



DESIGN OF PICK AND PLACE MECHANISM FOR 3D PCB ASSEMBLY PROCESS

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Engineering (Hons.)

by

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Tajuk: **DESIGN OF PICK AND PLACE MECHANISM FOR 3D PCB ASSEMBLY PROCESS**

Sesi Pengajian: **2018/2019 Semester 2**

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Sekian dimaklumkan. Terima kasih.

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.....
(MOHD NAZRIN BIN MUHAMMAD)

ABSTRAK

Pemilih dan peletakkan peranti adalah salah satu mengendalikan sistem dalam banyak industri perkilangan. Ia sama ada digunakan dalam pengeluaran besar-besaran atau tugas sampling dalam kerja RnD. Sistem ini perlu tepat semasa penempatan komponen, memakan masa yang singkat, campur tangan manusia yang paling minimum dan ekonomi. Di samping itu, matlamat projek ini adalah untuk mencapai mengoptimumkan operasi pemilihan peranti penempatan separa automatik dengan tujuan utama meningkatkan kecekapan operasi pemasangan. Dalam kerja ini, komponen elektronik sama ada komponen SMT atau komponen berkaki, perlu dikendalikan dengan cekap semasa penempatan pada PCB atau 3D PCB yang kadang-kadang dipanggil 3D MID. Tumpuan projek ini akan lebih fokus kepada penempatan objek pada 3D MID seperti yang disebutkan, di mana struktur dan bentuk platform akan berbeza untuk mereka bentuk. Prototaip projek akan terdiri daripada pen sedutan, pam dan pemilih dan peletakkan mekanisme. Proses selanjutnya seperti pemilihan bahan, reka bentuk awal, pembinaan dan fungsi akan dibincangkan dalam bab seterusnya. Kesimpulannya, prototaip ini telah berjaya dicipta. Hasilnya, mesin pemilih dan peletakkan ini lebih baik berbanding cara lama yang dipraktikkan secara manual dalam pemilih dan peletakkan komponen elektronik.

ABSTRACT

Pick and place systems are one of the handling systems in many of the manufacturing industries. It is either being used in mass production or for sampling task in R&D (Research & Development) work. The system needs to be accurate during the component placement, not time consuming, minimum human intervention and cost effective. In this work, electronics component either SMT (Surface Mount Technology) components or through hole components need to be handled efficiently during placement on 3D PCB (Printed Circuit Board) or sometimes called 3D MID (Molded Interconnected Devices). The focus of this project will be designing a pick and place mechanism for assembling the electronic components on 3D PCBs. The work involves material selection, structural design, constructions and evaluation. As the conclusion, the prototype has been successfully developed. As a result, the new pick and place machine is better than the old practice of manually pick and place electronic components.

DEDICATION

Only,
my beloved father, Zainan Wagimin
my appreciated mother, Rozlen Macklin
for the moral advises, financial support, encouragement and also understandings
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LIST OF ABBREVIATIONS

PCB	-	Printed Circuit Board
R&D	-	Research & Development
SMT	-	Surface Mount Technology
MID	-	Molded Interconnected Devices
LED	-	Light-Emitting Diode
P&P	-	Pick & Place
PID	-	Proportional-Integral-Derivative
AC	-	Alternating Current
SPIDAR	-	SPace Interface Device for Artificial Reality
SPIDAR II	-	SPace Interface Device for Artificial Reality II
SMD	-	Surface-Mount Device
MEMS	-	Microelectromechanical Systems
CAD	-	Computer Aided Design
CAE	-	Computer Aided Engineering
Ch	-	Capacitor

CHAPTER 1

INTRODUCTION

1.1 Introduction

Ideas of this project generated during last internship with a company that working as research and development (R&D) focusing on assembly process efficiency for electronic components and devices. This chapter will focus on research background, problem statement, objectives, and research scope.

Firstly, electronic assembly is a process of two or more number of electronic components connected together to perform specific function, replaceable as an entity and commonly able of being dismantle [1]. The main key of electronics component assembly is PCB board. In the past few generation, the construction of circuit using point-to-point wiring was led to so much circuitry problem such as failure on junctions and short circuit when wire insulation began to aging and wearing out [2]. Figure 1.1 show the example of old-fashioned circuit construction using point-to-point wiring and Figure 1.2 show the present uses of PCB in electrical and electronics circuit.



Figure 1.1: Point-to-point wiring circuit

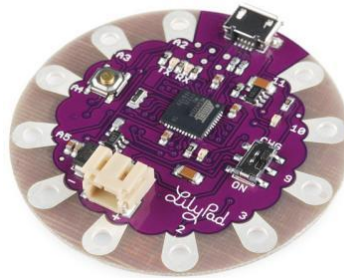


Figure 1.2: Present PCB that used nowadays

For normal electronics assembly, either for SMT components or through hole components is usually use the standard machine for the components placement on the PCB. Figure 1.3 show the basic production line machine for making the electronic assembly process starting from stencil machine, assembly and inspection machine and lastly is oven for reflow process.



Figure 1.3: Electronics assembly machine used in production line [3]

These machines or sometimes called chip shooter, mainly low precision placement and simple package components such as resistors, capacitors and LED (Light-Emitting Diode) [4]. There are several step of making PCB circuit assembly which is [5]:

1. Paste stenciling
2. Electronic placement
3. Reflow
4. Manual assembly
5. Inspection & testing
6. Washing
7. Packaging

PCB has two common type one is in 2-Dimension and another is in 3-Dimension. Traditional assembly machine that has mention just now has the abilities only for 2D PCB type only. Due to its inability, it seem impossible to assembly the electronics component on the 3D PCB which is in previous internship R&D lab were facing this issue when step of assembling electronics chip has to been stopped. Figure 1.4 show the different type of 2D and 3D PCB that is used in previous company.

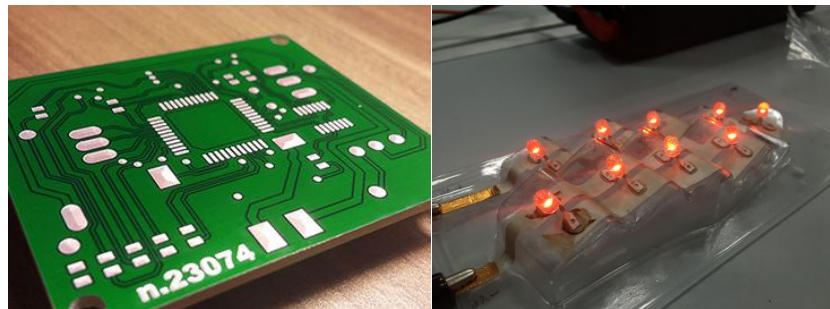


Figure 1.4: 2-Dimensional and 3-Dimensional type of PCB

Different from research and development level, despite of using the high speed of P&P (Pick & Place) machines that capable to mount dozens of component in short time, R&D only need to create a sample but very precise and efficient as good as from mass production P&P machine. The manual procedure is by placing the components with man hand is not practical as it will cause uncertainty placement that lead to inaccuracy. For 3D

PCB that is used in previous company is 3-Dimensional Molded Interconnected Devices or known as 3D MID which is a new technology for electronic components placing and assembly. 3D MID is a structural object that has some surface area and certain height. The concept of this structures are made by moulding process but it is different from other product of moulding, casting, forging or even fabrication due to circuit that planted on its surface. 3D MID is produced by few general processes as shown in Figure 1.5 [6].

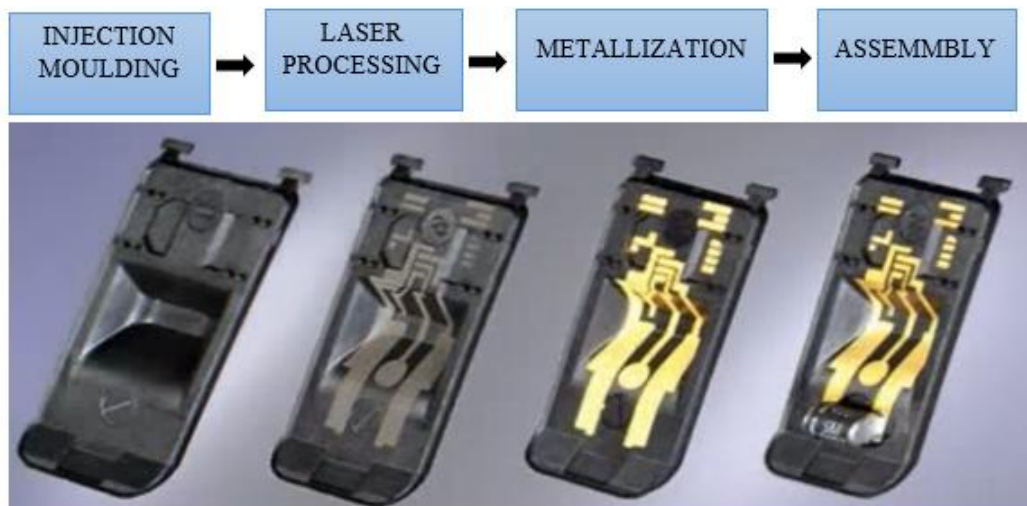


Figure 1.5: General Process Of 3D MID making.

Through the process mentioned, 3D MID can be develop in next step for electronics assembly. Advance usage of this technology implemented in modern electronics is due to its reliability for minimize the number of materials used to the product. 3D MID also bring the features of lesser costing product and time consumption.

1.2 Problem Statement

From previous internship, task of pick and place component on PCB is done manually that causing high time consumption in product testing which is impractical for industry level. For small components that need to be pick and place using tweezer such as LED chip, SMT resistor and capacitor that need to be handled carefully and slowly in order to place the component perfectly on top of the circuit location. Figure 1.6 show the LED chip that has been handled using tweezer in previous work inside R&D Lab.

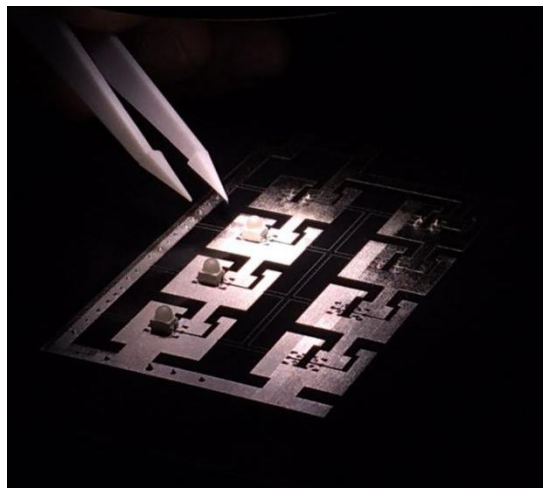


Figure 1.6: SMD LED handled with tweezer.

Next, other concerns that need to be taken action is the accuracy of placement upon placing the components on the circuits. As the electronic chip component are extremely light and small, the possibility of the chip to fall not in the designed location is very high. Thus the problem is cause by:

- a. Air and wind of the process surrounding that might flew the chip easily.
- b. The magnetic attraction between the tweezers tip and the chip cause it fell inappropriately.

1.3 Objectives

Determination of this project is to design a system of pick and place mechanism on 3D MID assembly process with the following objectives:

- i. To design a pick and place mechanism for assembling electronic components on 3-Dimensional surface.
- ii. To fabricate the pick and place mechanism.
- iii. To evaluate the performance of the pick and place mechanism.

1.4 Scope of Work

- i. Designing body frame of the project using Solidworks.
- ii. Hardware fabrication of the body frame.
- iii. Evaluation will be performed through experiments conducted by UTeM's students.