جامعة الملك فهد للبترول والمعادن
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Team Design 15

Automated PCB Assembly Using Robotic Arm

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Introduction

Problem Statement

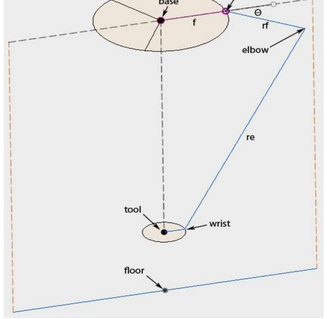
Nowadays the printed circuit boards (PCB) assembling process are still depending on human factor which cost a lot. Our project aims to reduce that dependence on humans and make assembling process fully automated

Constrains

- **Gripping tool weight : 16 g**
- **Suction cup diameter : 20mm**
- **Controller frequency : 16MHz**
- **Lower base must be in straight horizontal position: (θ≈0)**

Target Specifications

Precise in positioning: ± 0.01mm
Range of motion: ± 360 degrees
Minimum payload capacity: 500 g
Base radius (f): 250 mm
Bicep length (rf): 250 mm
Forearm length (re): 300.5 mm
End Effector radius (e): 80 mm
Base to floor distance (b): 750 mm
Steps per turn: 10286



Project Impact

The project has several impacts such as:

- Will reduce the dependence on human at the assembling process.
- Will improve the quality of the assembled PCBs.
- Increasing the production rate since the operation is fully automated.
- Reduction in the final PCBs cost.

Bill of Materials

Bill of material

Product: PCB assmebly robot			Assembly: Delta robot			Date: 9/5/2024		
item#	Part#	Qty	Name	Material	Source	Lead time	Price SAR	Total
1	17HS19-16845-PG51	3	Nema 17 stepper motor with 51:1 gearbox	Metal	Desertcart	1 Week	234	702
2	TMC2209	1	TMC2209 4Pcs	Aluminium	Amazon	1 Week	155.15	155.15
3	A000067	1	Arduino Mega 2560	Aluminium	Amazon	1 Week	235	235
4	RAMPS 1.4	2	RAMPS 1.4	Aluminium	Desertcart	1 Week	59	118
5	Q-RAF#1010	1	Power supply 12v 10A lucky star	Metal	Electronic waves	1 Day	69	69
6	Plug	1	220V plug	Metal	Electronic waves	1 Day	11.5	11.5
7	Wires	3	Wires	Metal	Electronic waves	1 Day	4.35	13.05
8	Jumper	3	Jumper wire 20CM 10pin	Metal	Electronic waves	1 Day	8.7	26.1
9	UNO R3	1	UNO R3 Board Vacuum Pump Suction Cup Kit Robot Arm Parts for Arduino Mechanical Arm DIY	Metal	Ebay	1 Week	313.88	313.88
10	AUGYUESS	2	Magic&shell 2-Pack 8mm Flange Shaft Coupling High Hardness	Metal	Desertcart	1 Week	91.915	183.83
11	NULL	1	Rods , Screw pan, Hex nut	Metal	Masdar	1 Day	25	25
12	60424ZZ BW	13	Bearing	Metal	Bearing house	1 Day	11.5	149.5
13	NULL	1	Fabrication	Metal	MABCO	1 Day	975	975
14	NULL	1	Fabrication of bearing holder	Metal	ALAA ABDULLAH	1 Day	92	92
15	NULL	1	Bolt Cutter+ Bolts, nuts , washers , spanner	Metal	MABCO	1 Day	135.99	135.99
16	NULL	1	RC Car Push Rod,1/10 RC Car Aluminum Allo	Metal	Desertcart	1Week	161.24	161.24
17		2	uxcell 5Pcs M3 x 300mm Fully Threaded Rod 304 St	Metal	Desertcart	1 Week	95.51	191.02
18		1	Road end + nuts and bolts				785	785
19					Electronic waves			0
20					Electronic waves			0
21					Electronic waves			0
22					Electronic waves			0
23		1			Electronic waves		318.55	318.55
24					Electronic waves		Total cost	4660.81

3D CAD Model

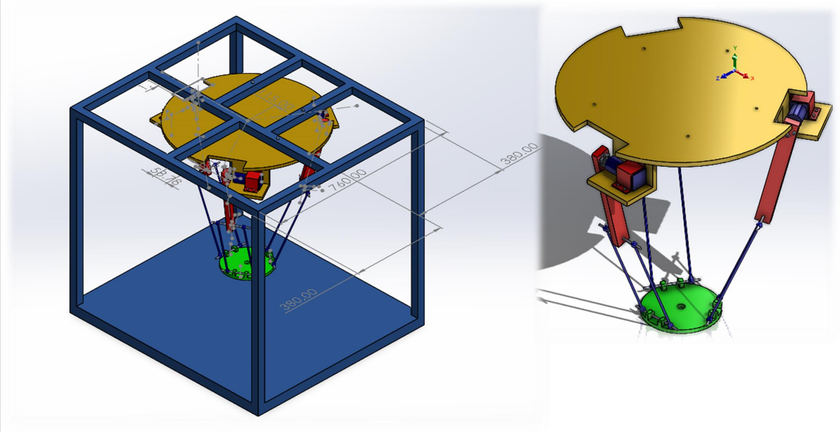


Illustration of 3D CAD model

Prototype Components

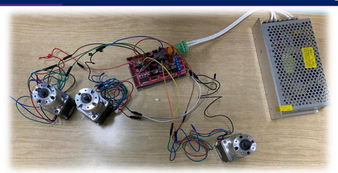


Illustration of motor connection

Illustration of vacuum pump & suction cup

Illustration of Bicep

Illustration of Forearm

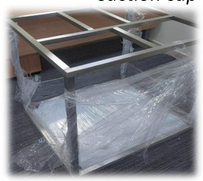


Illustration of Frame

Illustration of End rod

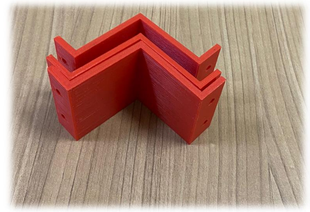


Illustration of mounting

Illustration of flange

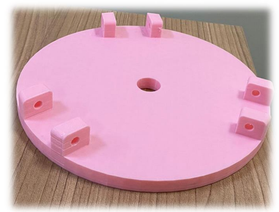


Illustration of lower plate

Testing/Validation

There is 3 main methodology we are following for testing the robotic arm which are:

- Functionality: to test functionality of the robotic arm, the measuring the accuracy of movement and the covered volume by the following equation

$$Accuracy = \frac{Number\ of\ correctly\ executed\ actions}{Total\ number\ of\ actions} \times 100$$

$$Coverd\ region\ ratio = \frac{Actual\ covered\ region}{Required\ covered\ region}$$

- Durability: To gauge the robotic arm's durability, we'll run it continuously for an extended period under normal conditions, simulating real-world use. We'll monitor its performance over time for any signs of wear or failure.

- User experience: To evaluate user experience, we'll involve a diverse group of users representing the robotic arm's target audience. They'll perform tasks with the arm, and we'll measure their performance and gather feedback.

conclusion

In conclusion, employing a delta robotic arm for automated PCB assembly offers significant advantages, including enhanced efficiency and precision. Its swift and accurate component manipulation streamlines production, reduces errors, and elevates overall assembly quality, promising increased productivity and competitiveness in electronics manufacturing.