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Improved Performance Evaluation For Line Of Mass Production Using Firefly Algorithm

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Abstract
Assembly planning of line mass production is a process which determine the reliable sequence of assembling products. The use of simulation in line mass production planning can reduce the cost of products industries with the help of CAE computer aided engineering programs. The aim of the present study is to develop a computational model able to enhance a mass production system. The firefly algorithm is used to find the optimum solution for product assembly processes. It generates the simulation information by using specific Monti Carol method using assembly line recognizer. The recognizer as a contribution in this research developed based on real data belong to general company for electrical Industries in Iraq/ Baghdad/ waziriya. The generated data organized by evolutionary algorithm based on the priority of station sequence and the distances between them. The simulation results provide an enhancement in the time of production due to the reduction of line processes.

Keywords: Monti Carol simulation, firefly algorithm

Evaluación de rendimiento mejorada para la línea de producción en masa utilizando el algoritmo firefly

Resumen:
La planificación del ensamblaje de la producción en masa en línea es un proceso que determina la secuencia confiable de los productos de ensamblaje. El uso de la simulación en la planificación de la producción en masa en línea puede reducir el costo de las industrias de productos con la ayuda de los programas de ingeniería asistidos por computadora de CAE. El objetivo del presente estudio es desarrollar un modelo computacional capaz de mejorar un sistema de producción en masa. El algoritmo firefly se utiliza para encontrar la solución óptima para los procesos de ensamblaje de productos. Genera la información de simulación usando el método específico de Monti Carol usando el reconocedor de línea de ensamblaje. El reconocedor como contribución en esta investigación desarrollada en base a datos reales pertenece a la compañía general de Industrias eléctricas en Iraq / Bagdad / waziriya. Los datos generados organizados por algoritmo evolutivo en función de la prioridad de la secuencia de la estación y las distancias entre ellos. Los resultados de la simulación proporcionan una mejora en el tiempo de producción debido a la reducción de los procesos de línea.

Palabras clave: simulación de Monti Carol, algoritmo de luciérnaga.

1. Introduction

Assembly optimization is a process of development the manufacturing production. Assembly planning involves two major activities: assembly sequence and assembly modeling (Wang 2009). The three dimension geometry play an important role in assembly technology. It can produce model similar to the real case by using computer aided design CAE programs. In general, the idea of CAE represents the best choice in scientific research (Seth, Vance, and Oliver 2010) (Stella & Jan, 2003). The history over assembly technology based computational methods started in the 70s, the first concept Cyberspace appear in 1984. Then, its developed to the virtual reality in 1989. The concept enhanced to the virtual words of Virtual environments in 90s. The word virtual came from Latin language (virtus) which means the power or the initial Force. The words (vis) means the force and the words v i r means the human which represents The Cause of the force generator(Fei, Yunpeng, and Yukun 2017)(Makris, Michalos, and Chryssolouris 2012). in other words, there is the reason which Create the force that means the virtual concept came from real issues based on exist conditions ((1997, Levy). Terkaj et al, in 2014 define the virtual reality as state-of-the-art budgie based on computational Technics. In addition to input and output devices to the present an integrated system which is able to create three dimensional environment. This environment enable the user to instruct with the real entities (Terkaj, National, and Urgo 2014). The high performance of the simulation can mimic the human concepts based on different realities.

2. Assembly line balance methods

Bin order to build the virtual line assembly, there are many fundamentals, rules and methods. The model limitation such as operation time, operation sequence and operation priorities must be considered (Terkaj, National, and Urgo 2014)(Seth, Vance, and Oliver 2010). For that, this paper is rated the assembly line balance as shown in figure 1.

Figure 1: the traditional methods in product line assembly balance

Precedence diagram method, it's also call presidents Matrix which presented my Hoffman. This m ethod structured as in the following steps, the first step my drawing priority plan which figure the relationship between the assembly operations and specify the priority of each process the next step is to convert the drawing In tor matrix. The trial and error method is to test all the possibilities that can balance the assembly line. This method is time consuming and needs a lot efforts. It's difficult to gain a significant result, that's because the present methods lake to sequence-specifications which reduce the test possibilities.ranked positional weight method is the method that organize the task list based on process weight. For that the tasks of the high weight will presented the first level of the work considering the priority of all tasks. Using the same sequence of operations, all the tasks will be organized. Also, the work organization can be apply the time bass for all process stations. This solution will present more effective distribution fireworks in the process stations .Kilbridge & Wester Method is organizes the tasks based on numbering the priority plan. the task numbering presents the amount of processes. After that, the method organization will consider the number of processes values. The tasks in the first level have less number off previous processes. for instance the number 0 will take place the first level in the operation processes then the number one, 2, 3 etc. The Largest Candidate Rule is a method that specify the work elements in each station and choosing the prior element Beast on descending order descending order. That means choosing the number of high time value in the beginning of the least. Then organizing the elements Beast on less time value (Groover 1987, P.149). finally, immediate Up First –Fit Method which is similar to Wight method, but it's considered the numerical points of the element. Then numerical points will be updated based on the available elements which have the priority. After that the method will specify the higher numerical Wight using the priority of the restrictions and time of process. This case, all the high numerical rank of elements will organized in sequence (Elsayed1994,P.363). This method has high flexibility 4 specifying the low rank of the time of operation in the station in addition it's easy to use and to understand and able to give a quick solution (wild 1972 , P.72).

3. Technique for Strategic Evaluation

Strategic evaluation is processes which provide the substantial amount of info with experience that could be helpful for best strategic plan. Strategic evaluations help to keeping the validity of strategic select. It also help to assesses whether a decision match intend strategic requirement. Many techniques used to gain the strategic solution.

Wang in 2009 apply genetic algorithms (GAs) to go towards the assembly sequence features of speed and flexibility (Wang 2009). Taktak et al, in 2012 apply simulated annealing (SA) algorithm to develop a computer-assisted performance analysis and optimization (CPAO) to help a SME manager (Hachicha and Masmoudi 2012). Feia et al in 2016 proposed collision detections algorithms depend on part assembly features. A functions characteristic with a realizations makes of dynamics sampling depend on virtual assembly for integrate transmissions are analyzes (Fei, Yunpeng, and Yukun 2017). The presented techniques are pave the way to new generation in manufacturing processes and assembly line design.

4. The System Methodology

The weakness early detection of the industrial processes can be achieved by applying modern technologies. Its increasing their services quality. Therefore, the firefly algorithm is used to find optimum line mass production. The firefly algorithms are developing by Xin-She Yang in late 2009 with 2010 at University Cambridge, is the type of swarm intelligences algorithms depend on a reactions of the firefly to the light of other fireflies (Hasnan 2017)(elewe et al, 2017). In order to apply this method, there are an essential steps must to be used. The first is to create a method that can recognize and organize the data to prepare the input representation of the algorithm as in the next subsection.

a) Recognizer design

The recognizer stage is a step to generate and organize the data in term of manufacturing layout, sequence of processes and time of operations. These conditions represent the objective functions of the system. The mathematical representation can be addressed these objective function as n bellow: The system layout represents the distances between the manufacturing stations. The distance in general express the time of transfer the materials from one station to the next. Therefore the mathematical expression is

$$D_i = \iint d(t_d).\,d_{ist} \qquad (1)$$

Where D_i is the step distance, d_{ist} is the position of station correlated with the sequence of processes and $d(t_d)$ is the step time. This formula is dependent on the time of process in each station. Also each station may involve one or more processes. For that the time of sequences operation can be expressed as:

$$D_l = \iint d(t_d).\, d_{ist} \qquad (1)$$

Where D_l is the step distance, d_{ist} is the position of station correlated with the sequence of processes and $d(t_d)$ is the step time. This formula is dependent on the time of process in each station. Also each station may involve one or more processes. For that the time of sequences operation can be expressed as:

$$O_{pl} = \iint d_l.\, dt_o \qquad (2)$$

Where O_{pl} is the total time operation and dt_o is the process time. Based on these two formulas, the Monti Carlo Simulation will create the data based on the actual boundary condition:

$$t_d = (0 \rightarrow n) \qquad (3)$$

$$t_o = (0 \rightarrow m) \qquad (4)$$

Where n and m are the time of material transfer from on process to another and time of operation in each process respectively.

The importance of this step consists of the ability to recognize the stations distribution based on the topological specification and organization of the factory. The present formulas provide a unique feature to work with multiple types of facilities in high flexibility. This feature has not been previously mentioned or suggested. Monte Carlo Simulations approaches were apply for generator synthetic info as a following:
Step 1: Generator random normal value for work station positions base on the boundary condition lengths that is identically with independent distribute.
Step 2: Generate random data series for time of material transfer from on process to another and time of operation in each process.

Step 3: Store a group of data to move to firefly algorithms to found a optimal sequence of operation depend on a presented objectives functions. A group will be identifying by a symbol Λ as in a formula below:

$$\Lambda = (Xi, Yi) \qquad (5)$$

Monte Carlo Simulations methods MCS can perform the full find space depend on a line equation of a material positions.
b) Applying Firefly Algorithm

This section will present the evolutionary algorithm that can solve the presented multi-objective functions based on the correlation between the actual station position and time of operation and transition. The main variables in firefly algorithm are light intensity and attractiveness. Attractive is depend upon a light intense; therefore, a light intense follow a inverse square law as a follow equations (Elewe 2016)(Elewe, Hasnan, and Nawawi, 2017)(Hasnan 2017):

$$I_{(r)} = \frac{I_0}{1+\gamma r^2} \qquad (6)$$

Where I(r) represent a light intense, r is distance, I_0 represent a light intense at a sources with γ is consider a light absorptions coefficient. A attractive β of the firefly are proportional to it is bright as express in a following equation:

$$\beta_{(r)} = \frac{\beta_0}{1+\gamma r^2} \qquad (7)$$

Where β0 represent a attractive at r = 0.A processes of search space main based on attractive. A dim between 2 fireflies can defin by using Cartesian distance:

$$r_{i,j} = \|x_i - x_j\| = \sqrt{\sum_{k=1}^{F}(x_{i,k} - x_{j,k}} \qquad (8)$$

Where F is a no. of matter parameter.

Firefly i is attract toward a more attractiveness firefly j, with a move is define as

$$x_i(t) = x_i(t) + \beta_0 r^{-\gamma r_{ij}^2}(x_j - x_i) + \alpha(rand - 0.5) \quad (9)$$

W p-
resent random no. uniform distribute between 0 and 1, r(i;j) is distances between fireflies i with j.

The step-by-step operate procedures of firefly algorithms based on Monte Carlo Simulation is described as follows:
Step1. Generate operation position using Monte Carlo Simulation based on the actual design condition of (general company for electrical Industries in Iraq/ Baghdad/ waziriya) layout using equations (1) and (2).
Step2. Specify the time domain of each process and transfer operation.
Step3. Evaluate a fine of all operations depend on equations (6), (7), (8) and (9).
Step4. Update a time and positions of each process.
Step5: Re-evaluate a fine of all processes.
Step6. If a fitness values achieve so far is a global good position, then stop operations.
5. Result and discussion

A present study refers to the complexity of critical path in line production system. The Data Base developed based on time scheduling and chain of operations using the real manufacturing data gathered from workstations. The assembly line for manufacturing what a pump designed for mass production with one specific feature of products. The assembly line designed for organizing the different product elements in order to facilitate the production complex method based on small difference part. The organization of relationships of Workspace elements developed temporary based on product element specification. This operation will continue along the time specification process under the condition of station time scheduling. The sequence of operation will use the list of tasks in order to inspect and control the tasks by ignoring the finish task and updating the schedule. This operation will be repeated tile the time of both tasks and operations matched. In this case the group of tasks elements in each station will be accounted. The sequence will reorganize The Matrix appropriations to create the priority Matrix. The chosen element must be met legal requirements of scheduling priority. Based on manufacturing cycle time. the continuous of rescheduling and updating will terminate the product elements manufacturing processes in the station in some cases, the time process Diffraction occur in the station because of deadlock. In this case the workstations will be developed and added one station. Table 1 present the time scheduling for water pump product

Table 1: time scheduling for producing water pump

No.	process description	time of process
1	Assembling the Stud bolts with a small bottom cover	10
2	Place two Washers with the Stud bolts	6
3	Place 2 Nuts with the blades and rotate half a cycle	3
4	Install Nuts through the Nut Runner Drive	10
5	Place the Stator and pull the wire from it and insert it into an 11.5 hole in the bottom cover and insert the Stud through two openings measuring 4.5	16
6	Insert Bush (to hold the wire) and push it to the bottom cover	5
7	Turn the wire round and then place it next to Stator	4
8	Collect the rotor with two washers and place it inside the stator	16
9	Install the large top cover above the Stud	8
10	Collect the large top cover with the stator by Press	12
11	stated two washers for each stud at the same time	5
12	Place 2 Nuts with the blades and rotate half a cycle	10.5
13	Install Nuts with Stud through Nuts Runner Drive antenna screwdriver	15.5
14	invert the pump and place it over the floor so that the axis direction to the top	10
15	Place the bush (to measure the wire) and push it through a hole in the bottom cover	6
16	Place a second bush and hold it through the Spacer Gong and be combined with the axle and leave a vacuum with the bottom cover 3mm	7
17	Place the plastic support base and assemble it with the hub and install the stud over	8
18	Place two washers and fixed it into the stud	5
19	Place 2 Nuts with their washers	11
20	Install the plastic base by tightening the Nuts with the compressed air drill	14
21	Place the impeller above the support base through the center	10
22	Install the impeller cover	14
23	electrical inspection and prepare check request	16
24	The process of pasting the trade mark on the top of plastic cover	4
25	Assembling the plastic cover Cap with the pump through the Stud bolts	7
26	Place two washers with stud bolts	5
27	Place 2 Nuts with the blades and rotate half a cycle	6
28	tightening the Nuts with the compressed air drill	10
29	Install 16 pumps on the test device to stabilize the temperature of the stator for each water pump	16
30	Conducting the final inspection to measure the amount of water pushing and temperature measurement of the external surface	13

Table 2 present the comparative results down by the Author. It can be seen the system used 30 processes and the recognizer specify and extract these processes into three groups. The first group involves the processes from 1 to 10, the second group is the processes from 11 to 23 and finally the third group is from 24 to 30. The firefly algorithm proposed a development in first group only, it eliminate the processes from 10 to 9 processes. The algorithm suggestion is to combine the third and fourth processes into one step process.

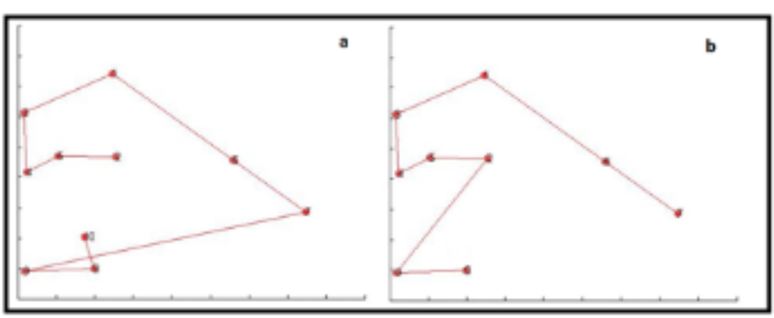

Figure 4: layout of manufacturing processes, a) the real manufacturing processes, b) the simulation results of processes

The results observe that the production time reduces 11 seconds for product transit time and 9 seconds for operation sequence time. That means the new simulation layout can save 20 seconds for each unit.

5. Conclusions

From the results of this study, it can conclude that the capability of feasible solutions finding from using evolutionary algorithms. Also,several points can presented as in below:

1. The type of input representation can be effect on the time of manufacturing process.
2. The evolutionary algorithms model present higher results than the real manufacturing conditions off time cycle. This information can present a significant knowledge for measuring the efficiency of the operation sequences.

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