The Pharma Innovation Journal 2022; SP-11(6): 3028-3032

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(6): 3028-3032

www.thepharmajournal.com
Received: 08-04-2022
Accepted: 17-05-2022

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Development of electronic triggering mechanism for basin Lister

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Abstract
Basin listing is one of the oldest practice traditionally known as tie ridging or bund forming. An implement which is used to create basin is referred as basin lister Although the work was tedious and time consuming it was extensively practiced across India for various crop requirements such as paddy, wheat, millets and vegetable crops. In modern days from past few years tractor drawn bund former is being used for the bund forming operation. The tractor drawn basin lister on which modification has been made was efficient for the basin formation of 6×2m, but due to its restricted length of bund forming mechanism the modification of the existing implement was taken under consideration for developing the electronic triggering mechanism for power transmission of tractor drawn basin lister. The entire algorithm and process was designed for the electronic working system for basin lister. The functional components of electronic systems are Arduino Uno, Relay, Keypad, LCD, I2C, IR sensor and DC motor. The Arduino was programmed with Embedded C language in environment IDE 1.18.9.

Keywords: Arduino Uno, IR sensor, tie ridging, moisture conservation, embedded C language, integrated development environment, DC Motor

Introduction
The current agricultural scenario is upon maximizing water productivity within the land used to feed the growing population of the country. Soil moisture conservation is a key part of increasing water productivity. To maximize the moisture availability to agricultural crops, in-situ moisture conservation methods must be implemented. (Muthamilselvan *et al.*) Mulching, deep tillage, compartmental bunding, and basin listing are some of the techniques that were used.

Tie ridges, furrow damming, furrow dikes, basin listing, and micro basin tillage are all words used to describe the tillage of a basin. (Jones and Clark, 1987). Basin shape and design are mostly determined by the topography of the area for which they are being constructed. The recent advancements show that using electronic components for agricultural operations resulted into more precision and optimism. Widely used electronic components in agriculture are Arduino, IR sensor, soil moisture sensor, Ultrasonic sensor, Rotary encoder and Solenoid valve. These electronic components aligned with ICT are increasing the ease of various operations which were being used to perform manually such as ploughing, sowing, harvesting, spraying and at some extent uniform seed distribution.

Basin listing is one of the most effective methods of soil and water conservation. Basin listing provides maximum time to rain water for infiltration into soil. This method should be adopted in heavy soils where water absorbs slowly and must remain in position for a long period to ensure adequate irrigation. The word "basin listing" refers to the process of forming alternate furrows of a specific width on the ground. **(**Muthamilselvan *et al.*) as per the studies it is observed that for fine-textured soils, longer basins could be created, whereas for sandy soils, the basin size must be kept smaller.

Basin listing technology is used to grow other crops across India are,

- Broadcast crops, such as grains most likely wheat.
- Trees, such as citrus and banana.
- Pastures, such as alfalfa and clover.
- In some areas, row crops like tobacco.
- Fodder crops such as dinanath grass, berseem, lucerne, etc.
- Other crops like, groundnut, sorghum, finger millet, onion and vegetable crops.

Benefits of using ICT and electronics in agriculture

The application of ICT and electronics and telecommunication technologies are increasing day by day in agriculture. The use of electronics drastically increased in irrigation, livestock production, agricultural machines and equipment's, biotechnology, agrometeorology, green house, robotics and fruit classification and grading.

The existing implement is a tractor-drawn basin lister, which is a mechanical device with a mainframe, side bund former, lister former, trigger mechanism with power transmission, and hitch mast as components. The machine's primary function is to create basin of 6 x 2 m that will simultaneously produce side bunds and cross bunds, dividing land into a number of basins. Currently, the machine operates on a gear ratio (3.85 for 6 m) mechanical control system for a specific distance of 6 m. Based on land availability and crop requirements, a mechanism that will construct variable-length basins is required. The basin lister was electronically automated for triggering lister blade. The electronically actuation of system will result into the basins of variable length.

The functional components of electronic system are an Arduino Uno, a DC motor, an IR pulse count sensor, a Relay, an LCD, and a keypad.

Materials and Methodology

Development of electronic triggering mechanism

The length of the basin should be selected depending on crop requirements, land availability, topography and soil type. As basins of large lengths are required for some crops such as paddy, wheat, and cultivation of pulses, as paddy grows best when its roots are submerged into water. To overcome the limitations of the existing mechanism without increasing the cost and weight of the machine, we have developed the electronically operated mechanism for basin listers. This electronic mechanism has the potential to make basins of varying sizes, i.e., from 2m to 10m.

Electronic components and their working

Arduino Uno

In developed electronic prototype we had used an Arduino Uno R3 board to serve the purpose. The Arduino microcontroller is a simple to use and easy to programme. The Arduino Uno is an ATmega328 based microcontroller board. It has 16 digital input/output pins, six analogue inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button on the board. It comes with a USB connector for connecting to a computer and an AC to DC adapter or battery for power. The simplicity of uno is that we don't need to know C language to execute important functions simply a few commands are required.

Relay

A relay is an electrical device which is activated by a current or signal in one circuit to open or close another circuit. It is a switch that is controlled electrically. We have used Relay to switch a DC motor on and off in our system. The relay module is wired with Arduino Uno and DC motor which means when the Arduino compares the input distance to pulse output of IR count slot sensor it immediately sends the signal to relay. After receiving the signal relay changes its contact for specified time in the programme.

Pulse generating wheel

As per calibrated values form table 1, the best suited wheel having six tooth was used because its travelled distance is not in fraction while operating machine in the field. We designed a wheel which has diameter 12.5 cm and circumference 40 cm. The designed wheel has thickness of 3 mm and 6 tooth on it. The purpose of making tooth equidistant to each other on wheel is to use those teeth for pulse counting in coupling slot of correlation photoelectric infrared slot count sensor. The 6-tooth wheel is fixed on the shaft of 2 ground wheels, parallel to it in between them.

When the electronically automated basin lister moves in forward direction the toothed wheel also move forward with ground wheel. The infrared count slot sensor is fixed on upward side of toothed wheel on the metal plate for its rigidity and to prevent accidental damage, when the wheel moves in forward direction The Tooths on it passes through the coupling slot of infrared count slot sensor. As The Tooths passes through coupling slot, sensor counts and generates pulse. We calibrated by mathematical calculation as 1 pulse equals to 0.20 cm and 5 pulses equals to 1 m. The ground wheel has circumference of 120 cm thus we made 6 tooths on the wheel used for obstruction in coupling slot so when the wheel starts to move and as soon as it travels distance of 1 meter then parallelly 5 pulse were generated. The data of pulse equal to distance is mentioned in table 1.

Table 1: Calibration of wheel with IR count slot sensor

Sr. No.	Distance, m	Pulse generating wheel 2 tooth	Distance, m	Pulse generating wheel 4 tooth	Distance, m	Pulse generating wheel 6 tooth
1	1.20	2	1.20	4	1	5
2	2.4	4	2.4	8	2	10
3	3.6	6	3	10	3	15
4	4.2	7	4.2	14	4	20
5	5.4	9	5.1	17	5	25
6	6	10	6	20	6	30
7	7.2	12	7.2	24	7	35
8	8.4	14	8.1	27	8	40
9	9	15	9	30	9	45
10	10.2	17	10.2	34	10	50

Correlation photoelectric infrared count slot sensor module

The correlation photoelectric infrared count slot sensor module was used for obstruction of tooth, i.e., to generate pulses by obstacle detection from toothed wheel. It has an infrared counter module with an embedded LM 393 chip in it. The sensor was attached on a horizontal metal frame of implement in a way, where the six toothed wheel will pass through the 10mm coupling slot of sensor and generate pulse with each time the wheels tooth passes through the sensors coupling it generates pulses as an output.

Table 2: Specifications of IR count slot sensor

Main chip	LM393
Operating voltage (VDC)	3.6-5
Average current consumption (mA)	33
Length (mm)	27.6
Width (mm)	20
Height (mm)	17
Weight (mm)	4
Width of optical coupling slot	10 mm

Fig 1: Six toothed wheel

As shown in the Fig. 1 There was a light on sensor which blinks when the wheels tooth passes through the coupling slot of sensor by obstructing coupling slot. The light turned off for fraction of seconds and the pulse reading signal is displayed immediately on LCD which is fixed on electronic hardware system.

Keypad

We have used a 4×4 matrix keypad for our input (distance in metre) to microcontroller. It features a total of 16 keys, all of which have the identical input values. in our system we mounted it on the upper side of box. We connected keypad pins to Arduino UNO board socket pins for giving input i.e., distances.

Liquid crystal display

LCD stands for liquid crystal display and is an electronic display module which is used to display data in a variety of applications. In our electronic system 16x2 LCD is fixed on the circuit box for easy operating. The numbers, i.e., distances and the pulses will be displayed on the screen. The microcontroller is attached to LCD, so that it will display the microcontroller's output, such as the distance we specified using the keyboard, sensor output in terms of pulses, and the status of the DC motor such as on or off.

I2C Module

We have connected the inter integrated circuit to our 16×2 LCD display module which is a multi-master bus. We have used it to minimize use of pin connections to LCD as it is a bus which encloses more pin connections. The display contrast of LCD can be adjusted by using I2C.

DC motor:

We have used the 12V DC motor which has assembly made up of several distinct components. The motor, gear mechanism, connectors, switch and other components are among them. The 12V DC motor is adequate for our purpose as its only work is to power chain and sprocket assembly.

The motor is fixed on main frame with 14 teeth sprocket fitted on it, another sprocket having 50 teeth is fixed on the cam shaft. The sprocket fixed on DC motor shaft rotates in the forward direction with gear ratio of 3.58 helps to trigger the stopper and actuates the trigger mechanism which release lister blade. These sprockets are covered with chain for the power transmission as shown in Fig. 3. The 12V DC motor has provided power from 12V battery.

Fig 2: DC motor

Fig 3: Power transmission with DC motor

Software used for programming

Arduino IDE

The Arduino IDE is a Java-based cross platform application for Microsoft Windows, Mac OS X, and Linux. It comes with a code editor that offers text cutting and pasting, text finding and replacement, automated indenting, brace matching and syntax highlighting, as well as one click compiling and uploading of program to an Arduino board. For our programing we used Arduino IDE version 1.18.9 and code has been written in embedded C language.

Embedded C programing language

The embedded C programing language is used to write the code. It is frequently used in the creation of embedded systems. The embedded C programing language follows the same syntax and semantics as the C programing language, including the main function, datatype declarations, variable definitions, loops, functions, statements, and so on. Different libraries are included like servo, EEPROM, Keypad, liquidcrystal_I2C and components pins were defined. Once the libraries are included and functions are defined program can be uploaded with the help of A to B USB data cable.

Assembly of different electronic components and their working

All the electronic component were assembled for proper functioning. Arduino board, 4×4 matrix keypad, LCD display. I2C, DC motor, switch for circuit, Single channel relay, 12V battery were housed in a hard plastic box and assembled on the tractor's mudguard with sturdy fitments. The IR sensor was fitted outside of the box on the implement as shown in Fig. 1. The battery was mounted outside of the box and wired with the Arduino board and DC motor.

The distance (meter) is entered using a 4×4 matrix keypad which has mounted on the box housed with Arduino uno and Relay. As the machine moves forward, the IR sensor detects

an obstruction in the coupling slot and begins generating pulses. which results in distance measurement. The sensor generates pulse, which are compared to the distance (metre) typed on the keypad. The movement when the entered and travelled distances are same the Arduino sends a signal to the relay. The contact position of a relay gets changed and turn its switch on for 3.5 seconds. The delay provided by Arduino to the DC motor causes the motor to turn on and start rotating 14 tooth sprockets on it which will move cam and it actuates the stopper by drawing back when the follower, allowing the next lister blade to take its place by moving the tractor in forward direction. the names of processes i.e., triggerring mechanism and DC motor on/off were displayed on the LCD.

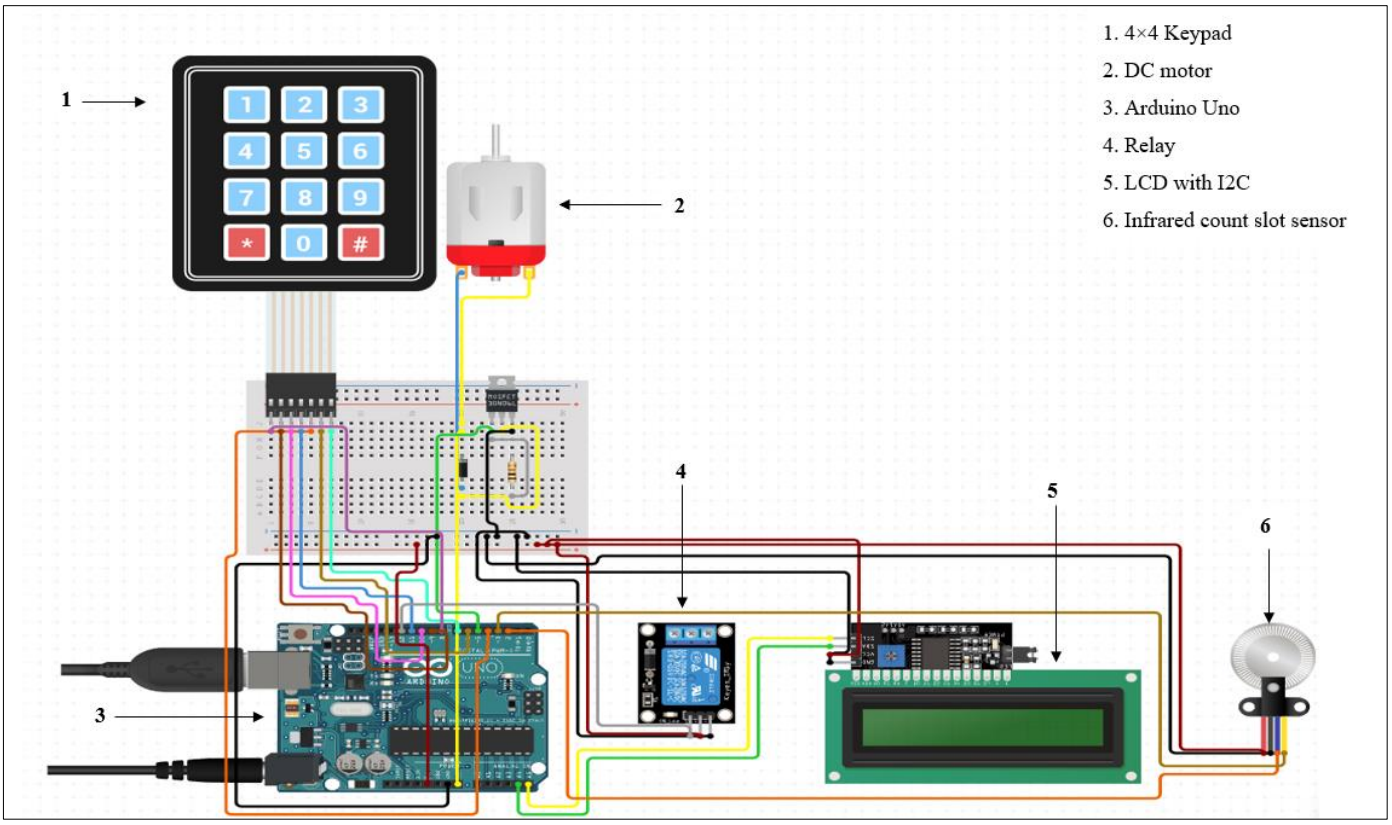

Fig 4: Circuit diagram of electronic system of basin lister

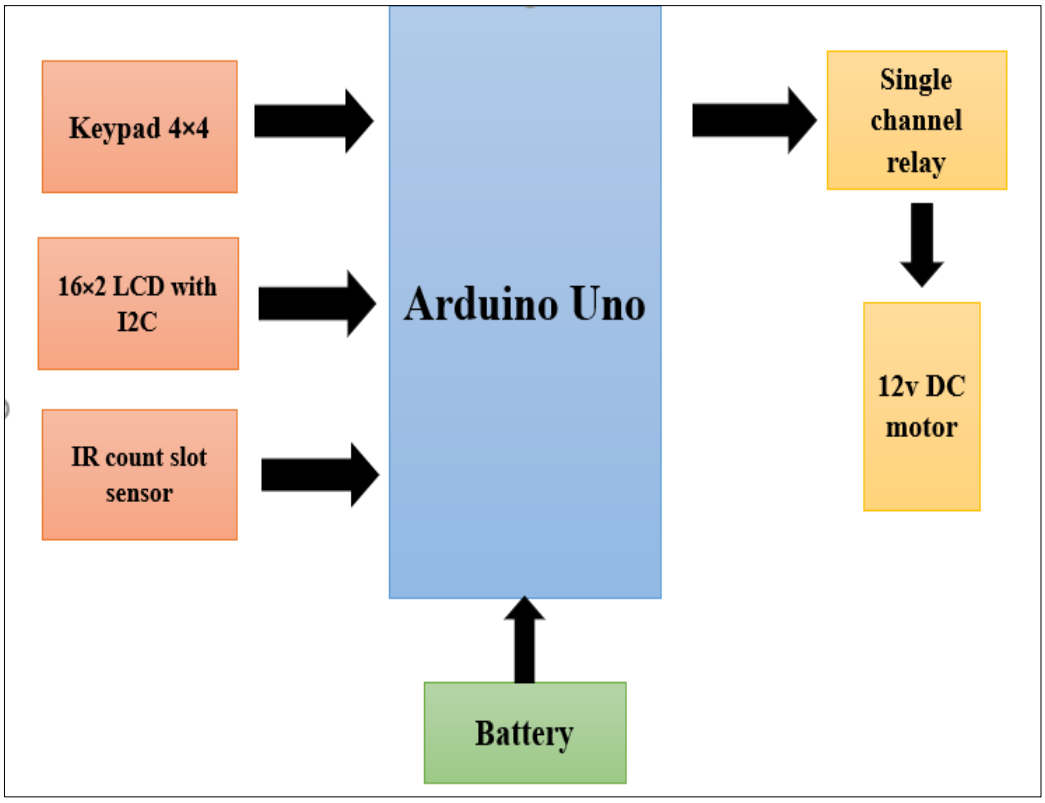

Fig 5: block diagram of system

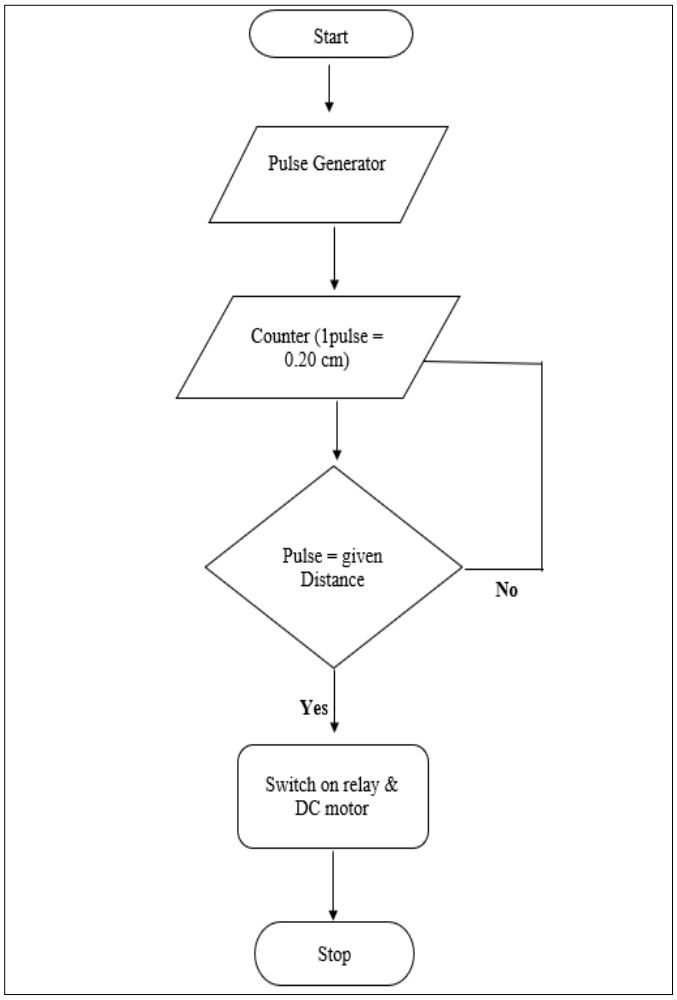

Fig 6: Flow chart of electronic system

Results

The electronically automated basin lister was able to perform well resulting into formation of varied length of basins i.e., 2.7m, 4.3m, 6.5m, 8.4m, 10.4m. The infrared sensor worked well in dusty field condition and indicated accurate results. DC motor was able to work long hours throughout the trials without getting heating up. The total area covered during the field test by the implement was 1.36 ha. The field efficiency of implement was varied from 76.63% to 80.27%. The field efficiency of electronically automated basin lister was found to be increased greatly and minimum wheel slippage was recorded.

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