Ultrasonic bund detection system for header of combine harvester

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There are appreciable physical losses to the header of a combine harvester operating in the fields during harvesting. To reduce these losses, it is desirable to effectively control the header height of the combine harvester. In the present study, a soil bund detection system has been developed for the header of the combine harvester using an ultrasonic sensor and tested under field conditions. In the laboratory, the best among five ultrasonic sensors (HC-SR04, US-100, JSN-SR04T, GY-US42 and MB-7092) was selected based on accuracy and response of the sensor operated for 27 treatments of soil bund height, sensor height and stubble density. Consequently, the soil bund detection system was developed using the US-100 sensor, Arduino UNO R3 microcontroller and two relays to control the actuator on prototype. The results showed that during sensor selection, the US-100 sensor had a maximum accuracy of 84.83% in BH3SH1SD1 treatment and a maximum response of 91.38 readings/sec in BH2SH2SD3 treatment. Furthermore, the developed system showed a maximum accuracy of 88.89% and 85.58% without the actuator in the field and with the actuator under laboratory conditions respectively. The highest response of 64.68 and 62.70 readings/sec was recorded for systems without the actuator in the field and with the actuator under laboratory conditions respectively. The study reveals that the increase in stubble density and sensor height causes a decrease in the accuracy, while the increase in bund height significantly increases the accuracy of the system. Moreover, an increase in vehicle speed causes a decrease in the response of the system, whereas with increasing bund height and stubble density, there is an increase in the response.

Keywords: Combine harvester, header height, linear actuator, soil bund detection, ultrasonic sensor.

India is 40%, which is low compared to other nations like Brazil (75%) and China (59.5%). The Government of India emphasizes maximizing the level of mechanization for different crops to increase productivity and efficiency[2]. In major crop-production hubs of the country, different types of agricultural machinery like rotavators, laser-guided land levellers, paddy transplanters, potato combines, power tillers, tractors, sugarcane harvesters and combine harvesters are being used to increase crop yield and productivity[3]. The combine harvester provides an efficient and rapid means to perform crop reaping, separating, threshing and cleaning activities in a single operation. On Indian farms, 900–1000 combines are being added every year. Initially, only western Uttar Pradesh, Haryana and Punjab used combine harvesters but nowadays, they are being used across the country for several reasons like high wage rates, shortage of labour, weather uncertainty and unpredictability[4]. The combine harvester consists of reel, header platform, crop divider, cutter bar, fan, grain sieves, platform auger, grain elevator, grain unloading auger, grain container, straw walkers, chaff sieves, feeder conveyor, grate and concave. Peripheral speed, combine forward speed, cutting height and feeding rate are machine-based factors affecting performance and crop loss of the combine harvester. Eight per cent of crop production loss occurs in the gathering and cutting processes, which are influenced by cutter height[5]. In support of this, 75% of crop loss occurs at the header during the harvesting process due to improper setting of the height of the header[6]. If, the height of the header is too large, it will decrease the total harvest yield[6]. On the other hand, if the height of the header has been set too low, it will touch uneven terrain and soil bund, leading to operator fatigue and equipment damage that affect header life and decrease the efficiency of the combine harvester. Further, a field with many bunds causes more stoppage