Conductive Ink Deposition System for 3D Printed Electronics

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Abstract: 3D printed electronics is one of the emerging area which offers great potential in fabrication of electronics. With the advancement in the technology, now 3D printing not only offers fabrication of intricate features and objects but also functional electronics. Utilization of conductive materials for 3D printing has opened a new domain where the electronic components can be printed in one setting by embedding electric conductive material in passive features which can be printed with insulating or dielectric materials. However, the conductivity of available polymer materials are much below the materials used for making conductive path. In this regard, a system needs to developed which can be used for deposition of conductive ink which have higher conductivity than printable polymers. The present paper discusses about the development of three axis controlling system for conductive ink deposition for printed electronics.

Introduction

Today printing is not limited to just a conventional idea of inking down a few letters, pictures, figures onto a substrate but something that is not restrained by any stereotypes, making impossible possible and taking this idea into a whole new level. Massive research and development going in this field and adding few prefixes have led to the genesis of new technologies like 3D printing, bio-printing, etc. 3D printing itself fragmented into a perennial number of domains has a massive scope of research.

Printing via conductive ink is one such field that still needs a lot of advancements. Conductive ink as the name suggests is a kind of ink that when inked down onto a suitable subject shows properties of conductivity(conducting electrical current). It is generally created by infusing different semiconductive materials into ink forming a semiviscous substance that constrains resistivity and adheres to the subject. Conductive inks could be an economical alternative to contemporary ancient industrial standards like etching copper from copper-plated substrates to create identical conductive traces on relevant substrates, as conductive ink printing could be a strictly additive method manufacturing with very little to no waste streams that then got to be recovered or treated. The printed circuit boards (PCBs) manufactures use complex and expensive techniques to fabricate the circuit boards which in turn levitates the overall cost.

Silver conductive inks have multiple uses these days as well as printing RFID tags as utilized in trendy transit tickets, these inks be a game-changer to improvise or repair circuits on computer circuit boards or pc keyboards containing membranes with written circuits. These conductive ink irrespective of the material in it just should show conductivity can be a complete game-changer and could make circuits in a whole new way and create unprecedented new technologies.

The conductive ink deposition system is a system by which we can print an electrical circuit without applying any chemical process. Today Printed circuit boards (PCB) are being used in the electrical device for connecting completely different parts to at least one another through a fancy array of circuits. These boards contain many layers of copper traces to form the connections, furthermore as plastics and alternative materials to shield those connections from the setting. Conductive ink deposition system can terminate the complexity and error in circuit printing and the Conductive ink deposition system will be an easy and less time-consuming method for printed electronics.

In order to investigate the feasibility of 3D printing electronic components several attempts have been made.

Development of conductive filament for 3D prining via fused deposition modelling process has been investigated. A low-cost printer was utilized to print electronic sensors [1-3]. Moreover, silver based conductive ink have been developed printed electronics. The resisitivity of the ink was reported as 4.6 μohms at 140 °C [4-8].

The present paper discusses about the development of three axis controlling system for conductive ink deposition for printed electronics. This will help to reduce the complexity of printing electrical circuits and to print the electrical circuit on desired surface, eliminate the acid trap problem, eliminate chemical process for printing electrical circuit, substitute the PCB technology, reduce the cost of manufacturing an electrical device.

Methodology

The methodology adopted for the work is illustrated in figure 1. The different phases are preented below:

Planning phase: Envisioning and indexing down the steps for the smooth processing of the entire operation.

Research: Studying various research papers and taking expert advice as well

Design phase: Use of high-end CAD software like Fusion 360, creo as an intermediate for creating a 3D model of vision.

Market research: Exploring the market and comparing for the most economical option

3d printing of a few required components: Assembly of all the required components and material that are conducive to the 3D printer

Assembly, assessment and evaluation: Use of various evaluation techniques and software like Ansys 14 to assess the product

Integration of various electrical components including Arduino mega 2560, Ramp 1.4, drivers, end-stops, etc and making proper connections.

Coding and programming for the operation of the printer using Firmware being merged with Arduino IDE.

Calibration of the entire model using software like Pronterface, feeding the right material to the extruder and controlling the entire customized conductive ink 3d Printer using software Ultimaker Cura.

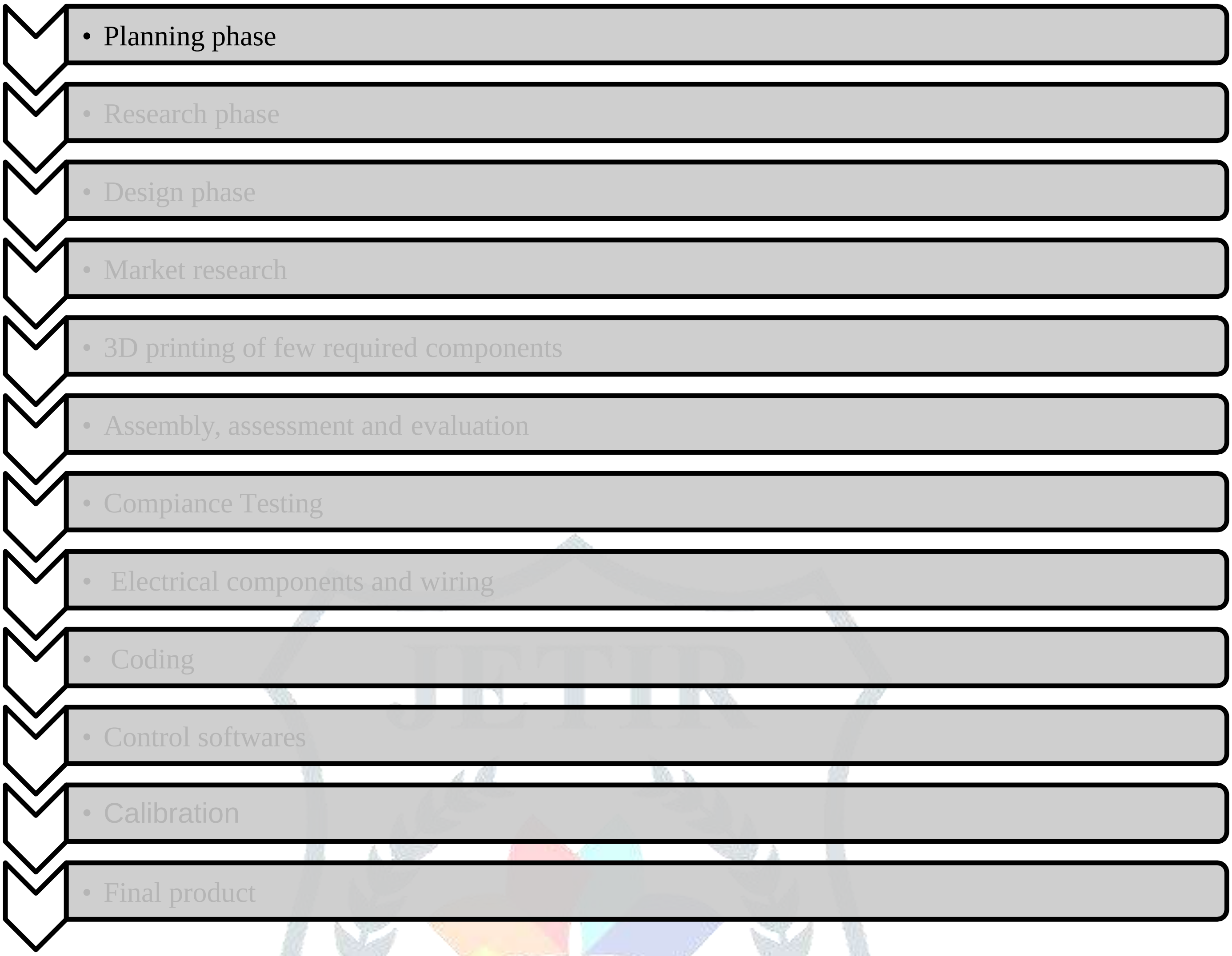
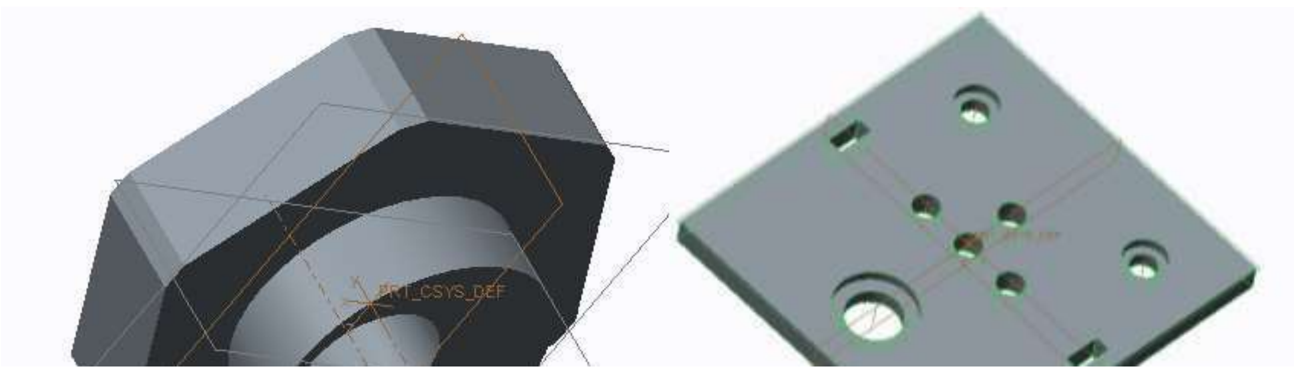


Figure 1 Methodology adopted for the development of the system structure

Experimentation

A cantilever type model was used for the structure of the deposition system. Various parts of the structure using PTC Creo 2.0 were designed as part files(.prt) and 3-D modeling was done after all stereolithography files(.stl) had been converted from their respective part files(.prt). Figure 2 illustrates the CAD model of the components used for the structure which were further 3D printed.



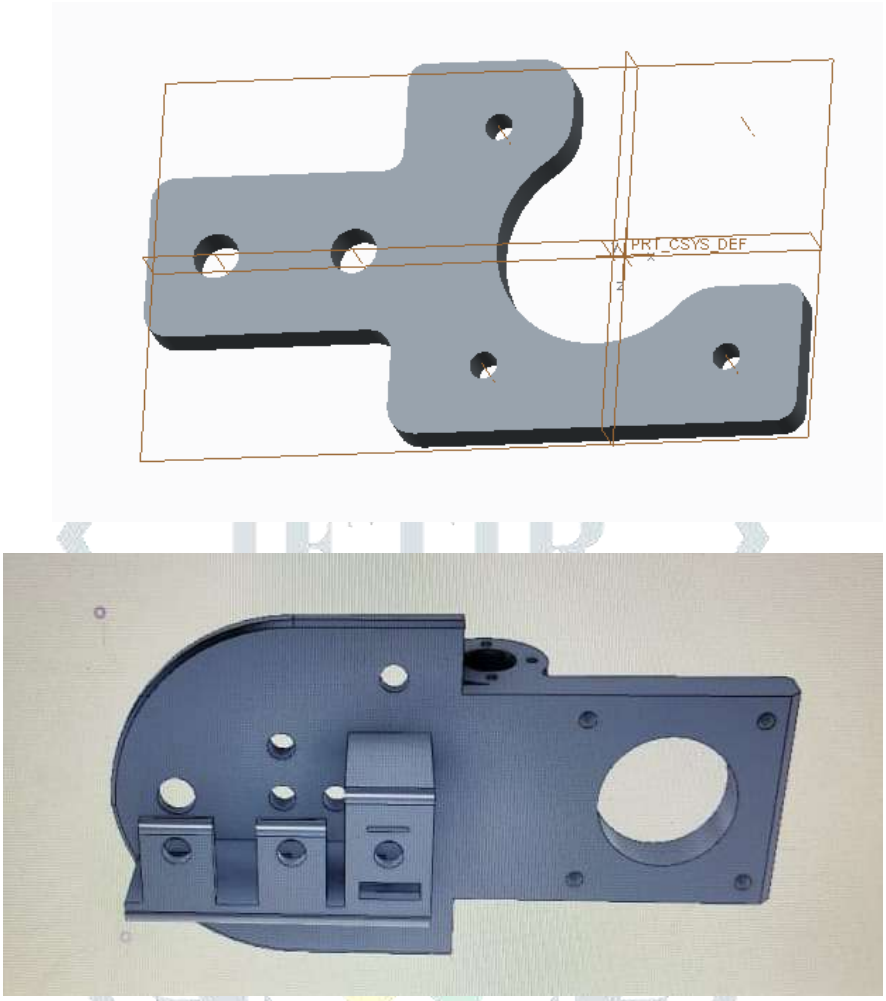


Figure 2 CAD models of the component 3D printed for the system

Figure 3 shows the structure fabricated for the deposition system. The 3D printed designed were also intergrated into the cantilever type structure for the axes movement. The structure of the system was buildt by 2040 T Slot Aluminium Extrusion Rods. Figure 5 shos the interface used for calibration of the stepper motor.

Figure 3 Structure for the deposition system

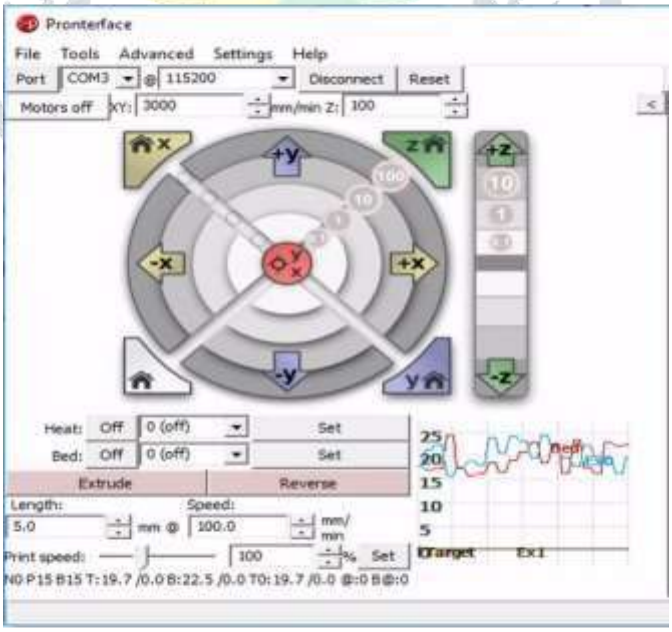


Figure 5 Pronterface software to align and calibrate the stepper motor

The system was controlled by the an opensource software Cura. Figure 6 illustrates the interface for the same.

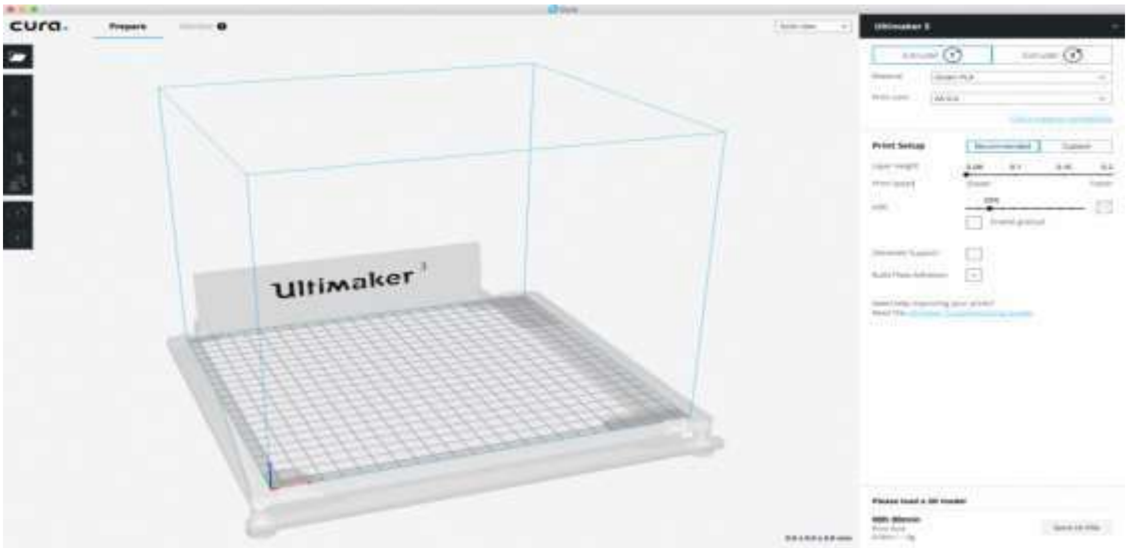


Figure 6 Controlling the entire System using Ultimaker Cura

Conductive material and its conductivity: Preliminary experiments were conducted on the materials that are already available in the market and for improving their performance few experiments were performed to improve the conductivity by adding fillers.

Conclusions

In order to deposit the conductive path on to various substrate a system is developed which can be controlled in three dimensions for laying down the conductive ink. An autonomous ink deposition system that could be easily controlled via CAD software to deposit the ink onto the required substrate in a controlled manner. A field that has still an enormous scope of research i.e. 3d printing, our efforts through our model is to contribute in this robust field by creating an alternative method to presently existing etching to make connections on PCBs by deposition of conducting ink with the held of customized ink deposition system autonomously.Conductive ink deposition systems can terminate all these problems which generally occur during the printing of circuits on printed circuit boards. Because for conductive ink deposition system no chemical process is required and the conductive ink deposition system can print electrical circuits on any surface in this process no chemical process required so there will be no over-etching.

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