ENGINEERING AND TECHNOLOGY IN INDIA

Volume 5 | Issue 1&2 | Apr. & Oct., 2014 | 26-31
e ISSN-2230-9284 | Visit us : *www.researchjournal.co.in*
DOI : 10.15740/HAS/ETI/5.1and2/26-31

ARTICLE CHRONICLE :
Received : 07.07.2014;
Revised : 28.08.2014;
Accepted : 18.09.2014;

RESEARCH PAPER

Development of micro processor based electronic metering mechanism for seed – an approach

■ **V.V. AWARE AND** S.V. AWARE

ABSTRACT

A microprocessor based electronic metering mechanism was design and developed for three row planter to meter the cowpea seeds. The previously developed mechanical metering mechanism exhibited various losses in mechanical linkages and hence proved to be less precise. The metering mechanism was based on the opto electric rotary sensing. The input was given to the micro controller in the form of electric pulses from the sensor and the switches, which defined the spacing of the seed. The performance of developed planter was tested in the laboratory. For the given input of 15 cm, the output seed spacing obtained was 16.2 cm.

KEY WORDS : Microprocessor, Electronic metering mechanism

How to cite this Article : Aware, V.V. and Aware S.V. (2014). Development of micro processor based electronic metering mechanism for seed - an approach. *Engg. & Tech. in India*, **5** (1&2) : 26-31.

INTRODUCTION

India as it is known is the land of villages and thus is dependent on agriculture for its most of the activities, may it be providing food to people or raw material to industries. Population and industrialization of India is growing at a fast pace. Thus it is necessary to increase the productivity of the agriculture sector to supplement these growths.

In recent years, with the development of precision seeding technique, precision seeding has become the main feature and developing direction of modern seeding technologies. Precision seeding can save seeds and effectively control the sowing depth, sowing densities and the sowing distance (Li *et al.*, 2013). According to stastics, the output of precision seeding increases by 10 per cent - 30 per cent compared with that of the conventional drill (Zheg, 2006).

It is feared that mechanization will render the farm labour jobless, but it is not so. Most of the farmers in a particular area take up farming operations simultaneously. So there is a dearth of labour at this particular time period. This can be overcome by introducing machines. The implements and machineries introduced must be precise enough to compete with the human labour. Any machine introduced newly must satisfy the farmers by its advantage over the prevailing methodology.

Seeding or the planting is one of the most important basic farm operations in agriculture as it decides the production of crops. Generally for sowing, drilling practice is adopted. The main drawback of drilling is that the seed rate and spacing between seeds cannot be controlled which causes hindrance to mechanized intercultural operations.

Precision planting is a prerequisite for mechanical cultivation and is an important factor in efficient land use. Planter is advancement over the seed drills in which single seed or group of seeds are placed at a predetermined depth and the space interval. Thus in planter row-to-row and seed to seed distance is maintained, which provides sufficient space for proper growth of the individual plant also interculture operations are eased and hence yields more production per unit area.

The microprocessor technology is used on precision seedng in many aspects. High-speed camera was used by Karayel to observe the trajectory of seeds while throwing seeds. He predicted the seeds spacing from the trajectory by microprocessor technology.

For lifting the seed from the hopper and delivering it to delivery tube at a uniform interval various mechanisms are used, these are called metering mechanisms. Different types of metering devices are available as per the requirement of shape and size of the seed. The precision of the planter depends on how accurately the seed is metered by the metering mechanism.

Mechanical metering mechanisms have proved to be helpful, but they do not provide the required precision and cause wastage in seed due to the loss in mechanical transmission.

Agriculture symbolizes the need of human beings while electronic symbolizes the speed. Therefore, electronics is useful for rapid production of the agriculture produce. Electronic metering mechanism may be one of the options to achieve accurate seed spacing with higher efficiency.

Electronic metering mechanism has following advantages :

- Check row planting is possible with the help of electronic metering mechanism.
- Accuracy is higher.
- By making small adjustments this metering mechanism can be used for various seeds.
- Electronic metering mechanism requires less maintenance.
- Number of seeds to be sown can be maintained.

Drake (1993) described the development of a two row-planting machine mounted on a 100 hp four-wheel drive tractor. The planter incorporates electronic programming for spacing and fertilizer application.

Durairaj *et al.* (1994) developed a bullock drawn seed drill with a simple electronic metering system. It had an electronically controlled check valve system that facilitated precision planting of seeds. Field tests indicated negligible variation in plant spacing from the required spacing and seed damage was minimum with an acceptable germination percentage and crop stand.

Rehman and Singh (2002) developed a sensor for seed flow from seed metering mechanism. A sensor based on a light interference technique had been developed for sensing the seed flow from the metering mechanism of the planter.

Theoritical considerations :

Metering mechanism for planter :

Devices for metering single seed usually have slots, notches, cavities or cells on a moving member or on an arrangement to pick up a single seed and lift it out of the seed mass from a hopper and release it into a seed tube. The height of fall must be short to keep the seed at exact place in the furrow. The ground wheels drive the plates. Seed rates may be changed by altering the speed or rotation of the disc or by varying the number of slots on it.

Rotary motion sensing mechanism :

The mechanical motion of the tractor should be converted in to electrical pulses so that the microcontroller would be able to sense the motion of the planter. The mechanism developed to sense this motion was a rotary plate with notches along this periphery. The diameter of the ground wheel was 30 cm. Hence, distance traveled in one revolution is $= \pi \times 30 = 94.24$ cm. Unit spacing was considered as 2.5 cm. Therefore, number of notches on the sensing plate periphery are $94.24 / 2.5 = 37.69 \approx 40$.

Gear ratio :

D.C. motor is used to transfer the final output pulse to the rotary motion of the seed plate. For one output pulse the motor shaft rotates through 60^0. The seed plate has 16 cells on its periphery thus each cell is 22.5^0 apart from each other. Hence, speed ratio = 60 / 22.5 = 2.667. Hence 18 toothed and 48 toothed gears are used.

EXPERIMENTAL PROCEDURE

Spatial dimensions of cowpea :

Spatial dimensions of cowpea were measured with the help of vernier caliper. Length, breadth and thickness of Cowpea were measured. Hundred readings of each dimension were taken by using vernier caliper and their average was taken for determination of grove size of the cell plate.

Electronic metering mechanism :

The electronic circuit is divided in three different parts

- Power circuit
- Main circuit

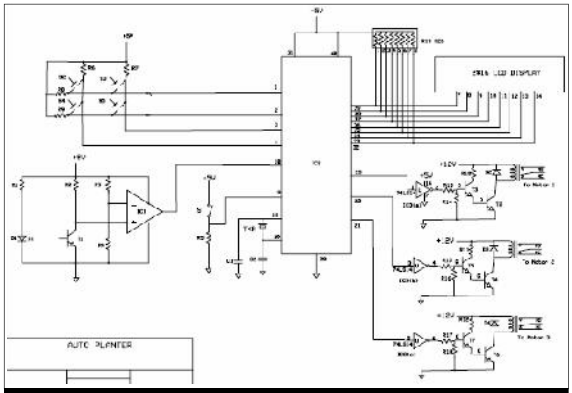

Fig. A : Microprocessor circuit

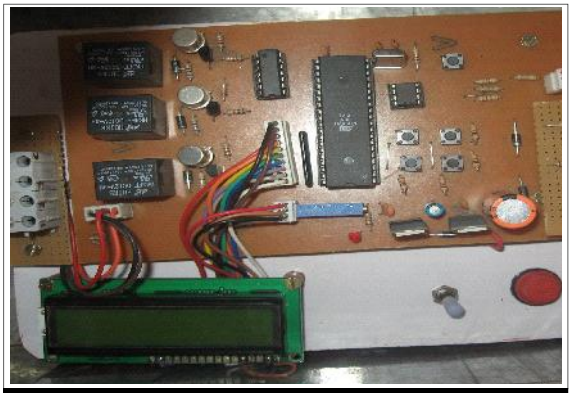

Fig. B : Microprocessor circuit

– Relay circuit.

List of components (power circuit) :

– TXR_1 = 12-0-12 1Amp Step Down Transformer
– D_1-D_4 = IN4007
– C_2 = 1000 µF/50V Electrolytic capacitor
– C_2, C_3 = 0.1 µF Disc capacitor
– IC_1 = 7812 (+12V voltage regulator)
– IC_2 = 7805 (+5V voltage regulator)
– Fuse = 1 Amp fuse

Fig. C : Laboratory test set up

– S = ON/OFF Switch.

List of components (main circuit) :

– Resistors
– Capacitors
– Diodes
– Transistors
– Integrated circuits
– LCD Display = 2 X 16 LCD Display
– S_1-S_5 = tactile switches
– TXR = 12 MHz crystal oscillator
– RLY_1-RLT_3 = 12V SPDT relay (single pole double throw).

Working of microprocessor based metering mechanism :

The 5 hp, 1440-rpm motor drives the ground wheel, which drives the sensor plate. The sensor plate generates 40 pulses in one revolution, which are sensed through the opto electric sensor.

The operational amplifier LM741 processes the input in the form of 230 V, 50 Hz A.C supply and generates the output in the form of a constant +12 V, +5 V D.C. supply. Meanwhile, input through the switches in the form of seed to seed spacing was given to the micro controller (AT89C51 IC).

The input data through switches and operational amplifier is processed in the micro controller and the low output is given to the hex-inverter IC, which converts it into high. The micro processor circuit is shown in Fig.A and B. This high output drives the Darlington pair BC547 and SL100 transistors, which drives the relay circuit. The relay gets activated and the DC motor starts rotating. One pulse of photo transistor sensor corresponds to 2.5 cm horizontal travel, hence for 5 cm spacing there will be two pulses and so on.

A D.C. motor was connected to the seed plate through a gearbox having speed ratio as 2.67. For one output pulse the D.C. motor rotates through angle of 60^0. Hence, the seed plate rotates through 22.5^0. There are 16 cells on the periphery of the seed plate. Therefore, as seed plate rotates through 22.5^0, one seed gets metered.

Development of software program :

The software selection is the backbone of entire project. Software development include program written from the interfacing of the micro controller and the external hardware. For this project, AT89C51 micro controller is used. The program was developed in the assembly language and was compiled by the compiler in hexadecimal code. Then it was copied on the RAM (Random Access Memory) available on the micro control.

Laboratory test :

Laboratory test set up was developed to simulate the forward speed of planter in the field. An electric motor (5 hp, 1440 rpm) was used for this purpose. The gearbox was used to reduce the speed of the D.C. motor. It was decided to test the planter at 4 kmph. As the diameter of the ground wheel was 30 cm, the pulley of the diameter and, respectively on electric motor and ground wheel shaft, so that the forward travel speed of the planter would be achieved.

Electronic metering mechanism was set for different spacing as 10, 15, 20, 25, 30 and 35 cm. Electric motor and metering mechanisms were started simultaneously. The numbers of seeds collected in one-minute interval were collected for different spacing. Laboratory test set up was developed as shown in Fig. 2 to check the seed to seed spacing.

EXPERIMENTAL FINDINGS AND ANALYSIS

Variety of cowpea used in the laboratory testing was *Konkan Sadabahar*. It observed that the length, width and thickness were 6.2 mm, 4.9 mm and 4.0 mm, respectively.

It was observed that for the input spacing of 15 cm the actual spacing obtained was 16.2 cm. The variations observed in the reading were due to that fact that the D.C. motor under variable loading conditions does not rotate at the rated speed. Similarly finding were observed by Zhang and Zhao (2008); Lou (2004), Wang and Wang (2006); Zhao (2002), Zhao *et al* (2013) and Wang *et al.* (2013).

Table 1 : Laboratory testing

Sr. No.	Length	Breadth	Thickness	Sr. No.	Length	Breadth	Thickness
1.	6.7	5.1	4.4	31.	6.3	5.4	4.4
2.	6.3	6.1	4.3	32.	6.2	5.0	3.8
3.	6.5	5.2	4.3	33.	6.8	5.2	4.1
4.	6.4	5.2	4.4	34.	6.5	4.9	4.4
5.	6.4	5.0	4.3	35.	6.1	4.9	4.0
6.	7.1	5.4	4.0	36.	6.0	4.5	3.4
7.	6.6	5.2	4.3	37.	5.8	4.7	4.2
8.	6.2	5.3	3.9	38.	5.9	4.6	3.9
9.	6.4	4.6	3.8	39.	6.2	5.0	3.9
10.	6.2	5.1	3.9	40.	6.4	5.0	4.1
11.	6.0	4.7	3.8	41.	5.9	4.4	3.6
12.	6.6	5.0	4.1	42.	5.9	4.7	3.8
13.	6.8	5.4	4.1	43.	6.2	4.7	3.9
14.	5.8	4.8	3.9	44.	5.8	4.7	3.9
15.	5.9	4.8	3.8	45.	6.2	4.8	3.8
16.	5.7	4.6	3.9	46.	5.4	4.4	3.9
17.	6.7	4.8	3.9	47.	5.8	4.6	3.5
18.	6.0	4.9	3.8	48.	5.6	4.6	3.4
19.	5.4	4.6	3.8	49.	5.9	5.1	4.1
20.	5.7	4.9	4.1	50.	5.5	4.4	3.7
21.	6.5	5.1	4.1	51.	6.3	5.0	3.9
22.	6.9	5.1	4.3	52.	5.5	4.3	3.4
23.	6.4	4.9	4.4	53.	5.9	4.9	4.0
24.	6.0	4.8	3.9	54.	5.6	4.3	3.7
25.	6.6	5.5	4.1	55.	5.7	4.6	3.5
26.	6.7	4.9	4.1	56.	7.3	5.5	4.7
27.	6.7	5.0	4.2	57.	5.7	4.7	3.9
28.	6.5	5.0	4.1	58.	6.2	4.7	4.1
29.	6.9	5.5	4.2	59.	6.9	5.4	4.4
30.	6.1	5.1	4.0	60.	6.0	4.6	3.9
				Average	6.2	4.9	4.0

Table 2 : Observations for various input spacing

Sr. No.	Seed to seed spacing entered through controller, cm	Expected no. of seeds to be metered	Actual no. of seeds	Actual average spacing, cm
1.	10	612	412	14.9
2.	15	408	379	16.2
3.	20	306	373	16.4
4.	25	245	294	20.8
5.	30	204	229	26.8
6.	35	175	169	36.2

Conclusion :

- It was observed that for the input spacing of 15 cm the actual spacing obtained was 16.2 cm.
- Electronic metering mechanism can be used as modification over the orthodox mechanical metering mechanisms.
- Electronic metering mechanism can be used for different seeds by changing seed plate and varying the input (seed to

seed spacing) to the micro controller.
– Electronic planter having more rows can be obtained by using more number of output ports.

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MEMBERS OF RESEARCH FORUM

AUTHOR FOR CORRESPONDENCE :

V.V. Aware
Department of Farm Machinery and Power
College of Agricultural Engineering and Technology
Dr. B.S. Konkan Krishi Vidyapeeth,
Dapoli, RATNAGIRI (M.S.) INDIA

CO-OPTED AUTHORS :

S.V. Aware, Department of EOES, College of Agricultural Engineering and Technology, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, RATNAGIRI (M.S.) INDIA