ISBN 978-93-84468-20-0
Proceedings of International Conference on Advances in Chemical, Biological & Environmental Engineering (ACBEE)
Singapore March 29-30, 2015, pp. 236-241

An Embedded System for Detecting Seed Flow in the Delivery Tube of a Seed Drill

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Abstract: A*n embedded system for detecting seed flow in the delivery tube of a seed drill has been developed to give a feed back to the operator about malfunctioning of metering mechanism. This system comprised an indirect incidence thin small outline package (TSOP) based infrared sensor for sensing flow of seeds from seed metering mechanism, a direct incidence infrared sensor for sensing choking of delivery tube of a seed drill with seeds and a microcontroller to control the input signals from the sensors and output signals (both visual and audible). A programme was written in Arduino uno compiler for controlling the input signals as well as the outputs. Sensing unit of the sensor was fixed to a small compact plastic pipe which was then fixed to the lower end of the delivery tube of the seed drill. The display unit had two separate continuous and intermediate audible buzzers along with visible outputs as red LED. The performance of the developed embedded system was evaluated using a laboratory setup at different seed flow rates for wheat and ragi seeds. It was found that the detection of seed flow in the delivery tube was working satisfactorily with the developed system at different rpms (40 to 80) of the seed metering mechanism for different seed rates of wheat (80-120 kg/ha) and ragi seeds (2-6 kg/ha).*

Keywords: *Embedded system, IR sensor, TSOP based IR sensor, seed drill, seed flow detection*

1. Introduction

Traditional agriculture by the farmer was meant for feeding his own family but modern agriculture has become an occupation of farmer which needs precise and efficient application of inputs for raising crop to increase its yield. Among all the operations required for raising crops, sowing is one of the important operations in which proper placement of seed in the soil for optimum growth and high productivity of any crop is very much desired (Gursoy. 2014). This is achieved by using seed drill/planter powered by tractor, power tiller, animal or human being. With the 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 agriculture operations. Hence, use of tractor drawn seed drills is gaining popularity for raising different crops. Mechanization in sowing wheat is 45% as compared to 12%, 5% and 5% for paddy, cotton and corn, respectively. 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 desired amount of seeds by taking a drive from ground wheel so that the seed rate becomes independent of forward speed of the tractor. The output of seed drill depends on whether seeds are metered in the furrow or not. As it is pulled by a tractor and the furrows in which seeds are dropped are closed by the furrow closer, the tractor operator doesn't get a chance to know whether seeds are flowing from the outlet of the metering mechanism and falling into the furrow or not (Raheman and Singh, 2003). Hence, to increase mechanization level in sowing, this problem is required to be overcome.

Seed missing in the furrow while operating a seed drill occurs due to two main causes i.e. either seed is not falling from seed metering mechanism or the seed delivery tube is choked (Cuhac et. al, 2012). These problems could be due to machine parameter, seed parameter, field parameter and human parameter. Machine parameter could be improper design of seed metering mechanism, boots of furrow opener, and ground wheel; shifting of stopper wheel (provided to control the exposure length of fluted roller) due to vibration. Seed parameter includes higher moisture content, shape and size (variety of seeds) and surface friction of seed. Field parameters include bigger clod size, higher soil moisture content, and presence of agricultural residue and undulation of field. Human factor includes failing to lower the seed drill after taking a turn during sowing, forgetfulness to refill the hopper with seeds.

Despite all these factors, the desired population for getting more yields is possible, if operator gets information whether seeds are falling into the furrow or not. With the increase use of electronics in agriculture, attempts are required to be made to sense the seed flow from seed metering mechanism to the furrow opened by the furrow opener and choking in the seed delivery tube. Only sensing of seed flow and choking may not help the operator, there should be some indication of these parameters in terms of light or sound (McCarty & Meyer, 1983), so that the operator gets information about the seed in the seed delivery tube for efficient seed metering to get the desired seed dropped per unit area. Therefore keeping the above points in view, the present study has been undertaken to design and develop an embedded system for sensing of seed flow from seed metering mechanism and choking of seed delivery tube of a seed drill for precision sowing.

2. Development of embedded system

2.1. Concept of the developed system

An embedded system was developed for detecting missing of seed from seed metering mechanism and choking of seed in the seed delivery tube during operation of seed drill in a laboratory setup. In this embedded system, an indirect incidence infrared TSOP based sensor for sensing missing of seed from seed metering mechanism and a direct incidence infrared sensor for sensing choking of seed delivery tube were used and their outputs were fed to a microcontroller (Okopnik and Falate, 2014). The outputs for these inputs in both visual (LED) and audible (Buzzer) signals were controlled by the microcontroller. The flow diagram of the developed system is shown in Fig. 1. Before trying the system in actual field condition, the developed system was tried in the laboratory to finalize various components.

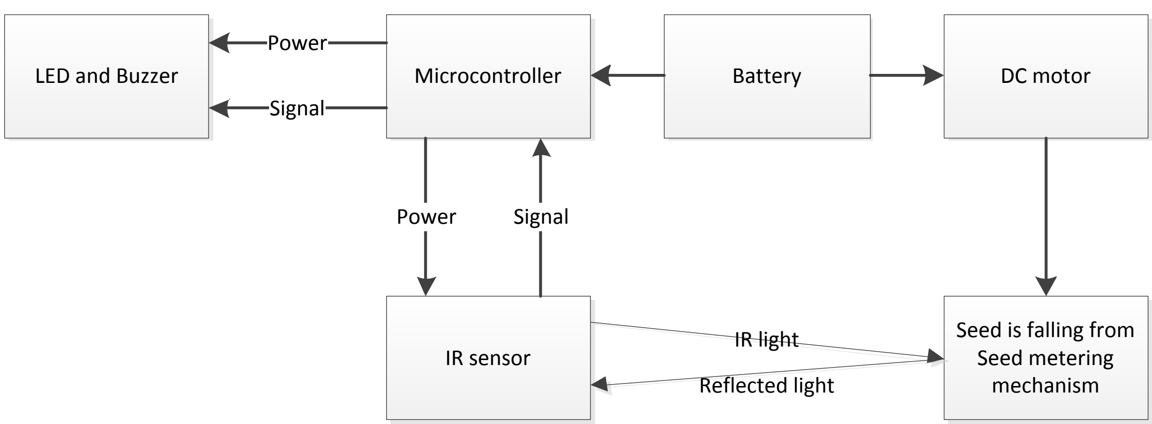

Fig. 1: Flow diagram of the developed system.

2.2. Development of indirect incidence TSOP (thin small outline package) based IR sensor for sensing of seed from seed metering mechanism

Indirect incidence TSOP based IR sensor was developed for sensing of seed from seed metering mechanism. The reflection of the radiation ray by light colour objects compared to black colour objects are more and this concept was used to build the IR sensor inside the plastic tube. When IR LED and photodiode were placed side by side, close together, the radiations from the IR LED get emitted in a horizontal plane in conical form and the photodiode couldn't receive any direct radiation within the specified range. If an opaque object passes through the emitted radiation zone, the incident rays were reflected back and sensed by the photodiodes. The amount of reflected radiation depends on the colour of the detected objects.The circuit diagram of the developed indirect incidence TSOP based IR sensor sensing system for seed flow is given in Fig. 2.

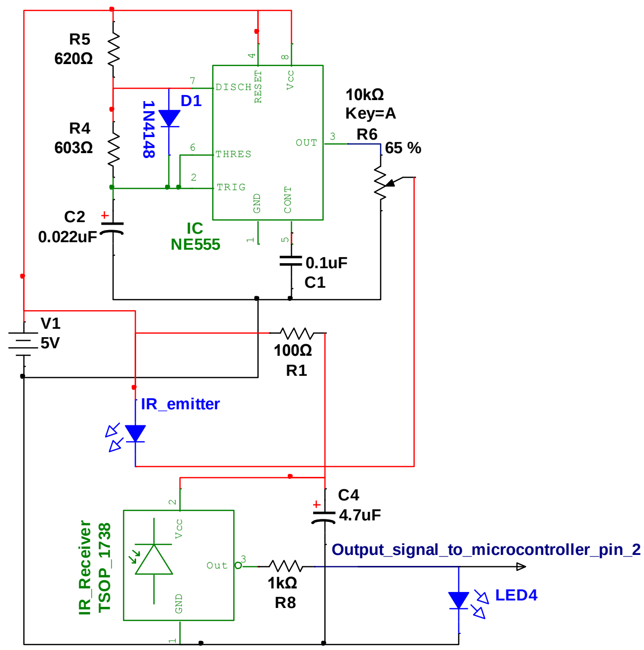

Fig. 2: Circuit diagram for the developed indirect incidence TSOP based IR sensor.

The indirect incidence TSOP based IR sensor comprised two IR LEDs to provide radiation and one TSOP based IR receiver to receive the reflected radiations. The indirect incidence TSOP based IR sensor comprising two IR LEDs were fixed to a 'Y' shaped pipe (Fig. 3) in such a way that the radiation coming out of the LEDs should not fall directly on the TSOP based IR receiver fixed in between the two IR LEDs. The output signal coming from the TSOP based IR sensor was fed to the Arduino UNO microcontroller board as well as to the red LED in IR sensor board.

Fig. 3: IR LED and TSOP receiver fitted inside a 'Ý'pipe.

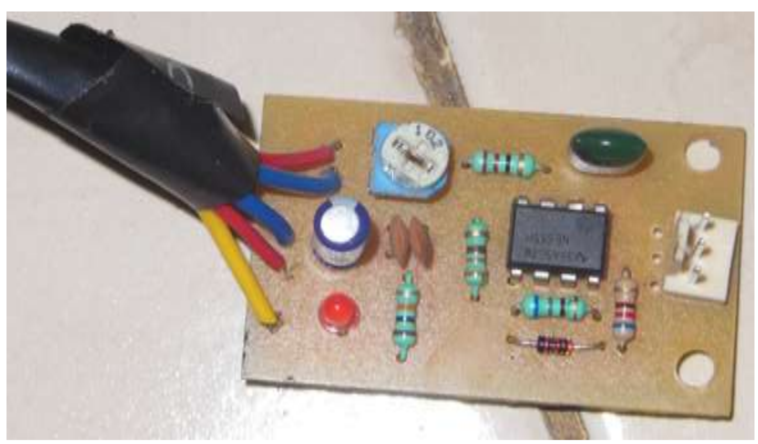

Fig. 4: Indirect incidence TSOP based IR sensor Board.

When the seeds fell from the seed metering mechanism, it passed through the band of radiation coming out from the two IR LEDs, the reflected radiation was received by the TSOP based IR receiver. The output signal coming from the TSOP based IR sensor was taken to the male header of the sensor board that was connected to digital pin no. 2 of Arduino UNO microcontroller board as well as to the red colour LED in IR sensor board. The sensor board was powered by 5V DC taken from the microcontroller via two male header pins. The developed IR sensor board is shown in Fig. 4.

2.3. Program flow chart of the developed embedded system

The program flow chart for the developed embedded system for controlling the I/O signals is as given in Fig 5.

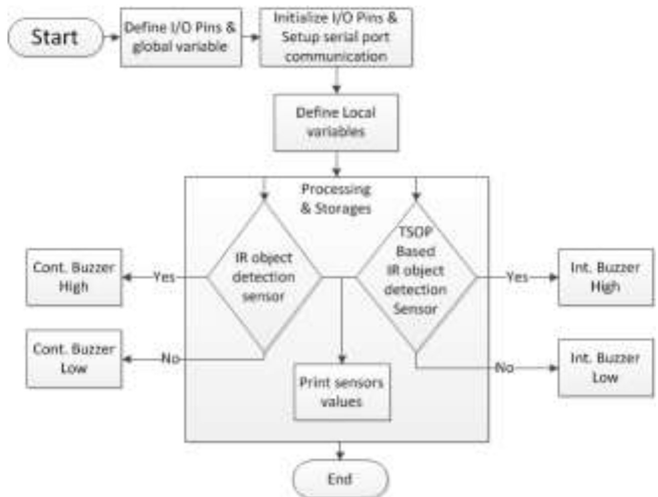

Fig. 5: Program flow chart for the developed embedded system.

2.4. Development of laboratory setup for testing of developed embedded system

A laboratory setup was fabricated to test the embedded system developed for sensing seed flow and choking of seed delivery tube. It comprised a hopper to store seeds, a fluted roller seed metering mechanism to meter seeds, a delivery tube, a 'Y' shaped rigid plastic tube and a developed embedded system. All the above components were mounted in a frame (100 cm×40 cm ×27 cm) made up of slotted angle iron as shown in Fig. 6. A DC motor powered by 12 V DC battery was used to rotate the metering mechanism by directly coupling the shaft of metering mechanism unit to the shaft of DC motor. The rpm of shaft of metering unit could be varied by using a potentiometer (resistance was varied by a knob) to vary the flow of current to the DC motor driver. This helped in varying the quantity of seeds dropped per unit time. The microcontroller of the embedded system was powered by the same 12 V DC battery. IR sensor and buzzer were powered by 5 volt DC from the output pin of microcontroller.

Fig. 6: Laboratory setup for detecting seed flow in a delivery tube.

2.5. Physical properties of wheat and ragi

The physical properties of grains i.e. wheat and ragi tested are summarized in Table 1.

TABLE 1: Physical properties of grains tested

Sl. No.	Properties	Type of seeds	
		Wheat	Ragi
1.	Moisture content, (% w.b.)	9.89 *c*	9.61
2.	Bulk density, kg/m^3	848	732
3.	Equivalent diameter, mm	-	1.63-1.7
4.	Dimensions		
	Length (L), mm	6.60-7.46	-
	Width (W), mm	3.41-3.43	-
	Thickness (t), mm	3.01-3.15	-

3. Performance evaluation of developed embedded system under laboratory setup

The performance of the developed indirect incidence TSOP based IR sensor for sensing of seed from seed metering mechanism was evaluated using the laboratory setup at different seed flow rates, rpm of the metering unit and type of seeds. The output signals for detection of seed flow are shown in Fig. 7. From this figure, it can be seen that when the sensor sensed the seed flow, it gave an output as 0 (Low voltage) and it gave an output '1' (high voltage) when there was no flow of seeds from the metering mechanism when seed rate was changed from 80-120 kg/ha and 2-6 kg/ha for wheat and ragi seeds, respectively. When there was no flow of seeds in the delivery tube it gave an indication to the operator in terms of red light and sound. From these observations, it was concluded that the detection of seed flow was working satisfactory with the developed system at different rpm and seed rates for wheat and ragi seeds.

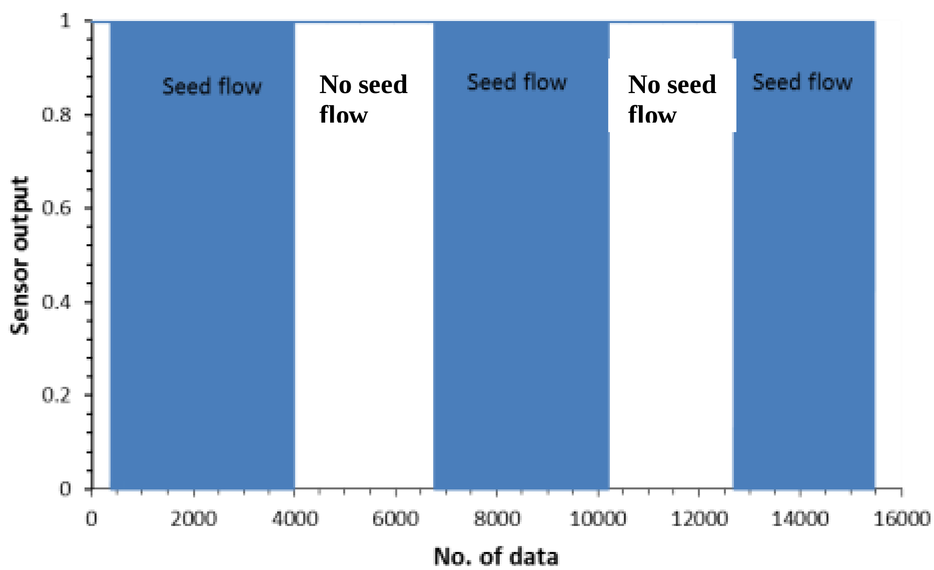

Fig. 7: Sensor output while detecting seed flow in the seed delivery tube of a seed drill

4. Conclusion

The developed embedded system could successfully sense flow of seeds such as wheat and ragi for a seed rate of 80-120 kg/ha and 2-6 kg/ha in a seed delivery tube giving a digital output of 0 and 1 whenever there was no flow of seeds and flow of seeds, respectively with a feed back to the operator in terms of light and sound.

5. Acknowledgements

Sincere thanks to MHRD, Govt. of India sponsored Food security Project for providing necessary funding to carry out this study.

6. References

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