

# **SHRI VAISHNAV VIDYAPEETH VISHWAVIDYALAYA, INDORE**



## **INTERNSHIP REPORT**

**2020-2021**

*A report submitted in partial fulfillment of the requirements for the Award of Degree of  
BACHELOR OF TECHNOLOGY*

**In**

***Mechatronics***

**By**

***Ojas Khamkar***

***17010BTMX01947***

**Under the Supervision of**

<b>Industry Mentor</b>	<b>University Mentor</b>
<b><i>Mr. Rajesh Murthy</i></b>	<b><i>Mr. Rohit Kanthaliya</i></b>
<b><i>CEO</i></b>	<b><i>Assistant Professor</i></b>
<b><i>Contrive Technologies</i></b>	<b><i>Electrical and Electronics Engineering</i></b>
<b><i>Indore, Madhya Pradesh</i></b>	<b><i>Shri Vaishnav Institute of Technology and Science</i></b>

**(Duration: 19<sup>th</sup> January 2021 to 31<sup>st</sup> May 2021)**

**Department of Electrical and Electronics Engineering  
Shri Vaishnav Institute of Technology and Science  
Indore-Ujjain Road, Indore (MP)-India- 453111**

# **SHRI VAISHNAV VIDYAPEETH VISHWAVIDYALAYA,**

## **SHRI VAISHNAV INSTITUTE OF TECHNOLOGY AND SCIENCE**



**2020-2021**

### **DECLARATION**

I hereby declare that work, which is being presented in the Internship Report as the partial fulfillment for the award of degree of **Bachelor of Technology** in **Mechatronics** in the **Department of Electrical and Electronics Engineering** at **Shri Vaishnav Institute of Technology and Science** of Shri Vaishnav Vidyapeeth Vishwavidyalaya Indore, is an authentic record of my work carried out under the Mentorship of **Mr. Rohit Kanthaliya (Assistant Professor) Department of Electrical and Electronics Engineering**. The matter embodied in this internship report has not been submitted for the award of any other degree.

Enrollment Number: 17010BTMX01947

Student Signature

Date:

# **SHRI VAISHNAV VIDYAPEETH VISHWAVIDYALAYA,**

## **SHRI VAISHNAV INSTITUTE OF TECHNOLOGY AND SCIENCE**



**2020-2021**

### **INTERNSHIP APPROVAL SHEET**

This is to certify that **Mr. Ojas Khamkar** enrollment number **17010BTMX01947** has successfully completed his industrial internship starting from 19<sup>th</sup> January 2021 to 31<sup>st</sup> May 2021 and has submitted the final report. His work has been found satisfactory and it is recommended to accept it as a partial fulfillment for the award of degree of **Bachelor of Technology Mechatronics Engineering** of the **Department of Electrical and Electronics Engineering** at **Shri Vaishnav Institute of Technology and Science** of **Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore.**

**Internal Examiner**

Date :

**External Examiner**

Date:

**SHRI VAISHNAV VIDYAPEETH VISHWAVIDYALAYA**  
**SHRI VAISHNAV INSTITUTE OF TECHNOLOGY AND SCIENCE**  
**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

**CERTIFICATE**

This is to certify that **Mr. Ojas Khamkar (17010BTMX01947)** has successfully completed his industrial internship, starting from 19<sup>th</sup> January 2021 to 31<sup>st</sup> May 2021 and has submitted the final report. He has successfully completed this Internship under the Mentorship of **Mr. Rohit Kanthaliya (Assistant Professor), Department of Electrical and Electronics Engineering** as a partial fulfillment of the degree of **Bachelor of Technology in Mechatronics Engineering** of the **Department of Electrical and Electronics Engineering at Shri Vaishnav Institute of Technology and Science of Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore** during the semester Jan – June 2021.

**Internal Mentor**

**HoD**

**Director**

**SHRI VAISHNAV VIDYAPEETH VISHWAVIDYALAYA**  
**SHRI VAISHNAV INSTITUTE OF TECHNOLOGY AND SCIENCE**  
**DEPARTMENT OF ELECTRICAL AND ELECTRONICS**  
**ENGINEERING**

## **Acknowledgement**

First, I would like to thank **Dr. Upinder Dhar**, Hon'ble Vice Chancellor of the University for giving me an opportunity to do the internship with the external organization.

Secondly, I would like to extend my sincere gratitude towards the Director **Mr. Rajesh Murthy** of **Contrive Technologies** for giving me an opportunity at their esteemed organization.

I also would like to thank all the people that worked along with me at **Contrive Technologies**. With their patience and openness, they created an enjoyable working environment. It is indeed with a great sense of pleasure and immense sense of gratitude, that I acknowledge the help of these individuals

I am highly indebted to Director and HoD **Dr. Namit Gupta**, for the facilities and continuous support provided by them to accomplish this internship. I would also like to thank my faculty mentors **Mr. Rohit Kanthaliya & Mr. Rajesh Murthy (Industry Mentor)** for their constructive criticism throughout my internship. I would like to thank them for their support and advice to complete internship in above said organization. I am extremely great full to my department's staff members and friends who helped me in successful completion of this internship.

Ojas Khamkar

17010BTMX01947

Mechatronics

## **EXECUTIVE SUMMARY**

*Contrive Technologies is an industrial automation solution and consultancy firm. It is an established organization with products in medical equipment, Implant grade medical equipment, Industrial printer control systems, Elevator control systems, Automated Weather Stations. These were some of the key products or service sector which have been implemented in-house at the firm. All the solutions and products are usually based on Embedded Systems.*

*I did my internship in Embedded Software Development so all my major tasks were for firmware development along with management of software codes written for microcontrollers. This provides a great opportunity to the employees as their learning period never ends and every time they use to get new things to work with. The training period gave us the knowledge to how to work in the working live project, how to deal and maintain the relationship with the customers, how to behave in the professional life and how to manage yourself while working in the corporate sector.*

*In this report, the work experience and instances are documented with the SWOT analysis of the organization. Moreover, a problem statement of interest to the organization has also been solved and suggested the possible solution to industry after analyzing the root cause and possible outcomes of the same. Also, a brief summary of the project assigned by the organization in the tenure of the internship has also been documented and visually explained.*

## **TABLE OF ABBREVIATION**

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<b>S. No.</b>	<b>Abbreviation</b>	<b>Meaning</b>
1.	$\mu$	Micro
2.	ARM	Advance RISC machine
3.	AWS	Automatic Weather Station
4.	BiPAP	Bi-level positive airway pressure
5.	BSP	Board Support Package
6.	CAGR	Compound Annual Growth Rate
7.	CI/CD	Continuous Integration and Continuous Deployment
8.	CPAP	Continuous positive airway pressure
9.	CPU	Central Processing Unit
10.	CRO	Cathode Ray Oscilloscope
11.	CTO	Chief Technical Officer
12.	DSP	Digital Signal Processing
13.	ECG	Electrocardiogram
14.	EDC	Electronic Devices and Circuit
15.	ESR	Erythrocyte sedimentation rate
16.	GPU	Graphical Processing Unit
17.	GST	Goods Services Taxation
18.	HAL	Hardware Abstraction Layer
19.	I/O	Input or Output
20.	ICMR	Indian Council of Medical Research
21.	IDE	Integrated Development Environment
22.	IPC	Inter-Process Communication
23.	JDK	Java Development Kit
24.	JRE	Java Runtime Environment
25.	JTAG	Joint Test Action Group
26.	LCD	Liquid Crystal Display
27.	LTS	Long Term Support
28.	MDK	Microcontroller Development Kit

29.	MNC	Multi National Company
30.	OOPS	Object Oriented Programming System
31.	OS	Operating System
32.	PCB	Printed Circuit Board
33.	PIC	Peripheral Interface Controller
34.	QA	Quality Assurance
35.	R&D	Research and Development
36.	RISC	Reduced Instruction Set Code
37.	RTOS	Real Time Operating System
38.	SCM	Source Code Management
39.	SDLC	Software Development Life Cycle
40.	SOC	System on Chip
41.	STM	STMicroelectronics
42.	SWD	Serial Wire Debugging
43.	UV	Ultraviolet
44.	VFD	Variable Frequency Drive

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# Chapter 1

## A Brief Introduction of the Organization's Business Sector

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The Business sector of **Contrive Technologies** is the industrial automation solutions and consultancy. It is an established organization with products in medical equipment, Implant grade medical equipment, Industrial printer control systems, Elevator control systems, Automated Weather Stations. These were some of the key products or service sector which have been implemented in-house at firm. All the solutions and products are usually based on Embedded Systems. Most of the economy is turned by the same. Major clients of the organization are from medical domain followed by the Elevator sector. One vertical of the organization is towards training also which is dedicated to provide an exposure to industry and prove individual's skills.

India pursues global role in embedded software development. A number of large multinationals, among them Texas Instruments, STMicroelectronics, Motorola, Intel, Cadence Design, Synopsys, Analog Devices and National Semiconductor, have tapped India's established base of experienced programmers to create large design centers employing hundreds of engineers in the country. Embedded systems have come a long way since their inception. From smart clothing to smart banking, embedded systems have accentuated technology's growth by manifold. With growth and advancements in the field of electronics, wireless communications, networking, cognitive and affective computing and robotics, devices around you communicate in more ways than you ever imagined. Those times are not very distant when every object around us will have a small processor/sensor embedded within itself, invisible to us but still communicating with all other devices around, making our lives more connected and accessible than ever before. Embedded Systems Market size exceeded USD 100 billion in 2019 and is poised to grow at a CAGR of over 6% between 2020 and 2026. The rising trend of automation in the manufacturing sector to minimize energy, material, and labor waste is likely to accelerate the market demand. This makes organization's economy stable and keep the products in-demand as well.

## Chapter 2

# Overview of the Organization

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### **2.1 Brief History**

The GST number of the company is 23AADPI6382C1Z3 under name of Contrive Technologies. It is an active profit making organization with operations performed in Indore, M.P. and licensed under Government of India. Founded by Mr. Rajesh Murthy in 2007 as an industrial automation service provider and product manufacturer. Does commercials and marketing from Indore itself. Started the business with verticals like providing consultancy to industries on embedded technologies, Corporate training sessions for industries and organizations, take up training sessions in colleges / institutes on software development and Embedded Technologies. With its market presence is for around 13+ years, as an organization have developed high competence levels core embedded solutions for industrial automation needs.

### **2.2 Business Size**

Contrive Technologies is a private company established in 2007 with turnover of two crores to four crores approximately. It is involved in both manufacturing as well as third party work modes. More towards embedded software development with the strongest pillar as Research and Development on accurate solutions for problem statements. It is manufacturer and whole supplier for esteemed organizations in medical fields.

Design consultants to Shree Pacetronix Ltd (Pithampur, MP) for their design of Cardiac Pacemakers, Pacemaker programmers, ECG (Electro - Cardiograph) systems, CPAP / Bi-PAP machines etc. We have to our credit a full indigenous design of a Rate Responsive Cardiac Pacemaker and their ‘SMART’ Handheld Programmer for Shree Pacetronix ltd and their sister company – Biopace Technology Inc. Shree Pacetronix Ltd., A Company manufacturing quality Implantable Cardiac Pacemakers since 1988. On January 11th, 1988 the company was incorporated as a Pvt. Ltd. company. In 1993 the company was converted to a Public Limited Company. The company is listed on Bombay Stock Exchange and has strength of about 5500 shareholders today.

Number of permanent employees range between five to ten peoples but furthermore if counted the interns and temporary resource persons it scales up to higher and usually depend on project and product production requirements.

### 2.3 Production Lines

Company fulfills industrial automation in many ways which do not constrain to any specific technology. Not only electronics but the mechanics and mechanical models are also produced with other subsidiaries to give a customer whole product as a solution. Production line consists of all the subsystems required in a whole product design.

Some very much commercially products of company includes Blood Counter Monitor (BCM) made for sole purpose of convenience while blood donation facilities to weigh and mix the compound in blood and then seal it. It is a fully automated process designed and developed in organization's in house production line. Second machine in same domain which is another milestone is ESR machine used for automatically generate test reports of multiple blood samples using product which is again manufactured in the company.

Another in demand and a best in class product is Automated Weather Station (AWS). This product is not only best in class in terms of features and technology but have also been approved and certified by ICMR for the proven performance and much accurate statistics provided by the product. This is also designed, developed as well as deployed in the production line of Contrive Technologies.

Designed with the whole in-house R&D, the Elevator control boards which is again an acute and complete solution for overall elevator vertical transportation industry which includes all the domain like door drives, VFD drives, Display systems including Capacitive touch screens, Graphical LCD, Dot Matrix etc. Exclusively designed for the running environment and thus is a robust embedded system which is first simulated and tested in organization itself. Graded for high safety features and user convenience. Proven field tests and running without any major failure till date with lowest possible maintenance requirements. Other than these there many other products queued.

## 2.4 Competitors

Companies which are in same domain and with similar scale which work on nearly same technologies and therefore a healthy competition is appreciated. Competitors such as Embedded Technology Labs Pvt. Ltd., Advantal Technologies, Bit vivid, and Custom Devices etc. gives a healthy competition to the organization.

## 2.5 Brief summary of all the departments

Since the work which organization is of whole product design there are different departments regarding the tasks and expertise of technology required.

Research and Development department is responsible for generating a primary solution and a raw idea how the solution shall be proceeded and also works with the client closely for obtaining crystal clear image of requirements and technologies which can be implemented. In this department engineers have an acute idea of what needs to be done and how.

Embedded Software Developers' team converts the modules into working functions and come up with solution in form of working codes, scenarios, simulation, as well as instrumentation readings if in case logics needs to be analyzed. Whole team is interconnected and have to report to leads and Leads report and discuss with R&D team to keep track of the work is in right direction.

Hardware Design Department is responsible for works like PCB designing, prototyping models as well as embedded systems. Simulation and design for and aesthetic mechanics if required in way to develop a product. Also if in case while development hardware debugging is required in prototyping stage this department sees over it. Also responsible etching and drilling of handmade Printed Circuit Boards.

Assembling department, it is responsible for repetitive assembling soldering of manufactured Printed Circuit Boards (PCB) since organization is in-house production facility and some products continuously needs to be manufactured therefore a whole department is dedicated to it.

Testing department is responsible for Quality Check measures and find defect in both hardware as well as software.

## Chapter 3

### Plan of Internship Program

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I did my internship in Embedded Software Development so all my major tasks were for firmware development along with management of software codes written for microcontrollers. The base and the Operating System used was a flavor of Linux and its distribution is well known as Ubuntu 20.04 LTS. Working with advance microcontrollers and programming in advance C programming language with some portion of C++ as (OOPS) Object Oriented Programming Language. The advance microcontroller programmed and on which Real Time Operating System (RTOS) was integrated are STM32 series controllers with Arm based architecture and CPU which was Cortex M series.

My Internship period was 14 weeks starting from 19<sup>th</sup> January 2021 to 31<sup>st</sup> May 2021 which contains some minor discontinuation.

I worked in Embedded Software Development department which was responsible for firmware development, debugging, logic analyzing, source code management, continuous integration and building source codes. Programming the controllers and then checking the logics running according to requirement was major task of the day. This department was supervised by R&D head and CTO of the organization. All the monitoring tools such as pulse view analyzers, Task Thread analyzer, Logic analyzers, Cathode Ray Oscilloscope, Function Generator, and Multi-meter was used in daily basis and were taught to use appropriately. Source code management tools like Git and GitHub used for daily code commits. The controllers on which product was build was STM32M730V8T6 which has Arm Cortex M7 CPU of 216 MHz speed. All the software packages and dependencies installation was taught from scratch and was purely industrial environment which is therefore Linux based systems and Open Source Software and Freeware is used. The complex and advance C programming was taught and some conceptual experience was obtained while solving bugs and errors which is common in a real job scenario. Moreover training others as a secondary job role for the embedded system domain. Also was involved in some corporate training held in institutes in which setup installation practical lab sessions were arranged for client.

# Chapter 4

## Training Program

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### 4.1 Introduction

The whole training program was concentrated on Embedded Software Development and adapt the industrial requirements and learn concepts of advance C and advance Microcontrollers. Also the essentials of problem solving capabilities and debugging the systems using minimal tools and resources. To divide the main problem statement into smaller modules and then turning them into functions and forming a prototype. Dry running the actual prototypes and ensure the success of task and match the clients' requirements. Learning of Object Oriented Programming Concepts and their implementation in Embedded Systems. The Importance of Linux in field of any software development process was made to be realized and thus the program was designed to make intern gain experience on each it. Undergoing the whole Software Development Life Cycle (SDLC) makes the way for problem solving mindset and thus is also an important fundamental part which was implemented in the training program.

### 4.2 Prerequisites

To start over directly with advance modules is not recommended and thus there are some prerequisites of the training program. Fortunately all of the prerequisites get completed in college itself and thus I was able to pursue with the training program. Some of them are Understanding of C language and have a sound proficiency in it. Individual is expected to have good problem solving skills. Knowledge of at least one advance microcontroller and bare metal programming in it. In my case I had my minor project over PIC microcontroller thus was beneficial to me. Studied Digital Electronics, PCB designing, Control Systems, Electronic Devices and Circuits (EDC), Sensors and actuators, and Lab experience over using basic tools and inventory like CRO, Function Generator, Multimeter, and solder iron etc. These all requirements were fulfilled because all these things are taught in College with major subjects and laboratory experiments.

### 4.3 Duties and Responsibility

Embedded developers write code and programs that make devices in a variety of industries function as intended. As more and more devices use integrated or embedded computer software, embedded developers write programs for use in a variety of industries ranging from personal communications to transportation, defense, and medical settings. Embedded developers typically use the C and C++ programming languages. This role requires a great deal of collaboration, as embedded developers work with teams that include hardware engineers, manufacturing units, and user interface and experience professionals to ensure that software and hardware elements work together reliably and efficiently.

Design and implement software of embedded devices and systems from requirements to production and commercial deployment, design, develop, code, test and debug system software, Review code and design, Analyze and enhance efficiency, stability and scalability of system resources Integrate and validate new product designs, Support software QA and optimize I/O performance, Provide post production support, Interface with hardware design and development, Assess third party and open source software.

Embedded software needs to include all needed device drivers at manufacturing time, and the device drivers are written for the various hardware devices. These device drivers, called BSP (Board support package), form the layer of software containing hardware-specific drivers and other routines that allow a particular operating system (traditionally a real-time operating system, or RTOS) to function in a particular hardware environment (a computer or CPU card), integrated with the RTOS itself. The software is highly dependent on the CPU and specific chips chosen. Most embedded software engineers have at least a passing knowledge of reading schematics, and reading data sheets for components to determine usage of registers and communication system. Conversion between decimal, hexadecimal and binary is useful as well as using bit manipulation. Software development requires use of a cross compiler, which runs on a computer but produces executable code for the target device. Software development requires use of a cross compiler, which runs on a computer but produces executable code for the target device.

Debugging requires use of an in-circuit emulator, and debugging hardware such as JTAG or SWD debuggers. Software developers often have access to the complete kernel (OS) source code. Embedded debugging may be performed at different levels, depending on the facilities available. The different metrics that characterize the different forms of embedded debugging are: does it slow down the main application, how close is the debugged system or application to the actual system or application, how expressive are the triggers that can be set for debugging (e.g., inspecting the memory when a particular program counter value is reached), and what can be inspected in the debugging process (such as, only memory, or memory and registers, etc.).

Embedded software developers are responsible for designing, developing, optimizing and implementing the software that is programmed into devices built around a microprocessor. Write code to solve problems and implement systems that make a physical hardware device work through software. Take the concept right through to delivery; from the briefing, writing, testing and fixing stages to final release. In general terms, aim is to ensure embedded software accomplishes desired goals, exploiting the full potential of the hardware for the benefit of the user. Embedded software development demands patience and attention to detail. For embedded software developers, submitting a software patch is usually difficult or not an option at all. There are no re-releases once it leaves your charge. It has to be right. This translates into long and thorough release and testing cycles because often there are no second chances. Patience and focus therefore are essential virtues. But the satisfaction at the end of the project is immense. Having something tangible, operable and functional directly resulting from your own creativity and hard work is a rewarding experience. Embedded software's main objective is to control and/or manage a hardware device. Therefore it is optimized to meet the specific needs of embedded systems, all for the benefit of its user. Thus, even if embedded software engineers work on PCs, they do not code for PCs; their software runs on other platforms (e.g. an electronic board with a microcontroller). Specifically, embedded software developers flash their binary executable files on an electronic circuit board for example. They do this using debugging tools or through specific ports. Embedded developers constantly work to enhance the reliability, efficiency, and scalability of their programs.

## 4.4 Project Assigned

A Flat-bed printer control system was needed to be designed according to the client's requirement. This project was very complex and assigned after training and experience on other projects. It was implemented using STM32F730V8T6 an Arm Cortex M7 based controller. It consisted of many complex and time critical task which were needed to be handled precisely. Therefore Real Time Operating System was implemented in the project. The RTOS used here is FreeRTOS.

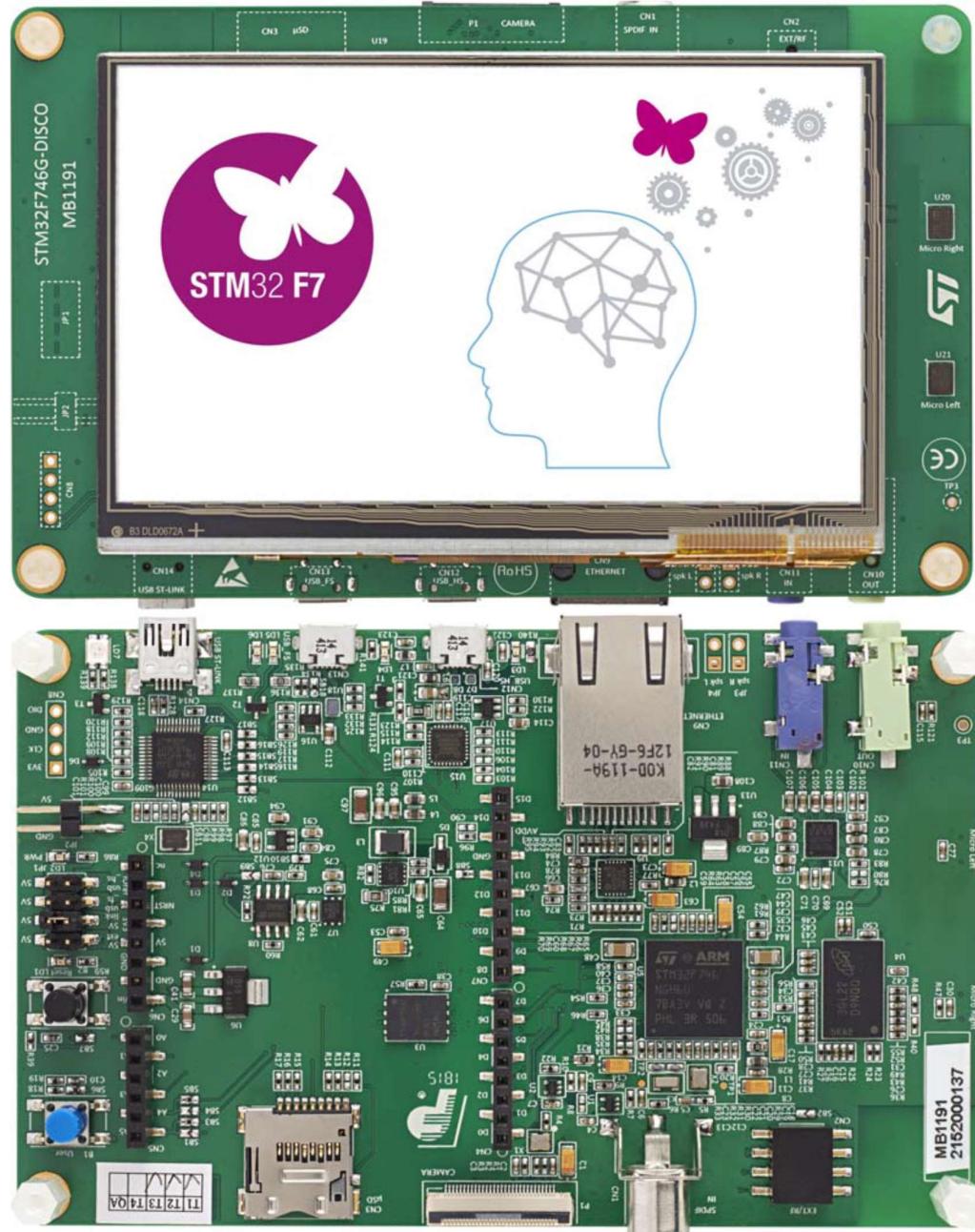


Fig 4.3.2 Touch Screen (Datasheet Mentioned) Back Pane

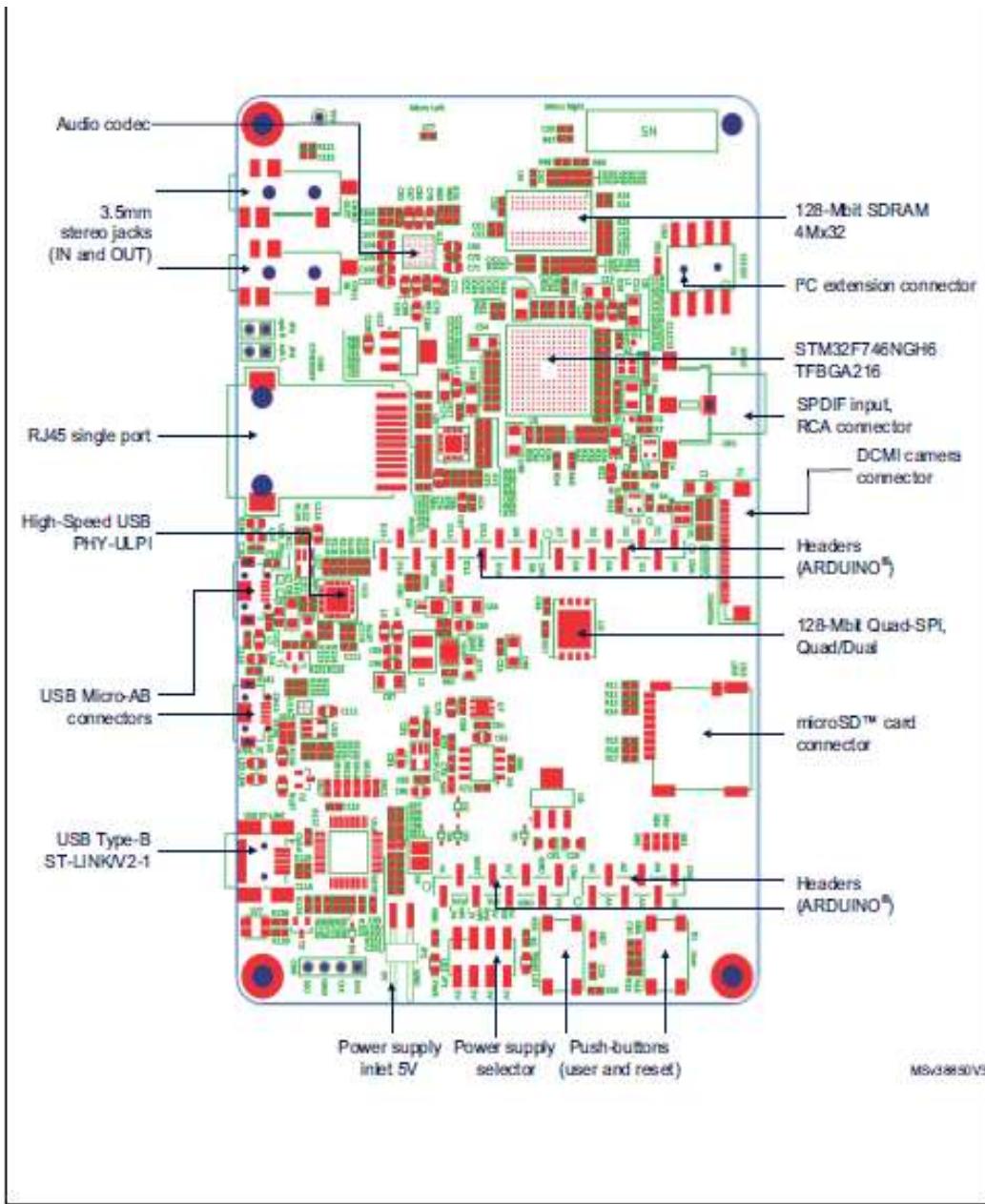


Fig 4.3.3 32F746GDISCOVERY Discovery board layout

Flatbed digital printers, also known as flatbed printers or flatbed UV printers, are printers characterized by a flat surface upon which a material is placed to be printed on. Flatbed printers are capable of printing on a wide variety of materials such as photographic paper, film, cloth, plastic, pvc, acrylic, glass, ceramic, metal, wood, leather, etc.). Flatbed digital printers usually use UV curable inks made of acrylic monomers that are then exposed to strong UV-light to cure, or polymerize them. This process allows for printing on a wide variety of surfaces such as wood or canvas, carpet,

tile, and even glass. The adjustable printing bed makes it possible to print on surfaces ranging in thickness from a sheet of paper often up to as much as several inches. Typically used for commercial applications (retail and event signage), flatbed printing is often a substitute for screen-printing. Since no printing plates or silkscreens must be produced, digital printing technology allows shorter runs of signs to be produced economically. Many of the high-end flatbed printers allow for roll-feed, allowing for unattended printing.

As per requirement we had only to design the control system board which was an embedded system based solution. The board was designed and populated by Hardware design team and then once tested ok come to our department. The schematics and printed circuit board layout was designed in Altium Designer 2020 and routed in the same. The whole board was populated in assembling department since all the components were soldered and placed with initial Quality Check undergone once.

The programming done was in C language and internal architecture of code is depended on the Hardware Abstraction Layer (HAL) library which is supported by STM32 controllers. Integrated Development Environment (IDE) used for writing, compiling and flashing code was uVision Keil Microcontroller Development Kit (MDK) for Advance RISK Machine (ARM) version five.



Fig 4.4.3: ST-Link version 2 Downloader / Programmer / Simulator

It has a port exposed to directly connect STLINK which is a high voltage programmer for STM32 microcontrollers. On software side it is supported by all the IDE(s) hence can be compiled and programmed at once from same platform

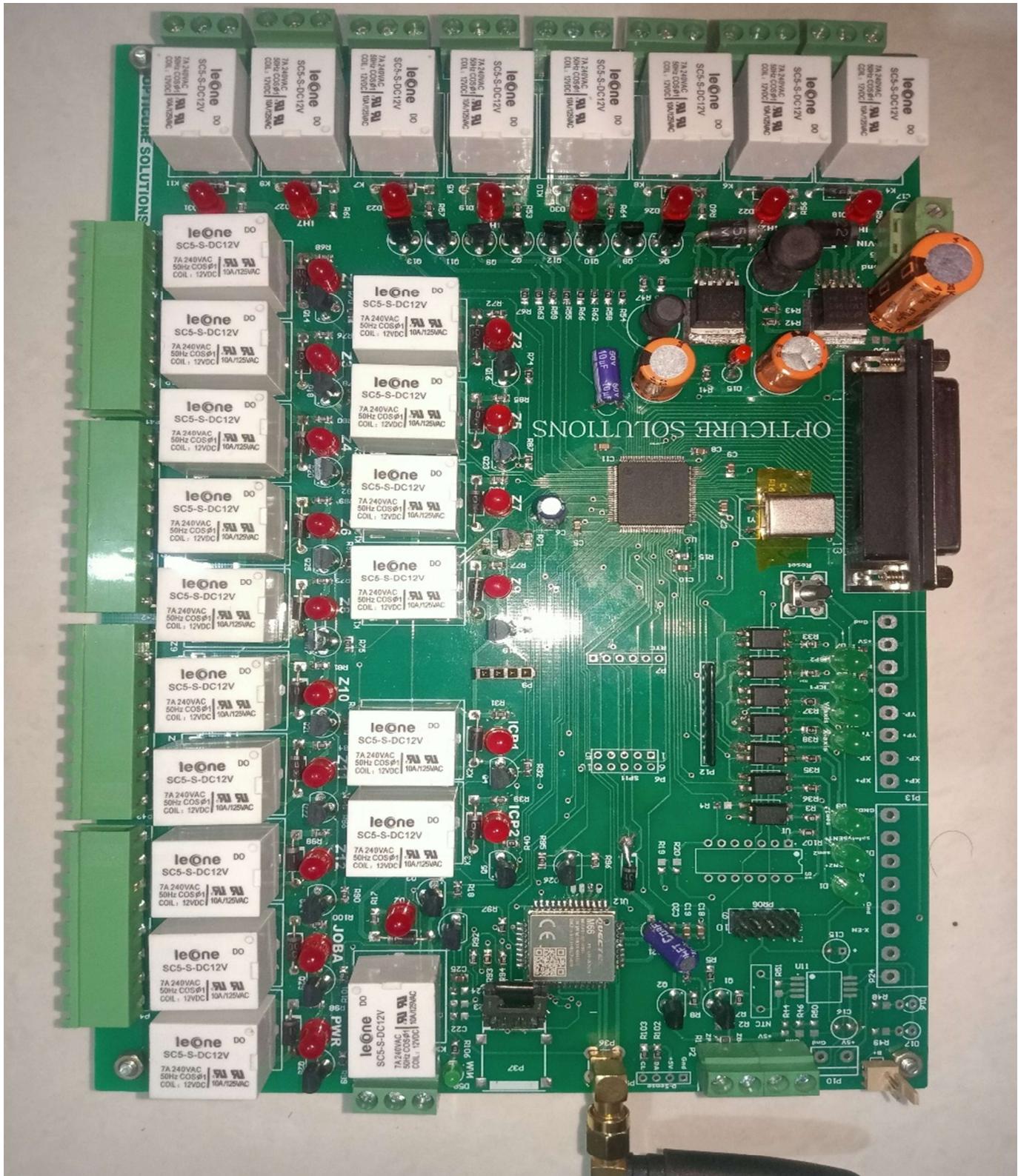


Fig 4.4.4: Control Board (populated PCB) for Flatbed Printer

## Chapter 5

### Learning Experience

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#### 5.1 Knowledge Acquired

A training in any field always gives knowledge that is quite new and beneficial for us. When it comes to an academic training, it helps us a lot in our further journey. Being from a Mechatronics background my industrial training with Contrive Technologies gave me satisfactory exposure. The working environment that I should be now habitual of was very necessary for me as very soon I could be working for a Core Company once I complete my graduation. Whole learning experience was structured and was a step by step systematic approach towards the settling of an Intern. All the process, training, execution, and experiments were guided and supervised by the industry mentors very well and gave a valuable learning for lifetime.

In order to get things done in an appropriate manner, proper steps are also to be taken. First getting inculcated with the fact that we might be working for a Core company and then in the last semester of our engineering getting chance to work for an industry of our choice was really good. Working on Embedded Software / Firmware Development with the rigorous training and challenging problems and coping with all of them was a great experience and most valuable since it increased my acceptance in industry

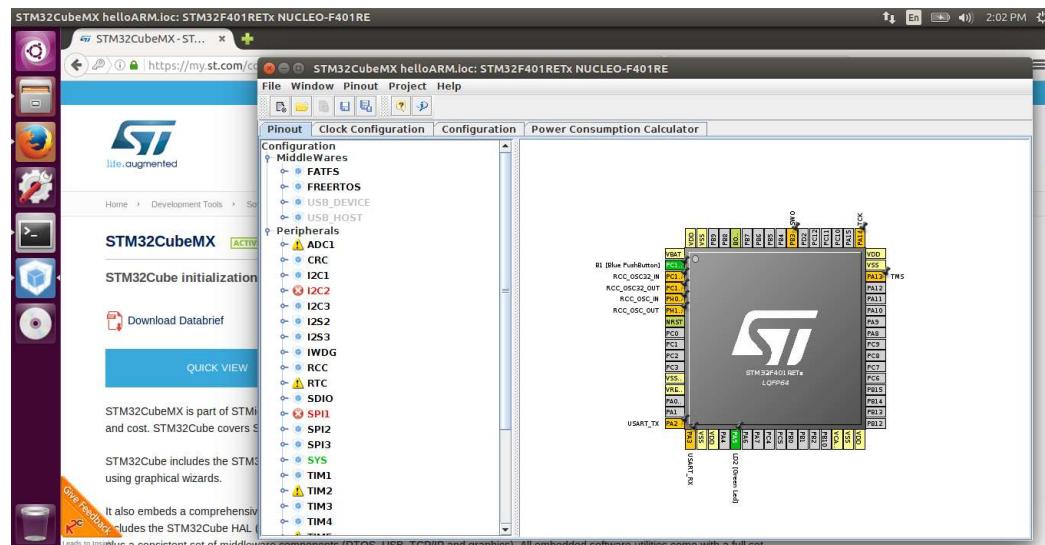
Some key factors in Internship included the professional environment and setting, the way communication is held was lot more different from college experience. Moreover our network grows in the same field in which we would be stepping in, so it comes out to be a major advantage. Working independently and overcoming the spoon feeding mindset which students may have is crucial attribute learned during the internship.

Technical area also gets strengthens very much as I learned the project management, software development life cycle, approach towards a problem statement given and many more. Analyzing the flow charts and converting them into algorithms is the most important thing I learned because it is independent of any technology and programming language. It is a part of planning and design which is must before we straight away rush towards writing source code and then getting messed up.

## 5.2 Skills Learned

Embedded software engineers today still need the skills of low level Hardware / Software programming at the register level, but the skills requirements are continuing to expand. Embedded engineers today are expected to be familiar with open source technology, such as Linux, or RISC-V. In fact, open source technology and licensing is becoming ubiquitous in embedded software. Also, software optimization skills at the SoC level are increasingly important for both performance, memory and increasingly power optimization. System-level thinking will be more important as embedded engineers are asked to do more with dedicated hardware accelerators like GPU, DSP, video, vision, security, and neural network accelerators. Building hardware/software systems utilizing these blocks for optimized use cases will increasingly be the norm in embedded computing.

For initial setup installation of propriety tools required and there drivers with all other tools and software packages. This should be well known to developer thus was one of the fundamental part. This propriety tools for STM32 microcontrollers were STM32 CubeMx which is Code configure tool which allows us to set the GPIOs and many more properties graphically. It required Java installed in system to run the program Therefore Java Development Kit (JDK 9) needs to be installed firstly and is also recommended to have Java Runtime Environment (JRE). It supports both Linux as well as Windows OS.



*Fig 5.2.1: STM32 Cube MX on Ubuntu Linux Distribution.*

The IDE used which is installed and run on Windows 10 operating system.

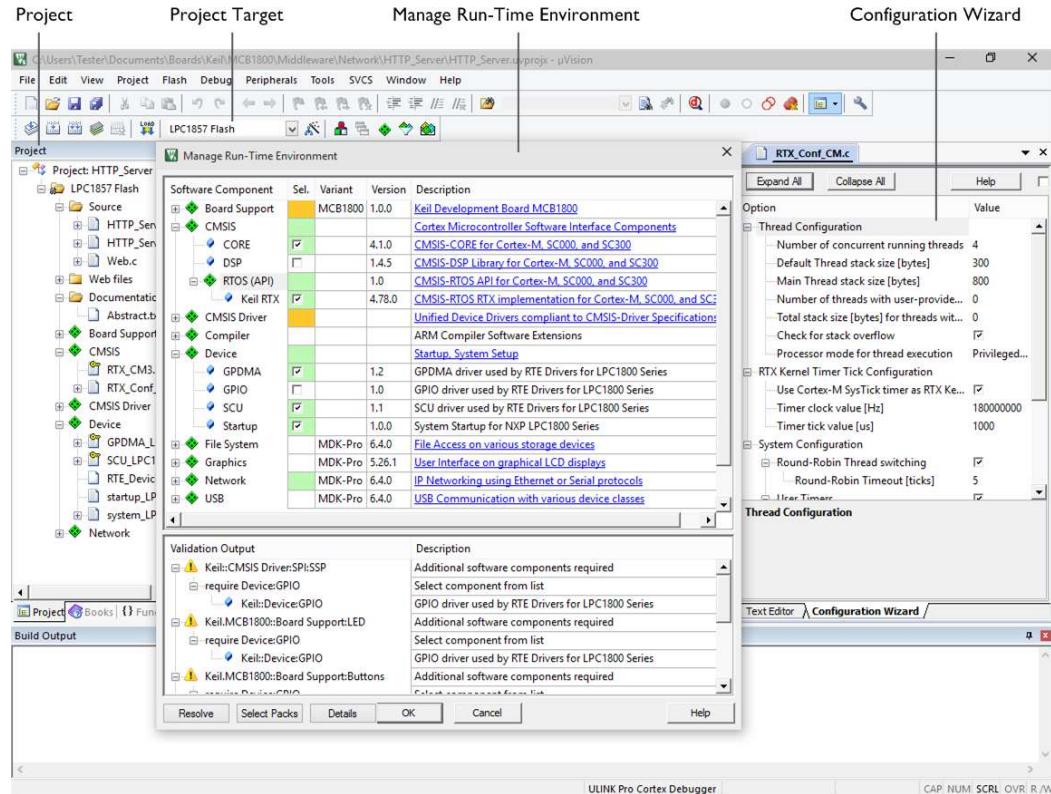


Fig 5.2.2: *μ*Vision Keil version 5 MDK-ARM

The touch screen configure tool and designer with code generator inbuilt – Touch GFX designer provided by STMicroelectronics for touch and graphical user interface design

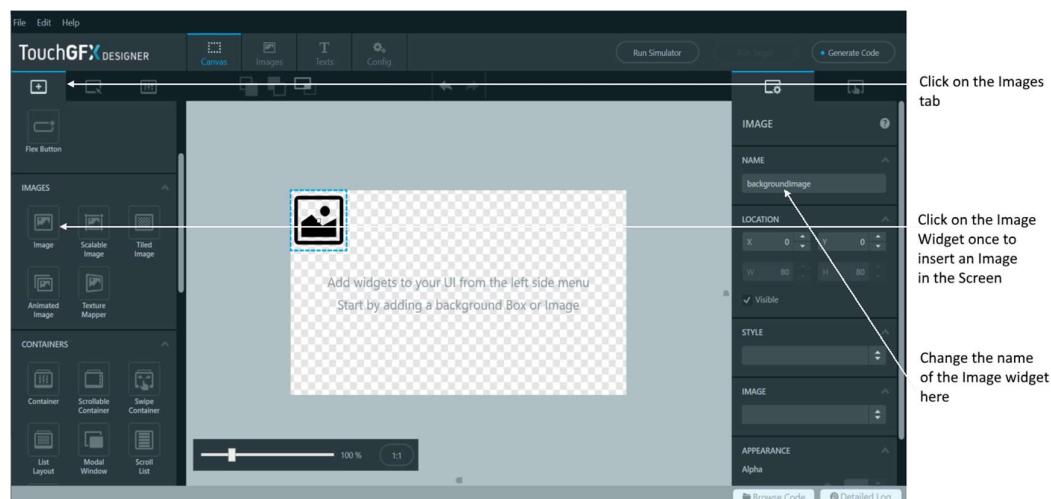


Fig 5.2.3: Touch GFX designer with simulation / programmer / code generation.

### 5.3 Observed Attitudes and Values Gained

When we follow a schedule on regular basis, it very easily becomes a part of our life. Same happened with me too as I did internship Contrive Technologies. The mindset behind the course was very simple and challenging too at the same time. To cover most of the portion of the course was the clear mindset with a confidence to get it done with full efficiency. With greater challenges comes greater demands from within. The above mentioned task could have not been possible without the required hard work and dedication to the work. It was my strong willing and desire to cover as much as I could. Many times it happened that the task was to be carried by me alone and with no colleagues of mine with near me. This challenge has built a new me during this internship. I succeeded in gaining the trust of my mentor and colleagues as well. Since the given task to me in the absence of any senior or even my mentor was carried out by me with a good and positive attitude and with minimum or even no error sometimes. Often what we think being spoon-fed is the way to learn, but working independently has proved to be very important. My internship taught me to make my own decisions and do things on my own. Being able to work independently with little guidance is very important in the working world. Honesty towards my work is something I have achieved, I would say, during this period. As being a student we people are not always honest towards our work but the desire to learn something new and more over something from foreign domain has made me honest towards work. Other could be the adaptability. As an intern, I was asked to be a part of other department learning, the previous day I wasn't part of. While I may have an interest in a particular aspect of the internship, a willingness to become familiar with the different parts of an organization is definitely viewed as an asset and also increases my exposure within the company. Although above things sounds good and motivating but none of them could be achieved without the punctuality. As an intern, I was both a guest in a new environment and a colleague on whom others must rely — I made sure that I respect those colleagues by being on time. This not only keeps the rules and regulation of the work place but also helps in maintaining a good and healthy environment within the work place. Consistently punctuality is a critical success factor. One of the important and very essential attitude and value gained in this industrial internship is nothing but the professionalism.

Being on the verge of joining and becoming a part of an Core industry this quality has to be build up in me and this working environment and type of work I was given has played a role in building up this attitude of being professional.

## 5.4 The Most Challenging Task Performed

It is always observed that a fresh new start is easier than to get hold or catch the bug in running environment. This was practically experienced by me as I encountered my most challenging task in my internship process. The same project needed to be interfaced by a new sensor and have to establish communication between main board and that sensor module. The challenge which I faced was even if my code was reviewed by the senior members and was running accordingly the values were disrupted. Therefore I needed to use debugging skills such as see the pulses coming and decoding the binary logic using Cathode Ray Oscilloscope (CRO). The basic learning in college was very helpful for the sole purpose because I had to work there independently. This challenge was overcame by me by indulging many logic maps, reading documentation searching on internet if any other people have encountered same problem on Open Source Platforms. This issue stands resolved as a design flaw and a problem in hardware which was miss-populated resistor values. However the industry mentors stands impressed after this and courtesy to the basics of the subject which helped me overcome the pinch.



*Fig 5.4.1: Sample output screen (not actual protocol)*

Another challenging task was working with semaphore and mutex in real time operating system and also dealing with Inter Process Call (IPC) all of them core concepts of RTOS which overcame by going through thoroughly by documentation provided and getting hands on

# Chapter 6

## Strengths, Weaknesses, Opportunities, Threat, (SWOT) Analysis

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### 6.1 Strengths

When we discuss strengths, we're referring to a company's competitive advantages and distinctive competencies—that is, what the company does really well.

- Strong employee attitudes
- Excellent customer service
- Personal relationships with customers
- Leadership in product innovation
- Highly efficient, low-cost manufacturing
- High integrity
- Excellent place for fresher and interns to work as it gives personal attention on an individual.
- Works on latest technologies like touch screen, advance RISC machine, STM32, Altium Designer 20, Analyzers etc.
- Proven experience and post deployment support
- Goodwill of the organization is fair enough among the old customers and clients

### 6.2 Weakness

Weaknesses are the constraints that impede a company's success in a certain strategic direction—in other words, what the company does not do well.

- Limited product availability
- Lack of quantitative goals
- Reach to the target audience lacks in the organization
- Weak marketing and conventional methods for promotion of products and services
- Timeline and punctuality
- Presentation and feature description

### 6.3 Opportunities

- The business could also be developed internationally, building upon its strong global brand recognition. Contrive Technologies also has clients who are all over the country and it has a very good reputation among its clients too.
- Contrive Technologies provides a very good platform for any fresher and create a strong foundation for any fresher or trainee.
- Very good reputation in medical grade electronics and thus have many clients for the same domain. Organization also has developed implant grade medical and many life saving devices like BiPAP machines and Blood Counter Monitor (BCM).
- Have been recognized vendor of DRDO, India.

### 6.4 Threats

- Inadequate reach on targeted audience may lead to business loss and adversely affect the expansion of the company even though the production quality is best in class and affordable.
- Old marketing methodology may lead to wave off new orders and projects and may fail in the competitive world.

## Chapter 7

# Problem Identification and Solution

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### **7.1 Problem Identification**

Project management was the major problem identified by me. Since today many developers contributing to same complex structure of code needs a backup, secure integration, and management as well. It is a technical problem which was caused due to rushing towards completion of task anyhow. This reduces quality of product designed and scalability vanishes. Also feature addition is lesser possible and thus require lot of workforce. Thus results in delay and hinders the punctuality.

Developers also cannot work from home which has become very crucial nowadays and will continue to be a fundamental part even if pandemic normalize. In my case a costly hardware was provided for working and building projects from home when lockdown was implemented. But not possible give each and every guy to have the appropriate hardware.

Performance feedback is not bothered and according it credibility is missing which may lead to adverse effect on employee's determination and loyalty towards the organization and sometimes cause frustration and unhealthy competition environment. Therefore again time capability issues arises.

### **7.2 Consequences of the current problem**

Miss management of project leads to unequal distribution of workload over employees. For example at one instance some developer is very busy and had to overtime contribution while other has no work and testing or hardware team is idle with no work in hand and at other instance vice versa.

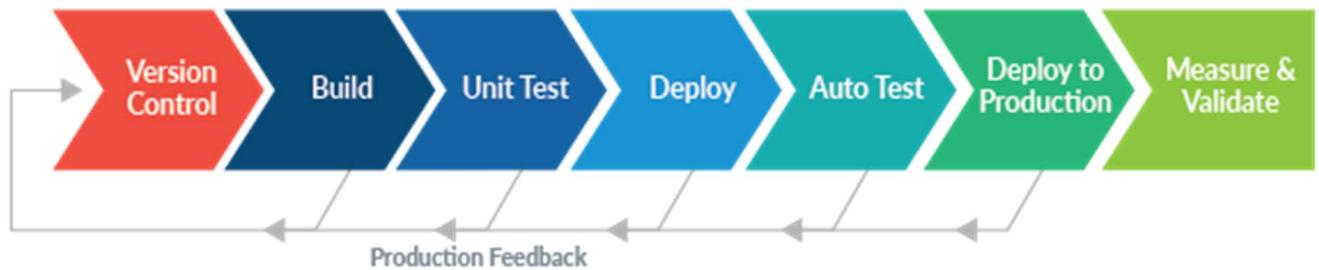
Loss of man-power and workforce with the time compatibility issues rise because of these culture. But still organization works because of determined members and overcome issues as all they are linked as if a family.

Individuals does only his/her part and thus have to be pushed for an all-rounder skill-set which helps organization which is a small scale organization and still in developing stage. Everyone shall be a full stack embedded developer there can perform outstanding in their individual job roles.

Currently these problem are overruled by the manual intervention and people need to be involved wasting a part of their time towards un-technical work. A manual supervision is also required all the time for purpose of continuous development.

### 7.3 Solutions

Proposed solution is using open source software tools for project management and continuous monitoring. Not only management is possible but also integration and building of the projects is also possible with test cases. Some suggested tools consists of Git, Gitlab, GitHub, JIRA, SCM (source code management), Ansible, Docker, Jenkins and building a Continuous Integration Pipeline using all these.



*Fig 7.3.1: Flow chart of proposed solution*

Once code is running, the next part of CI for embedded software is to make sure the code gets reasonable inputs from the world. Embedded software not only involves communicating with other code or other computer systems, but also an environment via sensors and other interfaces. Tests need to send representative data to the system under test, via the hardware interfaces used in the real system.

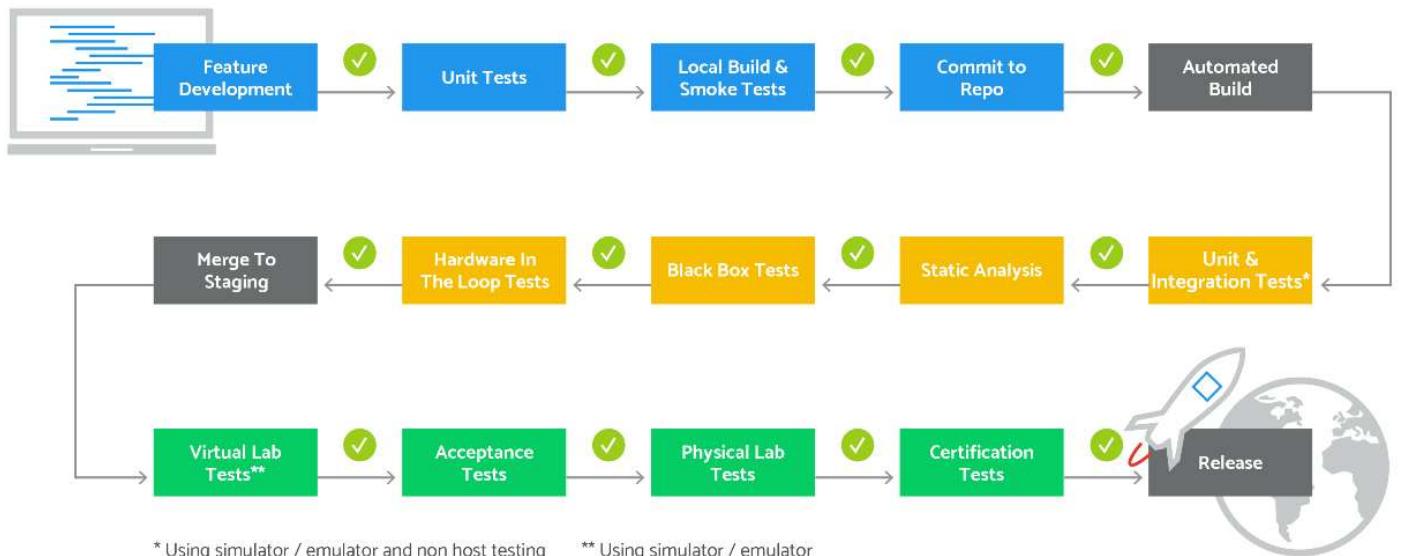


Fig 7.3.2: Ideal process followed by large scale MNC(s)

## Chapter 8

### Conclusion

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Working in the core domain gave me the knowledge to analyze my skills and learning which I have learnt in my engineering life. During my training period I learnt many of the basics topics and learned many of many of the software too. The most important thing I learned during this training period is how to analyses the things and learn them effectively. As being in the project based company it's the task of each and every employee to learn the new and updated technology with every new project. This provide the great opportunity to the employees as there learning period never ends and every time they use to get the new things to work with .The training period gave us the knowledge to how to work in the working live project, how to deal and maintain relationship with the customers, how to behave in the professional life and how to manage yourself while working in the corporate sector.

Taking everything in account I can conclude that this industrial internship is going to provide me a good exposure in my future career. This internship has been an excellent and beneficial experience.

While doing the project work I observed that it is not necessary that each and every time my mentor or my team mates are going to be with me to help me out whenever and wherever I get struck. The fact is that many time this happened that I was all alone to deal with a particular task that has to be carried out with the priority basis. These type of moments not only made me realize that dealing with problem is really important but also this has left an impact on me for rest of my life. Thus, after working in a real industry environment, I can say that I have gained a vast range of experiences from the company's atmosphere.

In the training we were provided with the different topics and we were asked to work in some of the small projects. Working in the live project enhances your skills professionally as well as personally. So this training helped me to learn many new technical things as well developed my personality according to work in the corporate sector.

## Chapter 9

### References and Sources Used

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- *Industry Mentor: Mr. Rajesh Murthy and Mr. Vinod Mehra*
- *College Mentor: Mr. Rohit Kanthaliya*
- <https://www.wikipedia.org/>
- <https://www.google.com/>
- <https://www.st.com/en/development-tools.html>
- <https://www.st.com/en/development-tools.html#documentation>
- *Datasheets and Internal IDE help section*
- <https://github.com/OjasKhamkar/>
- <https://aws.amazon.com/>
- <https://git-scm.com/>
- <https://www.jenkins.io/doc/>

## Appendices

### Fortnightly Report of the Student/Intern

(To be maintained by the Student / Intern)

	Period	Date from	Date to
Name of Industry Mentor with e-mail id	Eg, Vinod Mehra contriveindore @ gmail.com.	19 <sup>th</sup> Jan 2021	2nd Feb 2021
Main points of the fortnight	<p>TRAINING ON INDUSTRY ENVIRONMENT</p> <p>→ All the environments, code editor, assembler, TDF (s) and code configures made to be installed properly with all due configuration.</p> <p>→ Happening to be familiar with the environments of all controllers and their pinouts</p> <p>→ Some SPECIFIC THINGS LEARNED</p> <ul style="list-style-type: none"><li>• PIC 16F 15355 (PIC controllers by microchip and widely used.)</li><li>• PIC 16F 877A</li><li>• MPLAB X IDE (IDE for program)</li><li>• MPLAB X IPE (hex file burner)</li><li>• PicKit 3 (High Voltage code gen)</li><li>• Numerous Sensors like HALL-effect, Reed switches implemented.</li></ul>		



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## Fortnightly Report of the Student/Intern

*(To be maintained by the Student / Intern)*

	Period	Date from	Date to
Name of Industry Mentor with e-mail id	Mr. Rajesh Murthy contriveindore@gmail.com	19 <sup>th</sup> Jan 2021 3 <sup>rd</sup> Feb 2021	18 <sup>th</sup> Feb 2021
Main points of the fortnight	<p>Basic Overview training and mini-projects completed and handed over to Mr. respective commercials.</p> <p>Journey of actual Industrial controllers ARM (advance RISC machines) starts.</p> <p>KEY POINTS UNDERTAKEN :-</p> <ul style="list-style-type: none"> <li>→ Overview of Coding Platform           <ul style="list-style-type: none"> <li>↳ STM Cube MX (version 15.41)</li> <li>↳ STM Cube Programmer</li> <li>↳ MDK Arm (ukeiel) IDE.</li> </ul> </li> <li>→ Overview of hardware subsets           <ul style="list-style-type: none"> <li>↳ STLINK</li> <li>↳ Controllers exclusively used:               <ul style="list-style-type: none"> <li>* STM32F103CB76 (cortex M3)</li> <li>* STM32F407VE1G (cortex M4)</li> <li>* STM32F730V8T6 (cortex M7)</li> </ul> </li> </ul> </li> </ul>		



## Fortnightly Report of the Student/Intern

*(To be maintained by the Student / Intern)*

	Period	Date from	Date to
Name of Industry Mentor with e-mail id	Mr. Rajesh Murth, contriveindore@gmail.com	19 <sup>th</sup> Jan 2021 19 <sup>th</sup> Feb 2021	5 <sup>th</sup> March 2021.
Main points of the fortnight	<p>Basics of ARM controller series of STMicroelectronics completed with interfacing numerous peripherals like GPIO(s), I<sup>2</sup>C communication protocol, CAN (Controller Area Network) etc.</p> <p>Advance Embedded Software Development starts with the Real Time Operating Systems used (FREE-RTOs) in STM32 controllers.</p> <p>Indulging in commercial product development which are been developed all around core STM32 and many technologies like GSM / GPRS and communication protocols like CAN Controller Area Network 2.0 B.</p>		



## Fortnightly Report of the Student/Intern

*(To be maintained by the Student / Intern)*

	<b>Period</b>	<b>Date from</b>	<b>Date to</b>
Name of Industry Mentor with e-mail id	Mr. Pradeep H.N. pd@hivegenie.com	15 <sup>th</sup> March 2021	30 <sup>th</sup> march 2021
Main points of the fortnight	<p>Introduction to Linux System</p> <p>To work on Ubuntu 20.04 LTS operating system. Brief about command line interface and Bash Shell scripting. Using Ubuntu 20.04 LTS as OS. installations of proprietary tools.</p> <p>Knowledge of Software Development Life Cycle (SDLC) parsed and trained over the hierarchy of the company. Exposed to Object Oriented Programming and making C++ as a base language for development of projects. Understanding the documentation of the project and hierarchy followed in its Development.</p>		



## Fortnightly Report of the Student/Intern

	<b>Period</b>	<b>Date from</b>	<b>Date to</b>
Mr. Rajesh Murthy contriveindore@gmail.com	15 days	12 <sup>th</sup> April 2021	26 <sup>th</sup> April 2021
Main points of the fortnight	<p>Work from home initiated as Indore undergoes under lockdown. The Appropriate Hardware was provided by the respected company which is a discovery board by STMicroelectronics. About hardware provided: "STM32F746G -disco" capacitive touch screen based module. It contains on board programmer and debugger (STlink) and is programmed and debugged by Mini-B type USB cable. It has STM32F746NG as main microcontroller which is an Arm Cortex M7 based running at 216 MHz max clock frequency. It has 1 Mbyte of flash memory and 340 Kbytes of RAM in a BGA (Ball Grid Array) package. It has 4.3 inches RGB 480x272 color LCD-TFT with capacitive touch screen. Some more features :-</p> <ul style="list-style-type: none"> <li>• Ethernet compliant with IEEE-802.3-2002</li> <li>• SAI audio codec</li> <li>• Two ST-MEMS digital microphones</li> <li>• 128-Mbit Quad-SPI Flash memory</li> <li>• 128-Mbit SDRAM (64 Mbits accessible)</li> <li>• Two user and reset push-buttons</li> <li>• Board connectors: <ul style="list-style-type: none"> <li>– Camera</li> <li>– microSD™ card</li> <li>– RF-EEPROM daughterboard connector</li> <li>– 2×USB with Micro-AB</li> <li>– Ethernet RJ45</li> <li>– SPDIF RCA input connector</li> <li>– Audio line in and line out jack</li> <li>– Stereo speaker outputs</li> <li>– ARDUINO® Uno V3 expansion connectors</li> </ul> </li> </ul> <p>Software toolchains required to program, build application and debug it are TouchGFX – STM32 Advanced Graphical User Interface Designer and STM CubeIDE (Eclipse based IDE) with STM CubeMX (Code configurator). Installations and software management of these toolchains were understood during is period of internship.</p>		



## Fortnightly Report of the Student/Intern

	Period	Date from	Date to
Mr. Rajesh Murthy contriveindore@gmail.com	15 days	27 <sup>th</sup> April 2021	12 <sup>th</sup> May 2021
Main points of the fortnight	<p>Continuing with work from home on the same setup of Touch screen module "STM32F746N – Disco" board. Understanding the architecture of software framework and designer tool "TouchGFX" by STMicroelectronics. It generates some portion of basic architecture and skeleton code for us according the Graphical User Interface designed by us using its editor and widgets. The STM32 Graphical User interface offer is structured around the following pillars:</p> <ul style="list-style-type: none"> <li>• Industry's broadest advanced graphics-enabled MCU offer</li> <li>• State-of-the-art graphical development tools available for free</li> <li>• Support and documentation center</li> <li>• Reference designs and selected design partners</li> </ul> <p>With this we have all we need to do a full implementation of our GUI application for STM32 based hardware. TouchGFX consists of three main parts - two tools and one framework.</p> <ul style="list-style-type: none"> <li>• <b>TouchGFX Designer:</b> An easy-to-use GUI builder in TouchGFX that lets you create the visual appearance of your TouchGFX application.</li> <li>• <b>TouchGFX Generator:</b> A CubeMX plugin where the user can configure and generate a custom TouchGFX Abstraction Layer (AL) for their STM32-based hardware.</li> <li>• <b>TouchGFX Engine:</b> The TouchGFX C++ framework that drives the UI application. Handles screen updates, user events and timing. The advanced TouchGFX technology is optimized for STM32 microcontrollers, giving you maximum performance with minimum CPU load and memory usage.</li> </ul> <p>A TouchGFX project involves a set of activities that you will be addressing during the development phase. The effort in each of them are dependent on what the goal of your project is.</p>		





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## Fortnightly Report of the Student/Intern

	Period	Date from	Date to
Mr. Rajesh Murthy contriveindore@gmail.com	15 days	13 <sup>th</sup> May 2021	28 <sup>th</sup> May 2021
Main points of the fortnight	<p>In a simple device with the graphical user interface and only a few simple support tasks, like a timer, it is possible to structure the whole application around the user interface code. The application does very little besides the regular user interface updates, so the execution of the other tasks can with fair success be embedded into the user interface code. There we implement operating system for embedded system - RTOS</p> <p>A real-time operating system is a small piece of software that supports applications with various services and distributes computing resources to the tasks in the application. Using an RTOS allows you to structure your application in a number of independent, but cooperating tasks. These tasks are then executed concurrently by the RTOS when they have work to do and according to their priority.</p> <p>TouchGFX is tested with the FreeRTOS operating system during development. TouchGFX has very little requirements and can run on many other operating systems, but FreeRTOS is a good starting point unless you have some specific requirements. TouchGFX in its default configuration runs on FreeRTOS and uses a single message queue to synchronize with the display controller and a semaphore to guard the access to the framebuffer.</p> <p>FreeRTOS is a simple operating system that is free to use in commercial application. It is supplied in source code with the STM32 Cube firmware with ready to use examples for all STM32 microcontrollers. With proven robustness, tiny footprint, and wide device support, the FreeRTOS kernel is trusted by world-leading companies as the de facto standard for microcontrollers and small microprocessors.</p> <p>Understanding all the core concepts and fundamentals of OS like semaphores, mutex, IPC, threads, os-deadlock etc.</p>		





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**Form-II**

**INDUSTRY MENTOR EVALUATION OF INTERN**  
(To be printed on Organization Letter Head)

Student Name: Ojas Khamkar Date: 31/05/2021

Student Enrolment No. : 17010BTMX01947

Internship Address: \_\_\_\_\_

Dates of Internship: From 19<sup>th</sup> January 2021 To 31<sup>st</sup> May 2021

Please evaluate your intern by indicating the frequency with which you observed the following on a 10-point scale –

10– Outstanding, 9 – Excellent, 8 – Very Good, 7 – Good, 6 – Average, 5 – Satisfactory, below 5 Fail

S.No	Parameters for Evaluation	
1	Punctuality	9
2	Behavior	9
3	Shows interest in work	10
4	Learns quickly	9
5	Shows initiative	9
6	Accepts responsibility	10
7	Organizational skills	8
8	Creativity/Originality	8
9	Problem Analysis, Design, Solution	10
10	Communication Skill	9
	Overall performance of student / intern	
	<b>Total out of 100</b>	91

Additional comments, if any :

Name & Signature of Industry Supervisor: Mr. Rajesh Murthy



**Form-III**

**Feedback of Student on Internship**  
*(To be filled after completion of Internship)*

Student Name : OJAS KHAMKAR

Enrollment No.: 17010BTMX01947

Internship is:  with Stipend /  without Stipend

Company/Organization:

CONTRIVE TECHNOLOGIES.

Internship Address:

Faculty Coordinator : MR. ROHIT KANTHALIA

Department : ELECTRICAL & ELECTRONICS ENGG.

Dates of Internship : From 19th Jan To 31st May 2021

Give a brief description of your internship work (title and tasks for which you were responsible):

Was your internship experience related to your major area of study?

I was appointed as Embedded Software Development Intern for which the tasks and responsibilities was mainly focused over firmware development, source code integration and build management. It was related to my major area - Embedded Electronics.

- I. Yes, to a large degree
- II. Yes, to a slight degree
- III. No, not related at all

Indicate the degree to which you agree or disagree with the following statements.

This experience has:	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
Given me the opportunity to explore a career field		✓			
Allowed me to apply classroom theory to practice	✓				
Helped me develop my decision-making and problem-solving skills	✓				
Expanded my knowledge about the work world prior to permanent employment	✓				
Helped me develop my written and oral communication skills			✓		
Provided a chance to use leadership skills (influence others, develop ideas with others, stimulate decision-making and action)				✓	
Expanded my sensitivity to the ethical implications of the work involved		✓			
Made it possible for me to be more confident in new situations	✓				
Given me a chance to improve my interpersonal skills	✓				
Helped me learn to handle responsibility and use my time wisely	✓				
Helped me discover new aspects of myself that I didn't know existed before				✓	
Helped me develop new interests and abilities			✓		
Helped me clarify my career goals	✓				
Provided me with contacts which may lead to future employment	✓				
Allowed me to acquire information and/or use equipment not available at my Institute	✓				

### **Answer the Following Question**

- Q1. In the Institute internship program, faculty members are expected to be mentors for students. Do you feel that your faculty coordinator served such a function? Why or why not?

Without faculty coordinator's contribution the successful learning in Internship was not possible. Thus they served their role for which I am glad off.

- Q2. How well were you able to accomplish the initial goals, tasks and new skills that were set down in your learning contract?

The learning graph always starts with below and then gradually rises with time and dedication. This was applicable for me as well. At the I was able to accomplish each one them.

- Q3. In what ways were you able to take a new direction or expand beyond your contract?

The foothold which I got from this internship layed a foundation of my professional career in the core field by direction provided there.

- Q4. Why were some goals not accomplished adequately?

While most of the goals and target given or assigned to me were done to a satisfactory extent but couldn't accomplish adequately because of lack of experience.

- Q5. In what areas did you most develop and improve?

The areas which I developed most in this internship were problem analytics and solution skills with modular approach towards software development. also automation was major skill in which I felt confident enough to a permanent contact.

Q6. What has been the most significant accomplishment or satisfying moment of your internship?

Find the root cause of a bug arrived at runtime while development of a my project which came out to be a design flaw and which was then corrected.

Q7. What did you dislike about the internship? Considering your overall experience, how would you rate this internship? Give suggestions as to how your internship experience could have been improved.

I disliked the market approach of the internship, overall experience was good though and would rate 9/10. Suggested that the internship structure should be properly planned and organised.

Q8. Could you have handled added responsibility?

Yes, I was able to handle the responsibility due to prior training and work experience for which I also have been rewarded a good rating by industry.

Q9. Would you have liked more discussions with your professor concerning your internship?  
Was closer supervision needed?

Discussions was deep and meaningful and was satisfied by the supervision provided. Adding to point weekly log was also maintained by both the sides.

Q10. Was more of an orientation required?

No, the orientation and supervision provided was satisfactory and adequate enough for successful learning.

Date: 09/06/2021

  
Signature of the Student