



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**ROUTE OPTIMIZATION IN PRINTED CIRCUIT BOARD HOLES DRILLING
PROCESS USING TEACHING LEARNING BASED OPTIMIZATION
ALGORITHM.**

This report is submitted in accordance with the requirement of the University
Technical Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering
Technology (Industrial Electronic) with Honours.

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ABSTRAK

Papan litar bercetak digunakan untuk menyambungkan bahagian-bahagian elektronik menggunakan laluan konduktif, jejak atau jejak isyarat yang terukir dari lembaran tembaga ke substrat yang tidak konduktif. Lubang melalui papan litar bercetak biasanya digerudi dengan Mesin Kawalan Berangka Komputer. telah wujud sejak awal 1970-an untuk menggantikan beberapa proses pembuatan sedia ada menggabungkan lubang pengeboran papan litar bercetak. Dalam pemesinan mesin kawalan berangka komputer, menentukan keadaan pemotongan yang ideal atau parameter di bawah keadaan pemesinan yang diberikan adalah isu yang kita lihat. Isu akan diselesaikan dengan menggunakan pengoptimuman atau algoritma yang dipilih. Banyak yang sukar seperti multimodality, dimensionality dan differentiability dikaitkan dengan pengoptimuman masalah besar-besaran. Mengajar algoritma pengoptimuman berasaskan pembelajaran akan menyelesaikan masalah untuk mengarahkan proses pengeboran lubang papan litar bercetak.

ABSTRACT

A printed circuit board is utilized to connect electronic parts utilizing conductive pathways, tracks or signal traces etched from copper sheets onto a non-conductive substrate. Holes through a printed circuit board are ordinarily drilled with Computer Numerical Control machines. Computer Numerical Control machines has been around since the early of 1970's in request to replace some existing manufacturing process incorporates drilling printed circuit board holes. In the Computer Numerical Control machines machining, deciding ideal cutting conditions or parameters under the given machining circumstance is the issue we looked on. The issues will be solved by using optimization of algorithm that chosen. Many difficult such as multimodality, dimensionality and differentiability are associated with the optimization of a large-scale problem. Teaching Learning-Based Optimization Algorithm will be solving the problem to route printed circuit board holes drilling process.

DEDICATON

Thank you to my beloved parents, Abd Rahim Bin Abdullah and Zaiton Binti Zainud Abidin, family, lecturers and friends.

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LIST OF SYMBOLS

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α	Drill travelling unit
i, j	Holes Spacing
mm	Millimetre
n	Number of holes
v	Drill travelling speed

LIST OF ABBREVIATION

ACO	Ant Colony Optimization
CCSA	Combinational Cuckoo Search Algorithm
CNC	Computer Numerical Control
FA	Firefly Algorithm
GA	Genetic Algorithm
HGA	Hybrid Genetic Algorithm
HTGA	Hybrid Taguchi Genetic Algorithm
MOA	Magnetic Optimization Algorithm
NI	Number of Iterations
NS	Number of Students
PCB	Printed Circuit Board
PSO	Particle Swarm Optimization
SPSA	Shortest Path Search Algorithm
TLBO	Teaching Learning Base Optimization
TSP	Travelling Salesman Problem

CHAPTER 1

INTRODUCTION

1.1 Background of Study

In the manufacturing industry, holes-drilling movement is quite often unavoidable. Specifically, in electronics assembling, drilling holes on the PCB is a standout among the most significant processes. With the heightening development popular for computer and electronic devices, PCB assembly has without a doubt turned into a focuses market. Ismail et, al (2013). The expanding variety of products needing PCB has made it unavoidable for circuit board producing industry to robotize the holes drilling process. Many industries have received the CNC system in automating the hole drilling process because as a result of its control flexibility. In all machining process, time is spent on both situating the cutting tool and conveying the machining method and the holes drilling process is of no exception.

Printed Circuit Board is utilized to interface the electronics part electrically. This is finishing by making conductive way routes for circuit associating by scratching tracks from copper sheet covered onto a non-conductive substrate. A PCB consists of a leading layer that is consist of copper foil. Making a PCB is an including method that the individual who associated with electronics circuit manufacture have go through. Many tasks are the act of drilling the PCB holes. The shortest path of holes drilling act as the best significant can be apply during PCB holes drilling process.

An efficient optimization method called Teaching Learning Based-Optimization (TLBO) is proposed in this large-scale optimization problem to finding the best solutions. This method is based on the effect of the influence of a teacher on the output of learners in a class. The effectiveness of the method is tested on many benchmark problems with different characteristics and the result are compared with other population-based method. For this research, the time taken to drill a PCB can have a significant effect on the production efficiency in mass scale production. The best solution in solving the routing PCB holes drilling process and verify the viability of TLBO to solve the holes drilling path optimization problem effectively, with minimum cost and shortest time. the shortest path from one hole to other holes are determined as a good result because reduce the time taken and most important to reduce the cost. The result was compared with the different optimization algorithm such as Genetic Algorithm (GA) and Combinational Cuckoo Search Algorithm (CCSA). Another significant finding is the research carried out by Onwubolu (2004) that Proposed Particle Swarm Optimization (PSO) algorithm for holes drilling problem.

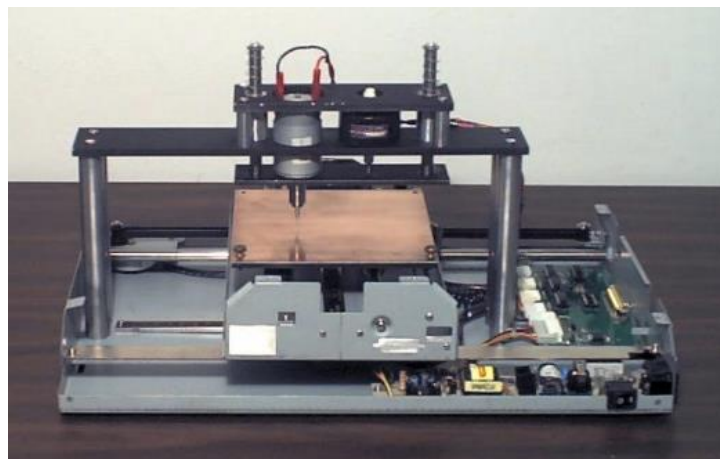


Figure 1.1 PCB Drill

1.2 Problem Statement

Today, CNC machines are found almost everywhere from small job shop in rural communities to large urban areas. Truly, there is hardly a facet of manufacturing that is not in some way touched by what these innovative machine tool can do. The CNC control will interpret a CNC program and activate the series of command in sequential order. The CNC machine control will activate the appropriate machine function because the axis motion will follow the instructions given in the program.

However, without any optimization, the cutting and drilling process will be taking much time and waste the energy. Optimization of operating parameters is an important step in machining, particularly for operating CNC machines. For minimize the time taken for drilling and cutting process, the machines need to go to each hole in the shortest path which is high efficiency and without any complex formula. Some optimization method needs to apply on the program. For this project, TLBO is the main optimization algorithm and shall be able to choose the best path in order to cut off time taken, and reduce cost needed to finish up the PCB holes drilling process (Jing Zhang, 2012). Therefore, movement time is an important element for improving productivity. Reducing machining time in a milling process is one of the important criteria to improve the overall efficiency of the machining process. (Ump, 2012)

1.3 Objectives

Objectives of this project are listed as follow:

- i. To modelling printed circuit board holes drilling process With Teaching Learning-Based Optimization algorithm.
- ii. To study the relationship between number of iteration and number of students of TLBO algorithm in PCB holes drilling process.
- iii. To identify the best solution in solving the routing PCB holes drilling process.

1.4 Scope of Project

To achieve the objectives, these are the scope that needed to be done:

There are three scopes for this project. Firstly, is to calculate the distance from first hole to last hole only. It only from start to last not include from the line of axis. There are two type of method to measure the distances between the holes. Firstly, is directly from machine during process. For example, CNC machine will run follow the short distance from one hole to others hole. Secondly, measure the distance follow the axis. Fortunately, for this project, the calculation to find the best solution for short distance is using second method which is calculate based on axis.

Next is the holes have a same size. It because, during drilling process it was used the driller same size to make a hole. The total of holes to drill is 14 holes only. This is much better to stabilize and get the accurate for distance. Distance between start position to first hole and last holes to start position was ignored.

Lastly, this project only in simulation by using MATLAB software and the algorithm that used is TLBO. The simulation will show the graph of iteration and graph for 14-holes. This method was used because want to benchmark with other journals.

1.5 Significant of Project

According to previous project that has been conducted by researcher, a lot of algorithm has been used in order to find the best solution of route for PCB holes drilling process. Most of the designed to drill the holes using the same size of driller PCB. However, it has not been solved as expected result.

Since, there are some difficult to identify the position of holes in finding the accurate value of coordinates parameter. Then, the researchers have been beginning to use optimization method in finding the best solution to achieve the best fitness for distance from first hole to last hole.

Therefore, this project was applied TLBO and implement due to simple optimization compared to the other optimization method.

CHAPTER 2

LITERATURE REVIEWS

2.1 Introductions

This chapter is to review some fundamental ideas from the research. It is necessary to study on journal that related to the project because knowledge and skills needed to complete the project. In other word, this chapter is the brief or idea on previous that is similar with this project of printed circuit board (PCB) holes drilling and optimization of algorithm. Then, develop the GUI to show the result related on the algorithm chosen.

2.2 Printed Circuit Board (PCB)

R.Jr, (2004) said, a PCB is used in electronics to build up the electronics strategies. A PCB will approach into two purpose in the construction of an electronics devices. The first one will be a place to mount the components, while other one is it can provide the connection of electrical between the components. Material of PCB consists the conducting layers are typically made of thin copper foil. The colour will able when the board was soldering is green usually, but others colour also normally available are blue and red. The unwanted copper will remove form the substrate after etching process.

PCB fabrication depends upon the holes drilling time, which is a component of the amount of drilled and the demand in which they are exhausted. A typical place PCB may have a few holes. At a starting time of the gathering technique, a numerically controlled drilling must move its bit over the gaps one by one and must complete the action in irrelevant time. The ask for by which the holes are visited is of remarkable importance for this circumstance.

2.3 Routing Problem in PCB Drilling Process

PCB consists of 14 holes of same size is used by author in their case study (Zhu, 2006).

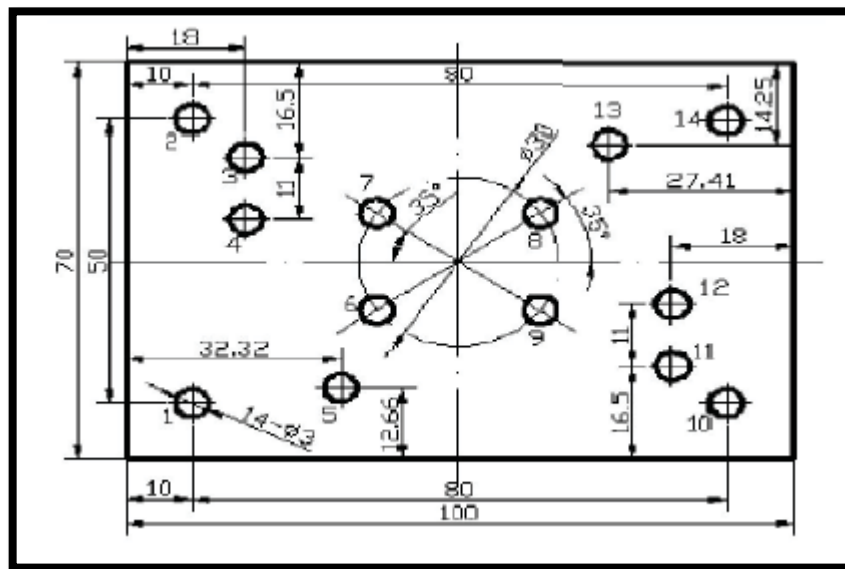


Figure 2.1: Image of the 14 Holes PCB

When drilling a gathering of gaps in a PCB utilizing CNC processing machine, the machine table is driven forward and backward in the X-Y bearing with the goal that every gap is to be drilled in its structured position. The ideal drilling succession can limit

the aggregate table development, in this way shortening the no-cutting time and extending working existence of the table driving framework. The X-Y movement which acknowledge utilizing stepper motor, are successive and dependent on the directions to be drilled was proposed by (Chen et, al 2014). Depends on the machine characteristics, the issue to be tackle here is to discover a grouping in which the holes to drilling with the end of goal that the instrument time is limited. Holes which are too close may create a tiny material strip in between which is liable to break during processing. Holes too close to the PCB edge could be damaged during profile routing. The routing process is a milling process in which a routing bit is used to cut the profile of the desired board contour.

2.4 Part Literature on Holes Drilling Process

An optimization algorithm is a method which is execute iteratively by looking at different arrangement till an ideal or an acceptable arrangement is found. There are two kind of optimization algorithm generally utilized today. Firstly, deterministic algorithm. They utilize rules for moving one answer for other. Secondly, stochastic algorithm. This algorithm is gaining popularity due to certain properties where is the first kind optimization does not have. Optimization problem is to find the best solution from all feasible solution. Optimization problem can divide into two part depends on the variable are continuous or discrete.