Using Petri nets in modeling automatic seeder for germination trays

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Abstract

This paper used Petri nets (RdP) technique in generating automation, same that was used to develop the modeling of a dosing device seed sower or seedbed pneumatic precision, this mechanism has been, for many years, object of study because it is the main element in a seeding machine places, transitions and workflow hotbed ensure that allowed duty cycle is. Petri nets are a tool that are based on systematic approach to the evolution of work to develop, transitions to meet and the graphical representation of the solution. Petri nets can be used as pre-simulation program with which the necessary model runs will be made. The representation of the model in their places and conditions that must be met for the seedbed function properly obtained.

Seeder, hotbed, Petri nets

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Introduction

For many years, precision seeding has been an important research topic for agricultural engineering, however, most of the research and development work has dealt with seeders for agronomic open field crops. The main purpose of planting the seed is placed at a certain space and to a depth in the seedbed. Precision seeders put the seeds in the required space and provide better crop area by seed. There are two common types of precision seeders: Empty and Band.

The vacuum precision seeders have a measuring plate with metering orifices to a predetermined radius. Vacuum is applied to these holes and is provided with a machined race in a bearing plate. As the plate rotates, the vacuum applied to holes measurement allows to collect seeds of seed hopper. Seeders precision vacuum have the following advantages over mechanical seeders: improved quality of work rate less damage to seeds, better control and adjustment of maintenance and wider spectrum of applicability (Soos, et al., 1989).

A seeder to place a seed in an environment in which the seed germinates and emerges reliably. Some of the factors that can affect the separation of the plants are, the quality of the seed, soil conditions, drill design and operator skill, all play a role in determining the final position of the plant. Some of the problems identified by the selection mechanism are: may or may not select or drop a seed, you can select and drop multiple resulting seeds in small gaps between seeds (Karayel, et al., 2004). Giannini et al. (1967) He published a detailed analysis of the need for precision planting and vegetable cultivation, they discussed the development of a very successful precision seeder for lettuce that uses vacuum singling early. Compared to the standard mechanical planter, seeder vacuum uses 90% less seeds reduces the weight, reducing time, resulting in a higher yield.

Wanjura and Hudspeth (1969) they found that the efficiency of vacuum plate pattern differs vacuum pressures, lower or higher, and the speed of the fastest wheel. They also found that in a precision seeder, the seed drop height 8 mm generated a better pattern fall if handled at a height of 15 mm. They recommended that the measuring device in a planter should be located as low as possible and that the seeds must free fall to the bottom of the trench soil. Hudspeth and Wanjura (1970) They developed a seeding system using the vacuum for planting cotton. Field tests showed that the distance between plants and germination are best developed with this system compared to conventional mechanical.

Parish (1972) He developed a seeder to vertical plate, which gave good precision with Cottonseed. Kachman y Smith (1995) they compared alternative measures of precision in placing the seed for sowing, according to the theoretical space seed, they recommended using four measures to assess the uniformity of planting. Its recommended measures include multiple indexes, error rate, power quality index and the index of precision. Bracy y et. al., (1998) they showed that the variability in the spacing of the seed in a precision seeder vacuum, decreased with increasing nominal space seed, but with a seeder belt, the uniformity of spacing of the seed was not affected by the nominal separation seed. Parish y Bracy (1998) they evaluated the uniformity of turnip seed, sorted by size and ungraded its size with precision seeders band and vacuum. They assumed that a seeder vacuum should have a wider range of a band precision, since the holes of the plate only seed must be smaller than the smallest seeds in the batch.

Karayel and Özmerzi (2001) they indicate that variability in the separation of seed in a precision vacuum planter increases with increasing forward speed.

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They found that a feedrate 1 ms-1, It produces a better and more consistent pattern in melon seeds and cucumber, when presenting a speed between 1.5 and 2.0 ms-1.

Özmerzi, et. al. (2002) they examined the effects of different planting depths seed corn planter precision vacuum. Field tests showed that the depth of planting nominal 60 mm was optimal, according to the uniform depth and rate of germination rate. Karayel and Özmerzi (2002) they evaluated the use of a vacuum precision seeder for sowing seed melon, watermelon and cucumber. They reported that the vacuum precision planter was effective in planting these seeds.

Petri nets.

Everything around us are systems which have been classified as Event Systems Continuous and Discrete Event Systems. While a continuous system is one that changes over time steadily, a discrete system is one that changes its state at various time intervals rather than steadily (Huayna, et al., 2009). One of the tools used in modeling, simulation and analysis are Discrete Event Systems Petri nets (RdP), which have the strength to represent graphically and mathematically a model for a discrete event system.

Theorical framework

1. Automatic precision seeders

Precision seeding is defined as the seed placement, so, individually, on the floor with the necessary spacing, depending on the plants to plant. Usually, agronomists, use "dibblers" hand to achieve this precision. Planting devices equipped with measuring systems are called Single seed planters. Seeders horizontal plate with cells in the periphery were first developed precision planters (Datta, 1974).

For many years, precision seeding has been an important research topic for engineering, however, most of the research and development work has dealt with seeders for agronomic crops outdoor.

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Seeders precision vacuum have the following advantages over mechanical seeders: improved quality of work rate less damage to seeds, better control and adjustment of maintenance and wider spectrum of applicability (Soos, et al., 1989).

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2. Duty cycle planters for trays

Gaytán (2006), mentioned stages of a working cycle machines sowing trays:

a) Phase separation or simulation seed individualization.
b) Loading phase or adhesion of seeds.
c) Removal phase adhering excess seeds.
d) Transport phase of the adhered or individual seeds with the tray cavities.

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e) Discharge phase or ejection of seeds in the cavities of the tray.
f) Cleaning phase of the suction holes.

3. Petri nets

Petri net is a tool for the study of systems. The theory of Petri nets can model a system using a Petri net, a mathematical representation of the system. Therefore, analysis of the Petri net can reveal important information about the structure and dynamic behavior of the modeled system. This information can then be used to evaluate the modeled system and suggest improvements or changes. Thus, the development of the theory of Petri nets is based on the application of Petri nets to modeling and system design.

Petri nets can be used as pre-simulation program with which the necessary model runs will be made. Petri nets will achieve a full understanding of the operation of the system to simulate before starting work programming and even before defining the set of attributes and model components. In other words, Petri nets allow graphically reflect the set of relationships between events and conditions that identify the system. This possibility inevitably contribute to raising the quality of the simulation model, a better match between model and simulated system. The following Figure 1 graphically shows this idea:

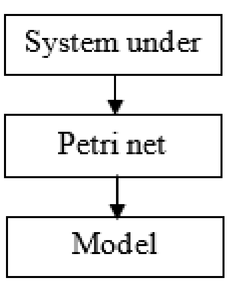

Figure 1 Integration of Petri nets and discrete simulation *(Gaytán, 2006)*

Methodology

Considering the definition of Petri net, defined by:

$$C = (P, T, A, w) \quad (1)$$

Where:

P, the places
T, transitions
$A \subseteq (P \ x \ T) \cup (T \ x \ P)$, arcs are formed of locations transitions and transitions to places.
$w: A \longrightarrow \{1,2,3, \dots \dots ..\}$, the weight function.

And defining the sequence of work for the automation of the seed or dosing cylinder must be:

1. Start.
2. Has seed tray are in the proper position, and the vacuum pressure required counts.
3. Advances to its starting position.
4. Check that is in the proper position and that there is vacuum pressure necessary.
5. Advances to the position ℓ.
6. It is in working position.
7. Release the seed removing vacuum pressure.
8. Activate vacuum pressure.
9. Turn the cylinder.
10. Check that the necessary pressure exists and is in the proper position.
11. Advances to the position ℓ.
12. In this way returns to position 7, 20 iterations to complete, as is the number of cavities of the tray.
13. In reaching its final position, the cylinder returns to its starting position to begin a new cycle of work.

Results

The structure of the RdP for the automatic dosing cylinder or roller sower arises, being raised as follows:

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$P = \{P_1, P_2, P_3, P_4, P_5, P_6, P_7\}$
$T = \{t_1, t_2, t_3, t_4, t_5, t_6, t_7\}$
$A = \{(P_1, t_1), (P_2, t_2), (P_3, t_3), (P_4, t_4), (P_5, t_5), (P_6, t_6), (P_7, t_7)\}$

$w(P_1, t_1) = 2 \quad w(t_1, P_2) = 1$
$w(P_2, t_2) = 3 \quad w(t_2, P_3) = 1$
$w(P_3, t_3) = 1 \quad w(t_3, P_4) = 1$
$w(P_4, t_4) = 2 \quad w(t_4, P_5) = 1$
$w(P_5, t_5) = 2 \quad w(t_5, P_6) = 1$
$w(P_6, t_6) = 2 \quad w(t_6, P_7) = 1$
$w(P_7, t_7) = \quad w(t_7, P_1) = 1$

Where:

Places.

$P_1 = Start$
$P_2 = Taking\ seed$
$P_3 = Starting\ position$
$P_4 = Get\ moving\ \ell$
$P_5 = Loose\ seed$
$P_6 = Tour\ hotbed$
$P_7 = Get\ moving\ \ell$

In Figure 2, the diagram is presented RdP developed. As seen in Figure 2, the onset occurs with the boot which is the position P1, immediately takes seed warehouse or store, if there seed and the necessary vacuum pressure is present. Then if you have the tray in planting position, you have the vacuum pressure necessary, then the seed is positioned at the start of the work cycle, walking distance ℓ, preset by the distance between the holes in the tray, if you are in work release position the seed, removing vacuum pressure.

Once completed this position, active pressure and the seedbed is rotated again to go the distance ℓ. Check back position and pressure, makes 20 complete cycles, as is the number of holes in the tray, to complete these 20 iterations, the device returns to its starting position to be ready for the start.

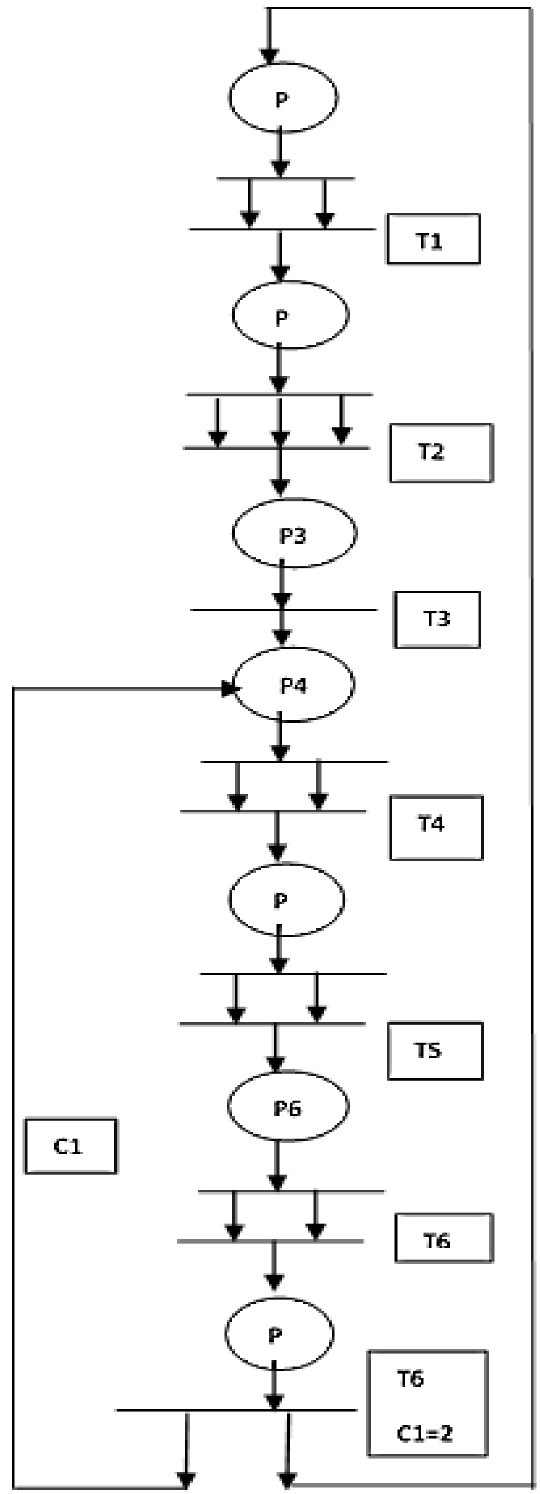

Figure 2 RdP sower of seed or cylinder

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Conclussions

Automating the process of planting trays significantly improve working conditions and ergonomics aspects of staff welfare by removing a set of repetitive and physically exhausting tasks. One of the major challenges in designing this type of agricultural implements is the design of roller or sower cylinder (seed), since it must ensure the performance characteristics that allow for efficient and effective planting, so is the part most relevant study.

Is necessary, our aid, a tool to represent the system components and the interaction that occurs between them, before conceiving the design that will be the final model of the system. In other words, we need to achieve an intermediate model in which to study the main aspects of the system, ie, the component elements and its static and dynamic interrelation. One of the tools used to start the modeling of seeding is to Petri nets, allowing develop the operating diagram of the automation, where the important parts of the system are presented, transitions that will make the change of location and order in which to perform.

Once having defined and performed the operation that requires that you have, you can start the mathematical modeling of the behavior of the seed, to generate the movements reflected in the study.

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