate of 100 kg/ha under laboratory condition

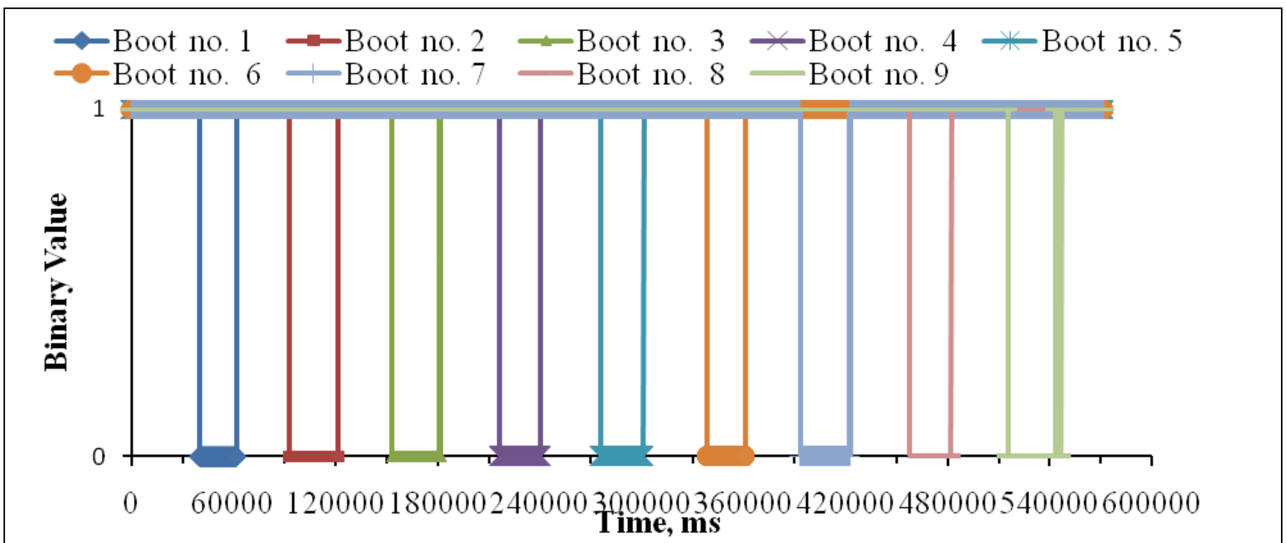
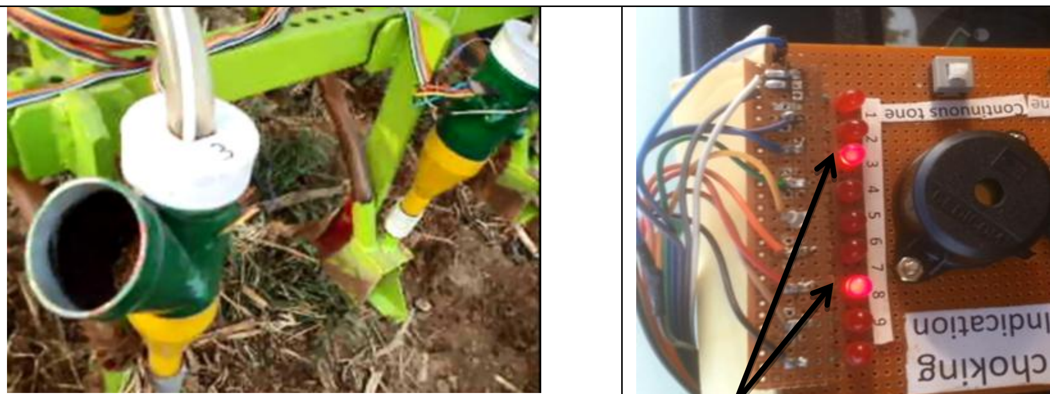


Fig.9 Choking of boot no. 7 and its visual indication

a. Boot no. 7 was choked | b. Red LED no. 7 ON

Fig.10 Choking of boot nos. 7 and 3 and their visual indication



a. Boot no. 7 and 3 were choked | b. Red LED no. 7 and 3 were ON

In conclusion, from the results obtained during evaluation of the developed monitoring system for choking of boots, it was concluded that the developed system could successfully detect choking of boots with wheat seeds for a seed rate of 80-120 kg/ha by giving a binary output of 0 whenever there was choking (red LED ON and cont. buzzer ON) and 1 (red Led OFF and cont. buzzer OFF) whenever there was free flow of seeds from seed metering mechanism to the furrow in the field. The red LED and cont. buzzer alerted the operator about the choking of boots satisfactorily. The developed monitoring system can be easily attached to the existing tractor drawn seed drill to ensure proper sowing to get optimum plant population and will improve efficiency in sowing.

References

Al-Mallahi, A.A., Kataoka, T. 2013. Estimation of mass flow of seeds using fibre sensor and multiple linear regression modelling. Computers and Electronics in Agriculture. 99, 116–122.

Amburn, R.D. 1980. Microwave seed sensor for field seed planter. US Patent 4,239,010.

Bachman, W.J. 1986. Capacitive-type seed sensor for a planter monitor. US Patent 4,782,282.

Bell, D.M. 1979. Optical seed sensor for a seed planter monitor. US Patent 4,163,507.

Changqing, L., Bingqi, C., Jiannong, S., Yongjun, Z., Jicheng, W. 2010. Study on the image processing algorithm for detecting the seed-sowing performance. International Conference on Digital Manufacturing & Automation. IEEE, pp. 551–556.

Friend, K.D., Falls, C. 1987. Article or seed counter. US 4,63,5215.

Goyle, S. 2013. Mechanization trends in India, Mahindra and Mahindra. Fourth World Summit on Agriculture Machinery December 5-6, 2013.New Delhi, India.

Grift, T.E., Walker, J.T., Hofstee, J.W. 2001. Mass flow measurement of granular materials in aerial application- part 2: experimental model validation. Transactions of the American Society of Agricultural Engineers. 27, 27–34.

Grimm, E.A., Paulson, G.E. 1978. Piezo-electric seed-flow monitor. US Patent 4,079,362.

Gürsoy, S. 2014. Performance evaluation of the row cleaner on a no-till planter. Transactions of the American Society of Agricultural Engineers. 57, 709–713.

IS 6813.2000. Indian Standard for Sowing equipment-seed cum fertilizer drill-specification

Karayel, D., Wiesehoff, M., Özmerzi, A., Müller, J. 2006. Laboratory measurement of seed drill seed spacing and velocity of fall of seeds using high-speed camera system. Computers and Electronics in Agriculture. 50, 89–96.

Kocher, M.F., Lan, Y., Chen, C., Smith, J.A., Kocher, M.F., Lan, Y. 1998. Opto-electronic sensor system for rapid evaluation of planter seed spacing uniformity. Biological Systems Engineering. 41(1), 237–245.

Merlo, A. 1981. Microwave seed sensor. US Patent 4,246,469.

Navid, H., Ebrahimian, S., Gassemzadeh, H.R., Mousavi nia, M.J. 2011. Laboratory evaluation of seed metering device using image processing Metho. Australian Journal of Agricultural Engineering. 2, 1–4.

Okopnik, D.L., Falate, R. 2014. Usage of the DFRobot RB-DFR-49 Infrared Sensor to detect maize seed passage on a conveyor belt. Computer Electronics in Agriculture. 102, 106–111.

Raheman, H., Singh, U. 2003. A sensor for seed flow from seed metering mechanisms. Journal of the Institution of Engineers (India): Agricultural Engineering Division. 84, 6–8.

Steffen, D.E. 1976. Solid state seed sensor. US Patent 3,974,377.

Watabe, Y., Honda, Y., Aizawa, K., Ichihara, T. 2001. Infrared sensor. US Patent 6,236,046.

Wang, C. and He, R. 2011. Performance Detection of precision seed-metering device based on single chip microprocessor. Science Technology and Engineering. 33 (12), 8300-8302.

Yongfang, N., Cheng, J., Zhang, S., Cao, J., Wang, Y. 2011. Detection precision of seedmeter for large-granule seeds. Journal of Northeast Agricultural University. (English Edition), 18 (1), 63-66.

How to cite this article:

Rajeev Kumar, Hifjur Raheman, Sukanya Barua, Mukesh Kumar Choudhary and Indra Mani. 2019. A Monitoring System for Detecting Choking of Boots of a Seed Drill. *Int.J.Curr.Microbiol.App.Sci.* 8(05): 1177-1187. doi: https://doi.org/10.20546/ijcmas.2019.805.134