Contribution to the implementation of software control for seeding plates

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Summary: *Seed plates of all seeding machines for widerow plants are powered by wheel of seeding machine and mechanical transmission. That has impact to volume and possibilitz of stearing.This paper show possibilities of using electromotor for power of seed plates as well as analysis possibylities acting stearing by electro system. In this paper are research measurement system and create stearing by programabil logic controller and shown idea for implementation steering of speed rotating of seed plates. That has aim to go about nominal seed space in row.*
KEY WORDS: *SEED MACHINES, SEED PLATE, PROGAMABIL LOGIC CONTROLER, ALGORITHAM.*

1.Introduction

The key agronomic factors that affect the nominal germination of seeds and consequently the adequate development of plants are the correct choice of culture in relation to the climate and type of soil on which seeding is performed, the method of soil preparation before seeding, the correct selection of seeds in terms of its type and geometric shape and selection of seeding dates and conditions [1,2].

The operation of one drill, and consequently the corresponding parts of the drill, can be divided into five phases:

1. shrinkage / leveling of surfaces,
2. surface consolidation by pre-compaction,
3. pulling the furrow and lowering the seeds,
4. pressing the seeds into the furrow and closing it,
5. compacting the soil around the seeds.

It should be noted that in most seed drill solutions, the individual phases partially overlap or occur simultaneously. Among all the mechanical assemblies of the seeder that ensure the execution of a certain phase of seeding, the highest degree of dynamism is possessed by the seeding machine by means of which the seed is lowered into the ground. As this is the most responsible machine assembly of the drill, there are a large number of solutions and designs that, in combination with the air flow, ensure the fulfillment of the role of the seeding machine [3].

The three key requirements for a seeding machine in the seeding process are:

-as much force as possible for pressing the seeds into the soil,
-the most precise distance and distribution of seeds per plot,
-no seed damage [4].

The germination rate depends on the manner and intensity of seed-soil contact, which later affects the resistance and development of the plant. Well-pressed seeds into the soil easier get moisture and nutrients, germinates faster and develops a root apparatus that affects the later stability, resistance and development of the plant. Therefore, it is necessary to achieve close contact between seeds and soil by pressing the seeds with as much force as possible. Depth of seeding for corn is 6-8cm, and for hemp and sunflower 4-7cm [5].

The even distribution of plants on the plot enables the plants to have equal access to resources, which entails even development and yield over the entire surface of the plot. A key prerequisite for achieving this goal is to invest the seeds in the soil at an equal, prescribed, distance between the seeds and later the plants within the row, since the distance between the rows is easy to adjust and maintain. Also, a very difficult requirement is placed in front of the seeding machine if "zigzag" seeding is needed, because then the work of the seeding machines on the seeder needs to be coordinated independently from section to section [6].

Damage to the seed is possible in several places during the journey that the seed crosses from the tank on the seeder to the furrow. Although not common, seed damage is still possible, mainly due to crushing and impact.

Each seeding machine takes the seed from the tank and lays / inserts it into the furrow formed in the soil. According to the stated requirements and functions that must be fulfilled by the seeding machine, it consists of three functional assemblies (Figure 1), closely connected and intertwined: seed plate which is the seed carrier from the moment of taking it from the tank to its ejection into the ground, scraper, excess seed from the seed plate which removes the seeds if the seed plate has taken several grains from the tank into one of its openings so that only one grain remains in the opening, and a seed ejector which is in charge of correctly and precisely laying the seeds in the soil. Air current of vacuum or compressor type is necessary in fulfilling the roles of the seeding machine, and in some types of pneumatic seeders it independently performs the roles of the above-mentioned assemblies [7,8].

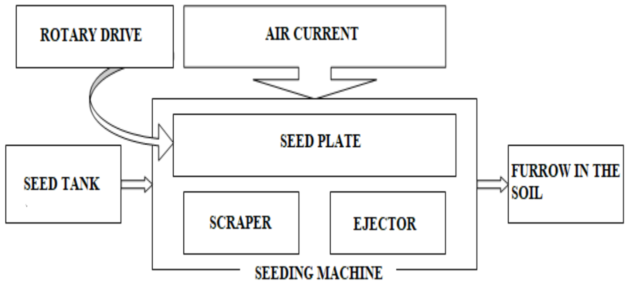

Figure 1*.Structural diagram of seeding machine*

2.Material and Method

In order to control the speed of the seed plows, it is first necessary to measure the speed of the tractor or the connected tillage machine. In this context, the speed of the tractor and the machine is transmission speed, and the speed of the seed plate is relative and depends on the transmission. It follows that it is necessary to measure the transmission speed, and introduce this signal as an input to the control body (programmable logic controller) which generates an output signal to control the speed of rotation of the working bodies through the executive control organ [9].

The measuring points for measuring of the transmission speed can be different depending on the type of machine and the type of sensor used. For mounted machines, the speed must be measured on the tractor as a driving machine. For towed and semi-mounted machines, which are most often used in practice, it is most convenient to measure the speed at the wheel of machine. In this case, it is possible to use an incremental encoder or inductive proximity sensor.

With the help of an incremental encoder, it is possible to measure the speed and angle of rotation of the seed plates with a resolution of up to 1/1500 per turn. However, the application of the incremental encoder on tillage machines has so far been mostly only theoretical, as these machines are exposed to high vibrations that adversely affect the accuracy of the encoders themselves. In addition, the working conditions on the fields imply the exposure of the sensor to dust and precipitation, so this also calls into question the reliability of the encoder in the role of a speedometer for the tractor or seeder in the work on the plot.

Inductive encoders are by nature sensors of much more robust construction, and as such much more adaptable to the agricultural complex, ie the needs and conditions that prevail in tillage. These sensors work on the principle of inducing metal objects, so it is necessary to additionally equip the machine itself. The best way is to place the screws on the rim of the wheel of the machine at the same radius from the shaft. The number of screws also dictates the measurement resolution.

However, as it is practically impossible to achieve the resolution as when using the encoder, it is enough to place one screw on the rim of the wheel, and fasten the sensor axially in relation to it so that one pulse is induced when the screw passes the sensor. In this case, each pulse corresponds to one turn, and the resolution is corrected by software. The response of the system in terms of control is always better when there are several benchmarks around the perimeter and when each turn is manifested with more impulses. However, since the speed when seeding is of the order of 5-8 km/h, then a completely satisfactory quality of control is achieved with only one benchmark on the rim.

The first module is a power supply unit used to convert the mains voltage to DC stabilized voltage, which is necessary for the safe operation of the PLC, and an external voltage, which is used to power other consumers. The module itself is realized as a switching power supply with galvanic isolation. On the front of the module there are LED diodes as an indication of the correctness of the input voltages, a connector for connection to the mains voltage and a connector for external voltage. At the back of the module there is an EBUS connector through which the other modules are supplied with a DC stabilized voltage of 8-24V DC. This power supply module also features short-circuit protection, current protection, temperature protection and soft start. The CPU executes the driver, manages the IO modules and communicates with the superior system. On the front of the module there is a connector for serial communication with a random station or other CPU module, a circular switch for determining the PLC address in the network as well as LED indications of correct operation of the module and a connector for connecting external power. A PC is used as a programming and testing workstation and programming is done in LD language in accordance with IEC 1131-3.

The digital input / output module has 8 digital 24VDC inputs with a common end and 8 transistor outputs. The first two digital inputs can be used as counters. The last module was added to power the previous one.

3.Research Results And Discussion

In order to control the speed of the seeder, it is first necessary to measure the speed of the tractor with the seeder. This speed is transmission and the speed of the seed plate is relative and depends on the transmission speed. Therefore, it is necessary to know the transmission speed, and to introduce this signal as an input speed in the control body (programmable logic controller) which generates an output signal for speed control of working bodies through the executive control body [10].

For seeders, the speed is best measured at the wheel of the seeder. In this case, it is possible to use an incremental encoder or an inductive proximity switch.

With the help of an incremental encoder, it is possible to measure the speed and angle of rotation of the seed plates with a resolution of up to 1/1500 per turn. However, the application of the incremental encoder on seeders has so far been mostly only theoretical, while for a wider practical application it would be necessary to perform such an assembly that would protect the encoder from vibrations that adversely affect the measurement accuracy. Also, in order to be more precise, protection from dust and dirt should be performed [11].

Inductive sensors are by nature sensors of much more robust construction, and as such are much more adaptable to the needs and conditions that prevail when working in contact with the ground. These sensors work on the principle of inducing metal objects and it is necessary to additionally equip the seeders itself in the form of protrusions that are placed on the wheel. One way is to place the screws around the perimeter of the seeders wheel at the same radius from the shaft. The number of benchmarks also dictates the measurement resolution. The higher the number of benchmarks, the higher the resolution. However, as it is practically impossible to achieve the resolution as when using the encoder, it is enough to place one benchmark on the rim of the wheel, and the sensor itself is fixed axially relative to it so that one pulse is induced when the benchmark passes the sensor. In that case, each pulse corresponds to one revolution, and the lack of resolution is compensated by software. The response of the system in terms of management is always better when there are several benchmarks around the perimeter and when each turn is manifested with more time intervals. However, since the seeding speed is in the interval 5-8km / h, then a completely satisfactory quality of control is achieved by using only one benchmark per rim. The time that elapses between two benchmarks, ie between successive passes of the benchmark against the inductive sensor, determines the time interval, ie the measurement period on the basis of which the average speed of the seeder in that time interval is determined. The mean velocity for that time interval is calculated as the quotient of the circumference of the circle of that radius which corresponds to the distance of the measuring benchmark from the wheel axis and the measured time interval that characterizes that measuring period [12,13]. The seeders speed thus obtained is used to calculate the required seed plate rotation speed, provided that new information on the average seeders speed is obtained at the end of each time interval. It is used during the next time period to control the rotation speed of the seed plate, ie to determine the time after which the disc should be rotated to achieve seed equidistance in the furrow and at variable seeders speed. The stated logic of speed control of the seed plate is manifested in the generation of the time after which it is necessary to rotate the seed plate, shown in the algorithm in Figure 2.

Control in such a system is realized by means of programmable logic controllers, so it is impossible to measure time continuously, but only discretely. That is why it is necessary to ensure that the controller has the best possible characteristics in the sense that the duration of equidistant pulses generated by the programmer's clock is as close as possible to zero. The number of these pulses n that pass between two passes of the benchmark against the sensor multiplied by the duration of one pulse t_i determines the time interval t used to calculate the average speed at that interval (if only one screw is placed on the rim of the wheel then it is also the time of one turn):

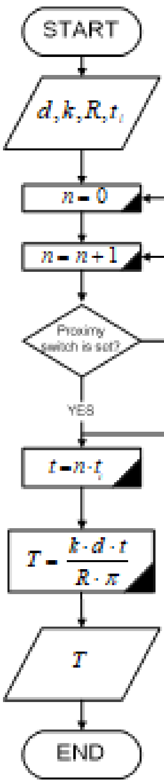

Figure 2. *Block diagram of algoritham for speed rotation adjustment of seed plates*

$$t = n \cdot t_i$$

where is:

T_i - the time after which the electric motor rotates the plate for a given angle,

k – number of benchmarks,

d - inter-seed distance,

t_{1-i} – time interval between two benchmarks in the previous countdown,

R - the diameter of the circle describing the center of the screw around the wheel axle.

The time after which the electric motor rotates the plate is subject to change and is always re-established at the end of each time interval required for the passage of the benchmark against the sensor which can remain unchanged if the controller stated that during the new and old measurement period, the same number of pulses was counted between the moments when the screws passed the sensor.

The benchmark itself has a certain dimension, so the sensor registers it along the entire length of that diameter when the screw passes against the sensor. Therefore, it is necessary to define that the controller measures the time intervals between the ascending or between the descending edges of the pulses that determine the activation / deactivation of the sensor, depending on whether the proximity sensor is set as normally open or normally closes the switch. In Figure 3, a variant of time measurement between the ascending edges of the pulse is selected.

In this way, the speed of rotation of the machine wheels, ie the machine itself, was measured, which is represented by the number of pulses between two adjacent passes of the benchmark next to the sensor (in the case of only one benchmark) that is, the number of pulses between the passage of two screw benchmarks near the sensor (in the case of two or more benchmarks). The number of pulses is inversely proportional to the number of benchmarks. The pulse diagram for the switches and parameters used is shown in Figure 3. Imp 10ms are programmer clock pulses of 10 milliseconds each, the switch is set when the sensor is against the screw, TrVrem is the number of counted pulses between the ascending edges of the pulse switch, PrVrem is the number of pulses in the previous countdown cycle.

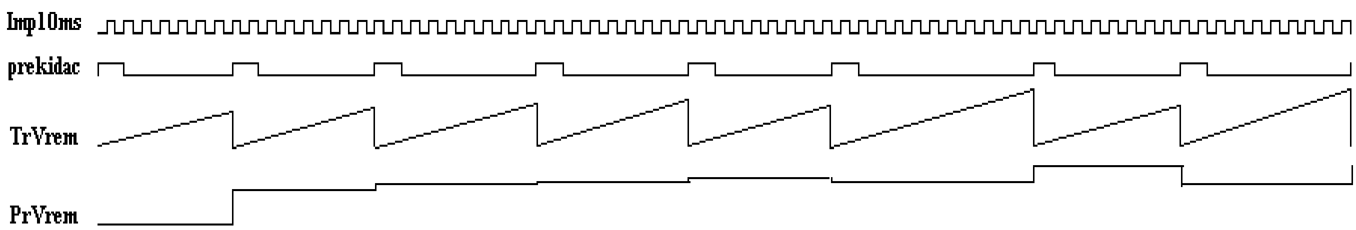

Figure 3. *Impuls diagram; during the testing of the software in the monitoring mode, a logical change of parameters was noticed, which indicates the proper functioning of the control body.*

4.Conclusion

One of the possible directions of development of pneumatic seeders could be automation of seed plate rotation, especially with vacuum seeders, which would simplify the construction of the seeders, reduce their robustness, and enable electronic control and monitoring of seeding. According to this possible solution, the seed plates would not achieve their rotational movement by means of bulky and complicated mechanical transmissions, but simply by means of electric motors or hydraulic motors. The speed of the seeder would be measured by means of an inductive proximity sensor placed on the wheel of seeder based on whose signal, and the appropriate algorithm and the desired seeding distance, the programmable logic controller (PLC) would control the engine speed and consequently the seed plate itself. The problem in the realization of this idea from the aspect of using electric motors could be the power of the motor to overcome the resistance, ie the realization of the desired torque. A hydraulic motor would not have a problem of this kind, but from its point of view, the problem could be a long response time, and an expensive and robust hydraulic installation. Further research should be directed towards testing the torques of seed plates in order to enable full automation of their work [14].

Further development of the entire control system should be done in the direction of connecting with adequate executive bodies that can respond to the control signal and at the same time physically achieve the same control. It is also possible to connect the control console to the display on the PLC or to connect the system to the tractor control system via the CANbus system. The software designed in this way supports the delay management system, whereby this delay is constant during the management process so that it does not affect its quality, because the time intervals in which the movement of the seed plate is initiated are equidistant.

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