A Project Report

On

REMOTE CONTROL OF 3D PRINTER

BY

**SURYA GADIRAJU SE20UCSE045**

**THARUNSHREY GURRAMPATI SE20UCSE209**

**AYUSHI GHIA SE20UCSE026**

**DEVEJYA EMANDI SE20UMEE012**

**GADDE ESWAR KALYAN SE20UCSE044**

**HANNOCK SINGH SE20UMEE015**

Under the supervision of

**KONDIAH P**

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**Ecole Centrale School of Engineering**

**Hyderabad**

Certificate

This is to certify that the project report entitled “**REMOTE CONTROL OF 3D PRINTERS”** submitted by Mr.Gadiraju Surya (HT No.SE20UCSE045) in partial fulfillment of the requirements of the course PR 302, Project Course, embodies the work done by him/her under my supervision and guidance.

**(KONDIAH P& Signature)**

Ecole Centrale School of Engineering, Hyderabad.

Date:

ABSTRACT

This abstract presents an overview of an app developed using the Flutter framework that serves as a companion tool for 3D printers integrated with OctoPrint. The app aims to provide a seamless and intuitive user experience for controlling and monitoring 3D printers remotely.

The app's core functionalities include printer control, file management, print monitoring, camera feed streaming, slicing integration, and plugin customization. Users can control their 3D printers by initiating, pausing, or canceling print jobs, adjusting printer settings, and monitoring vital statistics such as print progress, temperatures, and filament usage. The file management feature allows users to upload, organize, and select 3D model files from local or cloud storage platforms.

Real-time print monitoring provides users with detailed information about ongoing print jobs, enabling them to track progress and receive notifications upon completion or errors. The camera feed streaming feature allows users to remotely monitor their prints using webcam or IP camera footage. Integration with popular slicing engines like Cura and PrusaSlicer empowers users to configure slicing settings and preview the sliced models before sending the G-code to the OctoPrint server.

The app is developed using the Flutter framework, which allows for cross-platform compatibility and a consistent user interface across Android and iOS devices. Flutter's extensive widget library facilitates the creation of an intuitive and visually appealing user interface. Network communication capabilities in Flutter enable seamless integration with OctoPrint's API for printer control, status updates, and file management.

Additionally, the app supports plugin integration, enabling users to extend its functionality and customize their experience according to their preferences. The app follows standard security practices, requiring user authentication to establish a secure connection with the OctoPrint server.

In conclusion, this app developed using Flutter serves as a powerful tool for remotely managing and monitoring 3D printers integrated with OctoPrint. Its intuitive interface, combined with features like printer control, file management, print monitoring, camera feed streaming, slicing integration, and plugin customization, provides users with a comprehensive solution for controlling and optimizing their 3D printing process

CONTENTS

Title page………………………………………………………… …….1

Acknowledgements………………………………………….………….2

Certificate…………………………………………………………….....3

Abstract………………………………………………………………....4

1.Introduction ……………………………………………….……….....6

2.Litreature Survey ……………………………………………………..7

3.Problem definition…………………………………………………….8

4.Methodology………………………………………………………….9

5.Results and Discussion……………………………………………….10

Conclusion…………………………………………………………..…16

References…………………………………………………………..….17

**INTRODUCTION**

**3D printing**

3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file.

The creation of a 3D printed object is achieved using additive processes. In an additive process an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced cross-section of the object.

It is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine.

It enables you to produce complex shapes using less material than traditional manufacturing methods.

## How Does 3D Printing Work?

It all starts with a 3D model. You can opt to create one from the ground up or download it from a 3D library.

### 3D Software

There are many different software tools available. From industrial grade to open source.

## Examples of 3D Printing

3D printing encompasses many forms of technologies and materials as 3D printing is being used in almost all industries you could think of. It’s important to see it as a cluster of diverse industries with a myriad of different applications.

A few examples:industrial products (manufacturing tools, prototypes, functional end-use parts

dental products, prosthetics

**Remotely Controlling**

Remotely controlling a 3D printer involves the ability to manage and oversee the printing process from a location separate from the printer itself. This is typically achieved through network connectivity and software interfaces. With remote control, users can initiate and pause print jobs, adjust printing parameters such as speed and temperature, and monitor the progress and status of the print in real-time. It offers convenience by eliminating the need to be physically present near the printer, allowing for remote management and control. This is particularly valuable in scenarios where the printer is located in a different room or even in a different geographical location, enabling users to initiate and monitor prints from anywhere with an internet connection.

**LITERATURE SURVEY**

N. Shahrubuddin has presented an overview on 3d printing technology. Digital fabrication technology, also referred to as 3D printing or additive manufacturing, creates physical objects from a geometrical representation by successive addition of materials. 3D printing technology is a fast-emerging technology. Nowadays, 3D Printing is widely used in the world. 3D printing technology increasingly used for the mass customization, production of any types of open source designs in the field of agriculture, in healthcare, automotive industry, locomotive industry and aviation industries.

Vinod G has presented a review paper on 3D Printing Aspects. This is a research paper on 3D printing and the various materials used in 3D printing and their properties which become a notable topic in technological aspects. First, define what is meant by 3D printing and what is significant of 3D printing. This research paper deal with the history of 3D printing and study about the process of 3D printing and what materials used in the manufacture of 3D printed objects and select the best materials among them which are suitable for our 3D printing machine. Also, the advantages of 3D printing as compared to additive manufacturing

A.A.Shinde has presented A research paper on the 3D-printer in which reader introduced basic components operation materials used for making objects and applications. Now a day we are growing every day and every second. We adopt new technology with new invention and create new invention and create new things for enjoys life very easily. There are lots of new technologies we adopted in our daily life. In this technology one of them is 3Dprinter. This is one of innovation on this we can make many objects

Anand Nayyar has presented a research paper on raspberry pi. Raspberry Pi, an efficient and cost effective credit card sized computer comes under light of sun by United Kingdom-Raspberry Pi foundation with the aim to enlighten and empower computer science teaching in schools and other developing countries. Since its inception, various open source communities have contributed tons towards open source apps, operating systems and various other small form factor computers similar to Raspberry Pi. Till date, researchers, hobbyists and other embedded systems enthusiast across the planet are making amazing projects using Pi which looks unbelievable and have out-of-the-box implementation.

Hirak Dipak Ghael has presented a research paper on Raspberry Pi and Its Applications. Raspberry Pi, an efficient and powerful minicomputer having the dimension approximately equal to the size of a credit/debit card. It was invented by the United Kingdom Raspberry Pi foundation with the hope of enlightening and empowering the generation of learners to be more creative and efficient. Since its launch, many open-source communities have contributed towards open-source operating systems (OS), apps and various other forms of computers which are similar to Raspberry Pi. Moreover, various embedded system scholars and researchers across the globe are constantly involved in the development of innovative projects using this module which is observed to have out-of-the-box application.

**PROBLEM DEFINATION**

The problem to be addressed in the project on remotely accessing a 3D printer is to enable users to control and monitor the printing process from a remote location effectively and securely. This problem arises due to the increasing demand for remote operations and the need for flexibility in managing 3D printing tasks.

1. ACCESSIBILITY: is a key challenge in remotely accessing a 3D printer. It involves developing a solution that allows users to connect to and control the printer from any location, regardless of their physical proximity to the device. This requires establishing network connectivity and implementing appropriate software interfaces that enable remote communication with the printer.
2. INTERFACE: it is a user-friendly interface and is crucial to ensure an intuitive and seamless remote printing experience. Users should be able to easily initiate print jobs, adjust printing parameters such as speed, temperature, and layer height, and receive real-time updates and status notifications. The interface should be designed to accommodate different user preferences and skill levels, promoting ease of use and efficiency.
3. SECURITY: is a critical concern when remotely accessing a 3D printer. Implementing robust security measures is necessary to protect the printer and the printing process from unauthorized access, tampering, or potential malicious activities. This involves incorporating secure authentication mechanisms, encrypted communication protocols, and access control mechanisms to ensure that only authorized users can remotely access and control the printer.
4. RELIABILTY: is another aspect to consider in the remote access system. It is important to ensure that the system remains stable and dependable, minimizing potential disruptions or connectivity issues that could affect the printing process. Robust error handling mechanisms and remote monitoring capabilities can help identify and address any issues that may arise during the remote printing operation.
5. COMPATIBILITY: is a significant challenge due to the wide range of 3D printers available in the market, each with different makes, models, and connectivity options. The solution should be designed to be compatible with various printer types, ensuring interoperability and enabling users to remotely access and control their specific printer model without limitations.

The overall goal of the project is to provide a comprehensive solution that addresses these challenges and enables users to remotely manage and monitor their 3D printers with convenience, efficiency, and reliability. By overcoming the accessibility, user interface, security, reliability, and compatibility challenges, the project aims to empower users to take advantage of the benefits of remote 3D printing, such as increased flexibility, productivity, and convenience, while maintaining the necessary security measures to protect the printing process and the printer itself.

**METHODOLOGY**

Key Objectives and Proposed Solutions for Remotely Accessing a 3D Printer:

1. Objective: Enable remote connectivity to the 3D printer.

Solution: Implement network connectivity options such as Wi-Fi or Ethernet, allowing users to connect to the printer from remote locations. This can be achieved by integrating the necessary hardware and configuring the printer to connect to a local network. Additionally, cloud-based solutions can be employed to facilitate remote access and control.

2. Objective: Develop a user-friendly interface for remote control and monitoring.

Solution: Create a web or mobile application with an intuitive user interface that enables users to remotely initiate print jobs, adjust printing parameters, and monitor the progress in real-time. The interface should provide clear instructions and feedback, allowing users to easily interact with the printer and access relevant information.

4. Objective: Ensure reliability and stability of the remote access system.

Solution: Implement error handling mechanisms to address potential connectivity issues or errors during the remote printing process. This could involve automated error detection and recovery procedures to minimize disruptions. Implement remote monitoring capabilities to track printer status, detect failures, and alert users in case of any issues.

5. Objective: Ensure compatibility with various 3D printer models.

Solution: Develop a solution that can interface with different 3D printer models and their corresponding software protocols. This can be achieved by adopting industry-standard communication protocols, such as G-code or API integration, to establish compatibility with a wide range of printers. Additionally, providing a customizable interface or configuration options can accommodate specific printer settings and requirements.

6. Objective: Provide remote troubleshooting and support.

Solution: Include features in the remote access system that allow users to troubleshoot common issues remotely. This can include remote firmware updates, diagnostic tools, and access to online support resources. Incorporate a support ticketing system or live chat functionality to facilitate direct communication between users and support personnel for more complex troubleshooting or assistance.

By addressing these key objectives and implementing the proposed solutions, users will be able to remotely access and control their 3D printers securely and efficiently. This will enable them to initiate print jobs, adjust settings, monitor progress, and troubleshoot issues remotely, enhancing convenience, productivity, and flexibility in the 3D printing process.

**RESULTS AND DISCUSSION**

**SUCCESSFUL FUNCTIONS**

OctoPrint is a popular open-source software for remotely controlling and monitoring 3D printers. It provides a range of functions and features to enhance the user experience and streamline the printing process. Some of the key functions in OctoPrint for 3D printers include:

1. REMOTE CONTROL**:** OctoPrint allows users to remotely start, pause, and cancel print jobs. Users can upload G-code files directly to OctoPrint and initiate the printing process without physically interacting with the printer.
2. PRINT MONITORING: OctoPrint provides a real-time visual representation of the print progress. Users can monitor the status of the print, including details such as estimated time remaining, filament usage, and layer-by-layer progress.
3. WEBCAM SUPPORT: OctoPrint supports integrating webcams to provide live video streaming of the printing process. This feature enables users to remotely view the printer and visually monitor the progress in real-time.
4. PRINT SLICING AND VISUALISATION**:** OctoPrint can interface with slicing software such as Cura to generate G-code files. Users can slice and visualize their 3D models directly within the OctoPrint interface, allowing for streamlined preparation and print management.
5. PRINTER CONTROL AND SETTINGS: OctoPrint allows users to adjust various printer settings, such as extruder temperature, bed temperature, fan speed, and more. Users can fine-tune these settings remotely based on the requirements of the specific print job.
6. PLUGIN SYSTEM: OctoPrint has a plugin architecture that enables users to extend its functionality. Users can install additional plugins to add features such as thermal runaway protection, filament change detection, and advanced monitoring capabilities.
7. TIME LAPSE RECORDING: OctoPrint can capture images at regular intervals during the print process and generate time-lapse videos. This feature allows users to create visual records of their prints and share them with others.
8. FILE MANAGEMENT: OctoPrint provides a file management system for organizing and managing G-code files. Users can upload, delete, and organize files within OctoPrint, making it easy to access and control the printing process remotely.
9. REMOTE ACCESS AND CONTROL: OctoPrint supports remote access, allowing users to control and monitor their printers from anywhere with an internet connection. This feature provides flexibility and convenience for managing prints without being physically present near the printer.

These functions in OctoPrint enhance the user's ability to remotely control and monitor 3D printers, providing a comprehensive and convenient platform for managing the printing process.

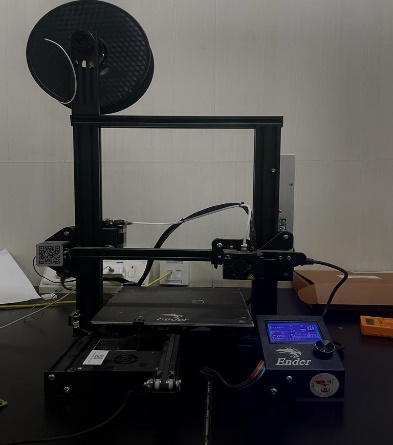
**FIGURES AND DESCRIPTION**

The Ender 3 is a popular and affordable 3D printer manufactured by Creality. It is known for its solid construction, ease of use, and reliable performance, making it a favourite among hobbyists, makers, and entry-level users.

Here are some key features and specifications of the Ender 3:

1. BUILD VOLUME: The Ender 3 offers a decent build volume of 220mm x 220mm x 250mm, allowing you to create relatively large 3D prints.
2. FRAME AND CONSTRUCTION: It has a sturdy frame made of aluminum extrusions, which provides stability and durability during the printing process. The printer's overall design is open-source and has a compact footprint, making it suitable for small workspaces.
3. BED LEVELING: The Ender 3 features manual bed leveling, which means you need to adjust the bed's height manually to ensure proper adhesion and print quality. However, there are various aftermarket upgrades available, such as automatic bed leveling kits, that can be added to enhance the printer's capabilities.
4. HOTBED AND NOZZLE: It comes with a heated print bed, allowing you to print with various filament materials like PLA, ABS, PETG, and more. The Ender 3 has a single extruder with a standard 0.4mm nozzle diameter, which can be replaced if desired.
5. USER INTERFACE: The printer has a simple and intuitive user interface, consisting of a rotary knob and an LCD screen. It provides basic control options, such as file selection, temperature adjustments, and print progress monitoring.
6. CONNECTIVITY AND FILE TRANSFER: The Ender 3 typically lacks built-in Wi-Fi or Ethernet connectivity. It connects to a computer or other devices via a USB cable for file transfer. However, there are add-on modules available to enable wireless printing through Wi-Fi.
7. SOFTWARE COMPATIBILITY: The Ender 3 is compatible with a wide range of slicing software, including open-source options like Cura, Slic3r, and PrusaSlicer. These programs allow you to prepare your 3D models for printing by configuring settings like layer height, print speed, and support structures.

Overall, the Ender 3 offers a reliable and cost-effective entry into the world of 3D printing, making it a popular choice for beginners and enthusiasts alike. Its affordability, solid construction, and modding community have contributed to its widespread popularity in the 3D printing community**.**

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**RASPBERRY PIE**

The Raspberry Pi with a camera module and OctoPrint (often referred to as OctoPi when installed on a Raspberry Pi) is a powerful combination that enables remote monitoring and control of 3D printers. Here's a description of each component and their functionalities:

1. Raspberry Pi: The Raspberry Pi is a credit card-sized single-board computer. It is highly versatile and widely used in various projects and applications. When used with a camera module and OctoPrint, it serves as a control hub for 3D printers.
2. Camera Module: The Raspberry Pi Camera Module is a small camera board that connects directly to the Raspberry Pi's CSI (Camera Serial Interface) port. It provides high-quality image and video capture capabilities and is available in different versions, such as the Raspberry Pi Camera Module V2 or the Raspberry Pi High-Quality Camera.
3. OctoPrint: OctoPrint is a powerful open-source software platform specifically designed for 3D printers. It offers a web interface that allows users to remotely monitor and control their 3D printers using a computer or mobile device. OctoPrint provides features such as live video streaming, print progress monitoring, temperature monitoring, job queue management, and more.
4. OctoPi: OctoPi is a pre-configured Raspberry Pi operating system image that includes OctoPrint. It simplifies the installation process by providing a ready-to-use solution for running OctoPrint on a Raspberry Pi. OctoPi is designed to be user-friendly and compatible with various Raspberry Pi models.

When the Raspberry Pi is equipped with a camera module and OctoPi is installed, you can connect the Raspberry Pi to your 3D printer and enjoy several benefits:

- Remote Monitoring: The camera module enables live video streaming, allowing you to monitor your 3D prints remotely. You can check the progress, observe any issues, and make necessary adjustments without physically being near the printer.



Fig 2: Raspberry pi with camera module

**APP BUILD**

OctoPrint Companion, the app for managing octopi for 3D printers, is developed using the Flutter framework. Flutter is an open-source UI toolkit developed by Google, which allows developers to create native-like apps for multiple platforms using a single codebase.

Here's an overview of how OctoPrint Companion is made using Flutter:

1. PROJECT SETUP: The development team sets up a new Flutter project using the Flutter command-line tools or an integrated development environment (IDE) like Visual Studio Code and Android Studio. They configure the project to support both Android and iOS platforms.
2. USER INTERFACE (UI) DESIGN: The app's UI design is created using Flutter's widget-based architecture. Flutter provides a rich set of pre-built widgets for building user interfaces. The team designs the app's screens, navigation flow, and user interactions using widgets like containers, rows, columns, buttons, and text fields. They ensure that the UI is visually appealing and user-friendly.
3. NETWORK COMMUNICATION: OctoPrint Companion needs to communicate with the OctoPrint server to control and monitor the 3D printer. Flutter provides libraries for making HTTP requests and handling WebSocket connections. The team uses these libraries to send commands, retrieve printer status, and receive real-time updates from the OctoPrint server.
4. STATE MANAGEMENT: Flutter offers various state management solutions to handle the app's state and ensure a smooth user experience. The team chooses a state management approach like Provider, BLoC (Business Logic Component), or Redux, depending on the app's complexity and requirements. This allows them to manage printer status, file uploads, print progress, and other dynamic data efficiently.
5. INTEGRATION WITH OCTO PRINT API: OctoPrint provides a comprehensive API that allows developers to interact with the printer and retrieve various information. The team utilizes Flutter's networking capabilities to communicate with the OctoPrint API endpoints, fetching data such as printer status, file lists, and print progress. They parse the JSON responses and update the app's state accordingly.
6. CAMERA STREAMING: To enable live video streaming from the webcam or IP camera connected to OctoPrint, the team utilizes Flutter plugins or writes custom platform-specific code to access the device's camera. They integrate the camera feed into the app's UI, allowing users to monitor their prints in real-time.
7. PUSH NOTIFICATIONS: Flutter provides plugins for integrating push notification services like Firebase Cloud Messaging (FCM) or OneSignal. The team configures push notifications to alert users when a print job is completed or encounters an error. They handle the receipt and display of notifications in the app.
8. TESTING AND DEBUGGIN: Throughout the development process, the team writes unit tests and performs manual testing to ensure the app functions correctly across different devices and scenarios. They utilize Flutter's testing framework and debugging tools to identify and fix any issues that arise.
9. DEPLOYMENT: Once development and testing are complete, the team prepares the app for deployment. They generate release builds for both Android and iOS platforms and upload them to their respective app stores (Google Play Store and Apple App Store). They follow the platform-specific guidelines for app submission and distribution.

By leveraging the power of Flutter, the OctoPrint Companion app is built with a single codebase while delivering a high-quality, native-like experience on both Android and iOS devices. Flutter's rich ecosystem of libraries and widgets, along with its cross-platform capabilities, enables efficient and streamlined development of the app.

**INTERFACE OF THE APP**

The interface of the OctoPrint Companion app is designed to provide a user-friendly and intuitive experience for managing and monitoring 3D printers connected to OctoPrint. While I can't provide an actual visual representation, I can describe the key components and screens commonly found in such an app:

1. LOGIN/AUTHENTICATION:

- Users are presented with a login screen where they can enter their OctoPrint server credentials to establish a connection.

2. DASHBOARD/HOME SCREEN:

- Upon successful login, users are greeted with a dashboard or home screen that provides an overview of their 3D printer(s) and ongoing print jobs.

- The dashboard typically displays the printer's current status, including bed and nozzle temperatures, print progress, and estimated time remaining.

- Users may see a list of active print jobs with relevant details like the file name, print time, and completion percentage.

3. PRINTER CONTROL:

- Users can access controls to manage their 3D printer's operations, such as starting, pausing, and canceling print jobs.

- The interface may include buttons or sliders to adjust the printer's movement axes, extrusion, bed temperature, and fan speed.

4. FILE MANAGEMENT :

- This screen allows users to upload, organize, and manage their 3D model files.

- Users can browse their local files or connect to cloud storage platforms (e.g., Google Drive, Dropbox) to access and select files for printing.

- The interface may provide options for organizing files into folders, deleting files, and queuing multiple files for consecutive printing.

5. PRINT MONITORING:

- Users can monitor the progress of their ongoing print jobs in real-time.

- The interface displays essential information such as print time, print progress (percentage), bed and nozzle temperatures, and filament usage.

- Users may have the option to receive push notifications or alerts when a print job is completed or encounters an error.

6. CAMERA FEED:

- If the user has a webcam or IP camera connected to their OctoPrint setup, this screen provides a live video feed of the printing area.

- Users can view the print progress remotely, ensuring quality control and monitoring for any potential issues.

7. SLICING INTEGRATION:.

- Users can select the desired slicing engine (e.g., Cura, PrusaSlicer) and adjust settings such as layer height, infill density, and support structures.

- The interface may include a preview of the sliced model to provide users with a visual representation before sending the G-code to OctoPrint.

8. SETTINGS:

- Users can access various app settings, including server configuration, notification preferences, appearance customization, and account management.

- The settings screen allows users to tailor the app's behavior and appearance to their preferences.

It's important to note that the specific design and layout of the OctoPrint Companion app's interface can vary based on the development team's design choices and the features they choose to implement. The descriptions provided above are general guidelines commonly seen in similar applications.

**CONCLUSION**

The remote control app for 3D printers revolutionizes the way users interact with and manage their printing processes. With the advent of advanced technologies, such as mobile applications and wireless connectivity, it is now possible to control and monitor 3D printers from anywhere, providing a level of convenience and flexibility that was previously unimaginable.

This app serves as a powerful tool that enables users to remotely control their 3D printers through a user-friendly interface. It allows them to initiate print jobs, pause or resume printing, and even cancel jobs if necessary. With just a few taps on their mobile device, users can have complete control over their printing process, saving time and effort.

One of the standout features of this app is the ability to monitor the progress of print jobs in real-time. Users can access detailed information about the ongoing print, including print time, completion percentage, and even live camera feeds to visually track the progress. This feature provides peace of mind, as users can keep a close eye on their prints and intervene if any issues arise, such as filament jams or adhesion problems. They can also receive notifications or alerts when a print job is completed, ensuring they are promptly informed of the results.

Furthermore, the app offers additional functionalities to enhance the user experience. Users can access their file libraries, where they can upload, organize, and select 3D models for printing remotely. The app also provides integration with slicing engines, allowing users to configure slicing settings and preview the sliced models before sending the instructions to the printer. This ensures greater control over the printing process and helps users achieve the desired quality and accuracy.

The app's compatibility with OctoPrint servers further enhances its capabilities. OctoPrint is a popular open-source platform that enables advanced control and monitoring of 3D printers. By connecting the app to OctoPrint, users gain access to a wide range of features and functionalities, including temperature monitoring, bed leveling, and firmware updates.

In conclusion, the remote control app for 3D printers brings convenience, flexibility, and control to the fingertips of users. By leveraging the power of mobile technology, wireless connectivity, and integration with OctoPrint, this app transforms the printing experience, enabling users to remotely manage and monitor their 3D printers with ease, efficiency, and peace of mind.

**REFRENCES**

* *D. A. Kolb, Experiential learning: experience as results of the availability of learning and development. FT press, 2014*
* *Joseph Muniz , Aamir Lakhani, “Penetration Testing with Raspberry Pi”, 2015*
* *Warner, T. L. (2013). Hacking Raspberry Pi. Que Publishing.*
* *Ruben Perez Mananes, Jose Rojo-Manaute, Pablo Gil, “3D Surgical printing and pre contoured plates for acetabular fractures”, Journal of ELSEVIER 2016.*
* *Dr.Muhmad Abu Khaizaran et-al, ‘Team paper on 3-D printing technology’,Birzeit university. Electrical and Computer system engineering department,2014,Pp.1-9*
* *P. Holzmann, J. Robert, A. Aqeel Breitenecker, Soomro, & J. S. Erich, “User entrepreneur business models in 3D printing,” Journal of Manufacturing Technology Management, Vol. 28, No. 1, pp. 75-94, 2017.*
* *Thomas, “3D printed jellyfish robots created to monitor fragile coral reefs,” 3D Printer and 3D Printing News, 2018. [Online].*
* *ISO/PRF 17296-1,"Additive manufacturing -- General principles -- Part 1: Terminology", 2015.*
* *Thabiso Peter Mpfou et-al, ‘The impact and Application of 3-D Printing Technology’ ,International Journal of Science and Research,Pp.2148- 2152,ISSN2319-7064*
* *Dongkeon Lee, Takashi Miyoshi, Yasuhiro Takaya and Taeho Ha, “3D Micro fabrication of Photosensitive Resin Reinforced with Ceramic Nanoparticles Using LCD Microstreolithography”, Journal of Laser Micro/Nano engineering Vol.1, No.2, 2006.*
* *Gabriel Gaala, Melissa Mendesa, Tiago P. de Almeida, “Simplified fabrication of integrated microfluidic devices using fuseddeposition modeling 3D printing” Science Direct.*
* *Pshtiwan Shakor, Jay Sanjayan, Ali Nazari, Shami Nejadi, “Modified 3D printed powder to cement-based material and mechanical properties of cement scaffold used in 3D printing”, Science Direct*
* *Siddharth Bhandari, B Regina, “3D Printing and Its Applications”, International Journal of Computer Science and Information Technology Research ISSN 2348-120X.*
* *Elizabeth Matias, Bharat Rao, “3d printing on its historical evolution and the implications for business”, 2015 Proceedings of PICMET: Management of the Technology Age.*
* *Frank van der Klift, Yoichiro Koga, Akira Todoroki, “3D Printing of Continuous Carbon Fibre Reinforced Thermo-Plastic (CFRTP) Tensile Test Specimens”, Open Journal of Composite Materials, 2016, 6, 18- 27*