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Plant layout design and assessment consideration of cellular manufacturing system via G.A

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Abstract

Cellular manufacturing is a wide world and many study and researches discussed are concerning with it because of the large demand in market and wheel technology push the scientist to find tools that can stand with this fast change in demand according specific market , so that they invent the best way to deal with optimization purpose. In this research the dealing with cellular optimization in such a way that can be manageable by AI and using type of AI that named natural optimization . The applying of genetic algorithms was carried out on factory of electrical motor also all data was taken from the factory which is depend on the position and sequence of operations took place in the factory . The theory in this field were also taking in consideration and the applications was carried out . the research deals with problem in two way theoretically that can take in consideration the positions of machines inside the plant and its equations that covers with some constraints and the secondly the routing of part during product life cycle and execute results and applying it on factory configuration . There are multi solutions (results) in the research for the problem that can achieve the flexibility , simplicity and also desired distance

Keyword: Cellular manufacturing , Genetic Algorithms , optimization, layout

1.1 Introduction

Cellular manufacturing system (CMS) it is one of Group technology which it analyzes manufacturing system into subsystems to make it more easier for managing rather than the manufacturing system itself . In such a system, parts are grouped according to its features and manufacturing process so Part are grouped based on similar process or machining needed for final product Therefore , the important tasks of designing CMS is to identify similarity between parts (families) and their related machines (cells) which can be known as cell formation problem (CFP). The partitions of CF are a set of parts into peculiar part types which means that parts of same family are similar in terms of exterior, production process requirements, flow of materials, etc. A assigning manufacturing cells or in the other hand assigning part to each related machine all the production process requirements of the corresponding part family such as machines, tools, manpower, etc. It has been shown that CMS is a suitable solution to the problem of productivity in a batch production environment which is used in 50–75% of manufacturing systems worldwide **[1]** . The main goal in CMS is the principle of "Similar things should be done similar procedure " which means the similar manufacturing processes and features should be stated and collected in same identified manufacturing cells.

1.2 Genetic Algorithms

Genetic algorithms it's a technique for optimization purposes. Its inspirited depending on evolution theory "survival fitness". Searching on best suitable solution in feasible possible region which mean you don't require for any possible solution in the feasible region to obtain a satisfying result. G.A. is established on the evolutionary process. In nature, the fittest individuals like to revive and mate; for that reason the next generation will more fitter and improved because they were bred from better parents. This same concept is applied to solve problems concerning designing plant layout or scheduling**[3]**.

2.1 Review

Here is some short literature survey of some scientist in same field and their contributions and research on G.A. will be beneficial if we narrative their work briefly .

[Liang Sun & etal] in this research they present retribution function in scheduling of job shop and they present in the progression of research an algorithms that has ability of election descendants according to moreover mutation and they present new strategy for Immortalize life span. During the research they design an adaptive algorithms can be used in both feasible and non-feasible region and simulate in twenty four bench mark. **[Zlatan Car & Tonci Mikac]** this paper the researcher proposed and assess algorithms and for regeneration manufacturing cell depending on G.A in this work they gloss over a new model that can be applied on system through rebuild the whole system in reverse way **[Hatim & etal]** in this work they present solution based on two basic steps first one assign basic product and their feature requirement and the second step reformation of manufacturing cell and also assort product based on their similar group. The proposed model has great flexibility to pick number of required cells which be more beneficial and important also they examine the work with other comparison study**.** **[Mihajlović, I & etal]** this paper describe Genetic algorithms for planning layout optimization and material handling system and reduce the material the research shows close result for unique solution as comparison with other studies that will be in two stage depending on self-clustering arrangement of facilities in the first they present road map for organize the facility that applied on the plant also arrange the production process in the production cell will it collect the similar product in the relationship (machining relation) and the requirements for each product in the second stage they examine the algorithms on intercellular movement taking in consideration the different type constraint and technical standards

3.1 Problem Assignment

Usually problems of designing layout take consideration of material to be handled and intercellular actions should be depend part-machine incidence matrix also its anticipated to form cells of machines in rapport to "distances" measured between them . these manufacturing cells are then modified by redistributing each part to its belong group where it machined . , Let

$$A = \lambda_{ip} \quad \dots\dots\dots\dots\dots\dots\dots\dots \quad (1)$$

Where

λ_{ip}

$$\begin{cases} 1 \; if \; part \; p \; visit \; machine \; i \; a \; step \; t \\ 0 \qquad\qquad\qquad\qquad if \; not \end{cases}$$

If part p take action on machines i , j respectively

$$\mu_{ip} = \begin{cases} 1 \; if \; \mu_{ip} * \mu_{ip} \neq 0 \; and \; |\mu_{ip} - \mu_{pi}| = 1 \\ 0 \qquad\qquad\qquad\qquad if \; not \end{cases}$$

…... (2)

Where μ_{ip} represent the constraint if the part will be machined at i & j in two stage or not . if we generalized the parts in all cells sections and machine

The objective function should be follow .

$$\sum_{i=1}^{k-1} x_{ij} + \sum_{j=k+1}^{n} x_{kj} \leq M - 1 \; where \; k = 1 \; to \; n \quad \dots\dots\dots (3)$$

$$x_{ij} + x_{ik} - x_{ki} \leq 1 \; where \; i = 1 \quad to \; n - 1$$

$$x_{ij} - x_{ik} - x_{ki} \leq 1 \; where \; j = i + 1 \; to \; n - 1$$

$$-x_{ij} - x_{ik} + x_{ki} \leq 1 \; where \; k = j + 1 \; to \; n - 1$$

$$\dots\dots\dots\dots\dots\dots\dots (4)$$

$$x_{ij} = \begin{cases} 1 \; if \; machines \; i \; j \; at \; same \; cell \; i = 1 \; to \; n - 1 \\ 0 \qquad\qquad\qquad\qquad if \; not \; j = i + 1 \; to \; n - 1 \end{cases} \quad \dots (5)$$

Constraint (3) organized traffic between machines when there are many machine (*M*) at predefined cell and it also keeping behavior of sequences(*K*) . Constraints in (4) it obligate the incorruption of cells. These formulas take the most important issues , sequences of process and the product routs and allowed size for sections, The proposed case adjusted the revisiting product to the same machine must not be more than zero but some limits it should be taken in a count like volume weighting in the routings. For problem if the sections or whole layout sizes are fixed it can be considered as quadratic assignment transportation or If there are k cells of pre-specified sizes $m_1, \dots\dots m_k$ and y_{ik} where i=1 to n & and k=1 to k the binary parameters keep the m machines are allocated to cell k and could be connected with (6) in relations as below **[16]** .

$$x_{ij} = \sum_{k=1}^{k} y_{ik} \; y_{jk} \; where \; i = 1 \; to \; n - 1 \; j = i + 1 \; to \; n - 1 \quad \dots\dots (6)$$

4.1 Implementation of a genetic algorithm ..

To implement the genetic algorithm its needed to clarify concept of problem and the requirements of implementation and environment of conditions that governs the optimization problem . Genetic algorithms are search heuristics that attempt to find an optimal solution based on a process of natural selection and evolution as it mentioned in the past of this work . The process involves generating random solutions and applying genetic operators in hopes that the solution will evolve to find the optimal solution.

4.2 Parameters on optimization process

After determining the problems, it's desired to define parameters that affect on production process to get optimal solution. And then encode parameters to be used in solution of the problem in terms of chromosomes, genes, and populations. And applied it in the objective function

4.2.1 Representation.

As it declared in previous, chromosomes represents a part of solution in the search space of the problem. Chromosome is just ordered list of sequences of operation in the manufacturing cell which each node is represented by its self, and gene is collection of chromosomes, a gene for the plant problem represent section and its location (x, y) according the site of plant .

4.2.2 Initial Population.

Now create a set of children, and the offspring are erratically reprogrammed to create a new set of chromosomes to be reinserted into the population. In this case it should be take same plant situation. The production in plant is for going into four phases each operation place are decimal coded

I "27-28-14-36-26-37-25-24-23-22-21-20-15-16-17"

II "27-34-32-33-35-24-23-22-21-15-16-17"

III "29-30-1-2-3-20-15-16-17

IV "27-13-11-12"

4.2.3 Selection

As it mentioned in the work of genetic algorithm procedure, Selection is one of the operators of genetic by picking parent of the plant operation status to regenerate the offspring .

4.2.4 Crossover.

After parents have been stated, the crossover operator mixed two chosen parents arbitrarily to produce two children chromosomes. In such case the crossover was done in multi stage which as known as multi-point crossover, because of four phases production process. which means each phase has suffered from mutation

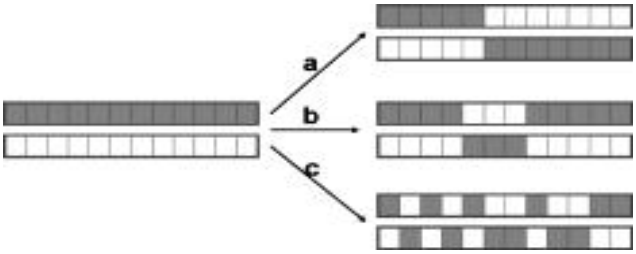


Figure 4.1 multi- point crossovers

4.2.5 Mutation.

The basics of genetic algorithms were build up to the degree of Mutation operation. This operation was done by changing gene value by another value under constraint of same phase of production process.

Before mutation

IV	27	13	11	12

After mutation

IV	27	13	11	27

4.2.6 Convergence.

The purpose of using convergence is to dispense huge populations and a large number of generations to enhancement the flexibility of algorithm by making benefits of parameters that used to reach the best constructed algorithm for finding best optimal solution.

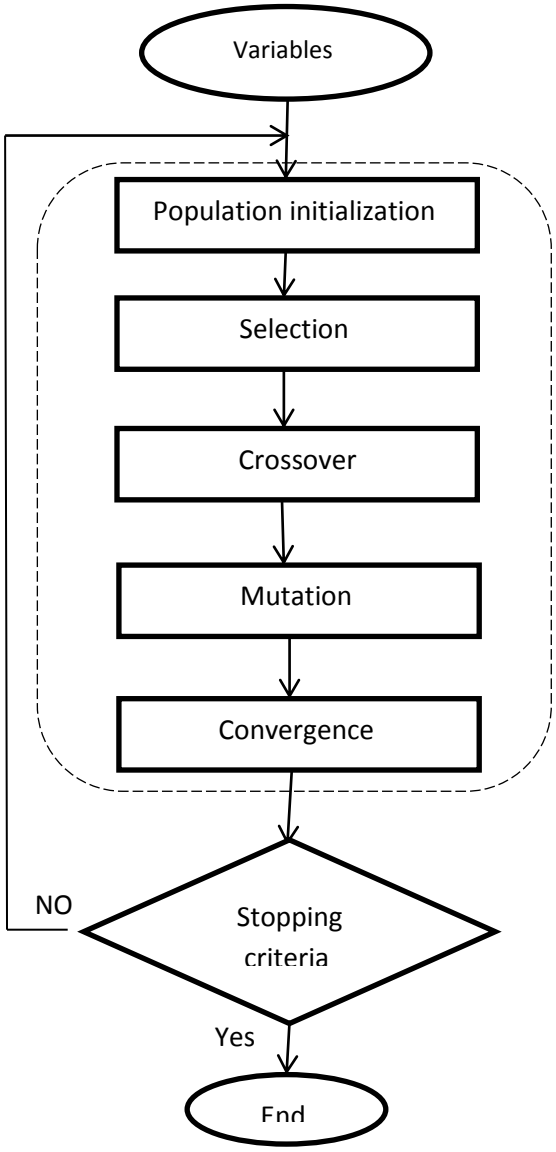
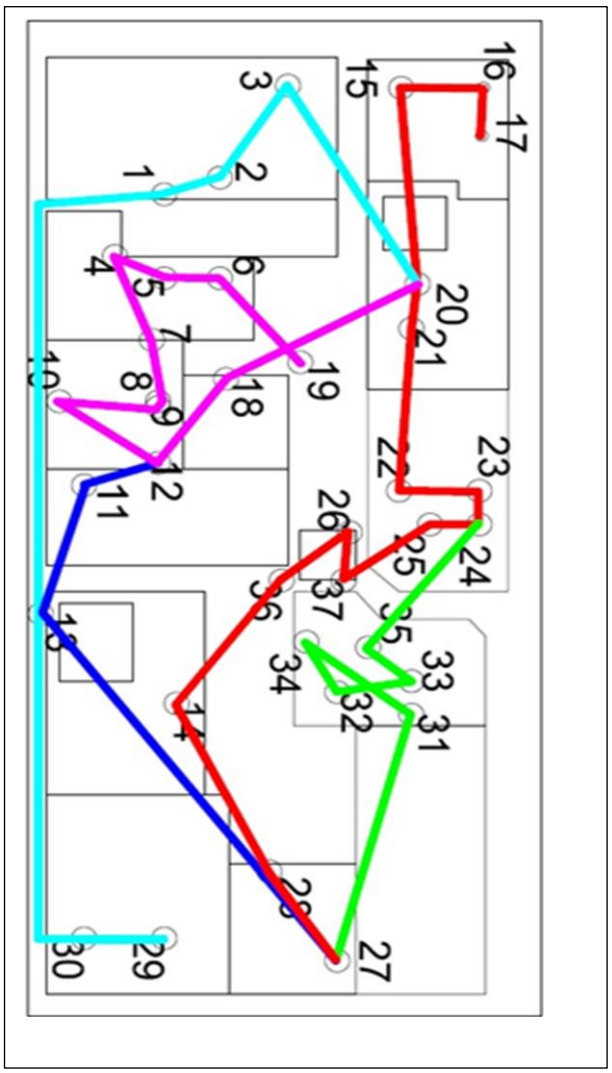


Figure 4.2 genetic algorithm



by using genetics showing how it will change the geography of the plant after using it

5.1 Results

The purpose of this section is to present and discuss some representative results of the work on the interaction genetic algorithms used in find the optimal design how they will affect on plant and route of the products cycle inside the product . First consider the product existing cycle inside the plant

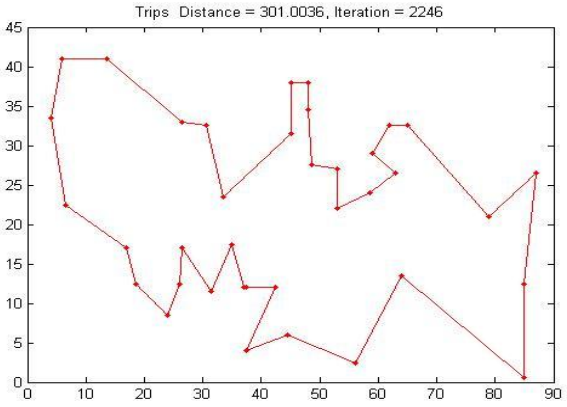


Figure 5.2 products for applying GA

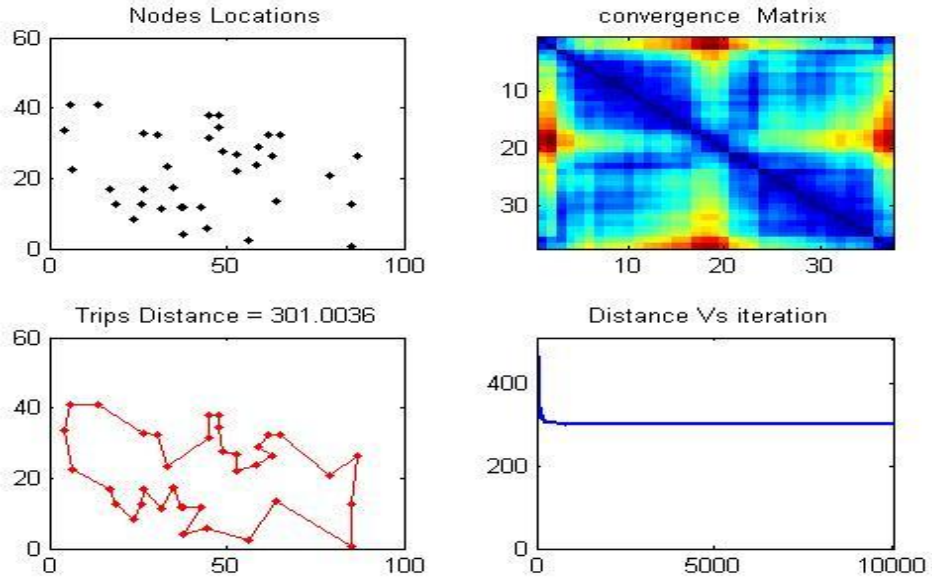


Figure 5.3 shows GA results

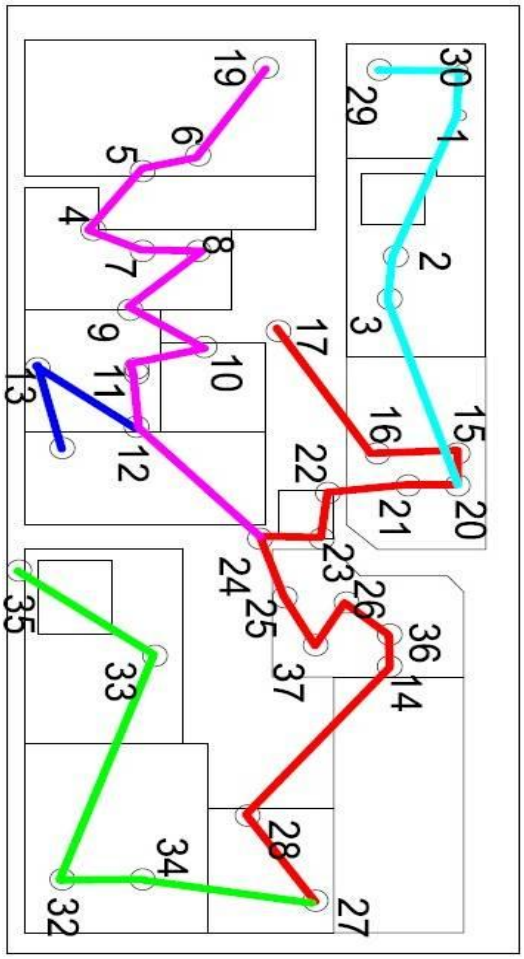


Figure 5.4 the product life cycle inside sections of the plant after applying GA

According to the result of work shown that the total distance should the products will travel about more than 800 meter inside the plant in addition there was home and away trips and that can be as multi-cycle before applying artificial work .

- The initialization scheme of algorithm must be accurate to maintain and state operation sequencing

- After monitoring the results and showing the site plan its significant to take in to account that the total distance that the products should cross about 301.0036 meter and iteration about 2246 (generation) .the above

- Results discus the behavior of product and life cycle inside the plant and how it will change the road map for changing the way and the procedure of solution as below

6.1 Future Work .

The contributions of this study may be further developed in several ways. Promising directions for future work are discussed in the following, separately for each part of the thesis .

- Enriched the algorithms with neural network and make a union algorithms works independently and extract best solution .
- Use GA to build update weight. And bias of neural network online in the plant parameters
- Rebuild ant colony algorithms dependent on genetic algorithm in such way that the genetic restructured the ant and swarm algorithms.

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كلية الكفيل الجامعة- قسم هندسة تقنيات الحاسوب

المستخلص :

تعد انظمة التصنيع الخلوي هي قلب الصناعات في الوقت الحاضر و هناك دراسات عديدة في هذا المجال و منها هذه البحث الذي ركز على تأثير مناقلة المواد و توزيع المكائن في النظام الخلوي . حيث تم استخدام الهندسة الوراثية في سبيل انشاء نظام خلوي مرن يتعامل مع معطيات و متطلبات سوق العمل . في هذه الدراسة تم البحث في اتجاهين الاول نظري و تم فيه مناقشة و طرح الصيغ الرياضية و المعاملات التي تؤثر في النظام من حيث الزيادة و النقصان لكل من المسافة و كذلك الوقت . بداية اخذت الحالة الاولية لمعمل صناعة المحركات الكهربائية الكائن في الوزيرية التابع لوزارة الصناعة (كحالة ابتدائية) و تم اخذ بنظر الاعتبار التوزيع الجغرافي للمكائن داخل المعمل و قدرة المكائن التصنيعية و كذلك مناقلة المواد . ثم بعد ذلك استخدمت المعادلات التي تحكم سير العمل في انشاء اول جيل للهندسة الوراثية مع اخذ بنظر الاعتبار المعاملات و القيود في سير العمل . فوجد بعد استخدام الهندسة الوراثية ان المنتج يقطع مسافة قدرها 400 متر بعد ان كانت 800 متر او اكثر . و من ثم نوقشت النتائج و اعطيت بعض الاستنتاجات و النقاط للعمل المستقبلي