CHAPTER 1

INTRODCTON

Accurate and secure attendance tracking is a critical component in academic institutions, workplaces, and other organizations. Traditional methods such as manual registers or RFID cards are prone to errors, proxy attendance, and data manipulation, making them unreliable for effective monitoring. With advancements in embedded systems and biometric technology, automated attendance systems have emerged as efficient solutions to these challenges.

Biometric attendance monitoring systems leverage unique physiological characteristics such as fingerprints for identification, ensuring a high level of security and eliminating the possibility of proxy attendance. Among various biometric modalities, fingerprint recognition is widely adopted due to its accuracy, ease of use, and low implementation cost.

This project presents the design and implementation of a fingerprint-based attendance monitoring system utilizing the ESP32 microcontroller, fingerprint sensor, LCD display, and a webpage. The ESP32 serves as the core controller, interfacing with the fingerprint sensor to authenticate users and using its built-in Wi-Fi capability to transmit attendance data to a remote server. An LCD display provides real-time feedback to users during the authentication process.

The proposed system offers a reliable, scalable, and cost-effective solution for automating attendance, enhancing administrative efficiency, and ensuring data integrity. Through the integration of biometric hardware with IoT and web technologies, this system supports real-time data storage, remote access, and long-term data management, making it ideal for educational and corporate environments.

CHAPTER 2

EXISTING METHODS

3.1 TRADITIONAL MANUAL ATTENDANCE SYSTEMS

Manual attendance systems are the oldest and most widely used methods in schools, colleges, and workplaces. These systems require an instructor, teacher, or supervisor to physically record attendance using registers, logbooks, or printed sheets. The process typically involves calling out names or roll numbers, to which individuals respond and are marked present or absent accordingly. Figure 3.1 illustrates a typical manual attendance register used in educational institutions.

Limitations:

- Time-consuming and labor-intensive
- Prone to human error and manipulation
- No real-time data tracking
- Difficult to manage and analyze large data sets

Figure 3.1 Manual Attendance Register

3.2 RFID-BASED ATTENDANCE SYSTEMS

RFID (Radio Frequency Identification) attendance systems use ID cards embedded with RFID tags. Users tap or swipe their cards at an RFID reader, which logs their attendance. Figure 3.2 shows a typical RFID reader setup. While this method offers simplicity and automation, it comes with several limitations. One significant drawback is the potential for proxy attendance, where individuals can misuse the system by swiping cards on behalf of others. Additionally, RFID systems lack biometric authentication, meaning the system cannot verify the true identity of the person using the card. RFID cards are prone to loss, theft, or damage, leading to increased costs for reissuance and the risk of unauthorized access if lost cards are misused.

Limitations:

- Possibility of card swapping (proxy attendance)
- Additional cost for card issuance and replacement
- No biometric validation
- Requires physical interaction (card tap)

Figure 3.2 RFID-based AT SYSTEM

CHAPTER 3

PROPOSED METHOD

4.1 METHODOLOGY

To enhance the limitations of traditional attendance tracking systems, we developed a biometric attendance monitoring system centered around the ESP32 microcontroller, a fingerprint sensor such as the R305, LiquidCrystal_I2C display, and a web interface for real-time data monitoring. This system, illustrated in Figure 4.1, ensures secure, reliable, and contactless attendance management.

The process begins with fingerprint enrollment, where each user registers their fingerprint through the biometric sensor. When a user places their finger on the sensor, it captures and processes the fingerprint image to generate a unique template. This fingerprint template is stored within the sensor's internal memory, assigned to a specific user ID. Upon successful registration, a confirmation message is displayed on the LCD screen, and the enrollment data is also transmitted to a remote database over Wi-Fi. This enrollment step ensures that only verified individuals are added to the attendance system.

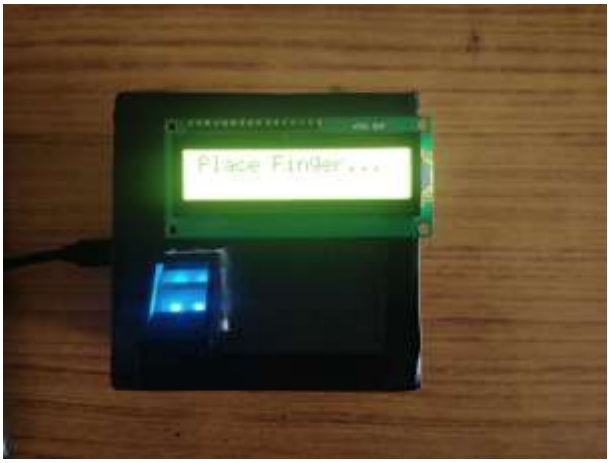

Figure 4.1 PROPOSED BIOMETRIC ATTENDANCE MONITORING SYSTEM

During the authentication process, users simply place their finger on the sensor. The system scans the fingerprint and compares it with the templates already stored in memory. If a valid match is detected, the user's attendance is logged, and a success message such as "Attendance Marked" or the person's name appears on the LCD. The attendance data is simultaneously sent to a remote server through the ESP32's Wi-Fi module, ensuring real-time database updates. In cases where no match is found, the system displays a "Fingerprint Not Valid" message and does not record attendance, thereby preventing unauthorized access and proxy entries.

A key component of this system is the web server integration, which provides a user-friendly dashboard developed using HTML, CSS, SPIFFS. This dashboard allows administrators to view attendance logs in real time, manage user data (including adding or deleting users), and monitor the overall health and operational status of the system. Administrators can also switch between enrollment mode and attendance mode remotely. Communication between the ESP32 and the server is handled securely via HTTP POST requests, maintaining the integrity of data transmission. Figure 4.2 shows Biometric Attendance Monitoring System Webpage

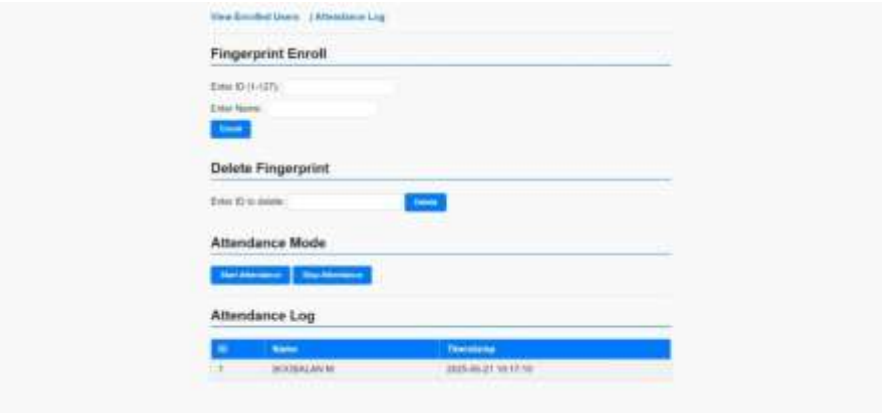

Figure 4.2 BIOMETRIC ATTENDANCE MONITORING SYSTEM WEBPAGE

The system features a 16x2 or 20x4 LCD display with an I2C interface, which offers clear and immediate visual feedback. It displays welcome messages, operational statuses during enrollment and authentication, and system notifications such as “Sensor Error” or “Wi-Fi Not Connected.” This ensures that users are well-informed throughout the interaction and enhances the overall usability of the system in various deployment settings such as schools, universities, and offices. Figure 4.3 shows LCD Display of attendance monitoring

This biometric attendance monitoring solution offers several distinct advantages. It eliminates proxy attendance and manual entry errors, supports hygienic and contactless operation, and allows real-time monitoring from any location via the internet. Additionally, it is cost-effective, requires minimal maintenance, and can be easily scaled to accommodate larger institutions.

Figure 4.3 DISPLAY OF ATTENDANCE MONITORING SYSTEM

4.2 FLOW DIAGRAM OF ATTENDANCE MONITORING SYSTEM

The flowchart in Figure 4.4 illustrates the operational workflow of the proposed Biometric Attendance Monitoring System. The process begins with the system determining whether the user is new. If the user is new to the system, it enters the enrollment Mode; otherwise, it proceeds directly to Attendance Mode. In enrollment Mode, the system guides the user through a structured sequence of steps. First, the system enters the user management stage, where administrative options such as adding a new user are handled. The user then selects their department, enters a unique fingerprint ID, and scans their fingerprint using the biometric sensor. Once the fingerprint is successfully captured, the user enters additional personal details required for identification. After completing these steps, a unique User ID is assigned and stored in the sensor and the database.

The system then returns to the main menu, ready for the next user or action. If the user is not new, the system proceeds to Attendance Mode, where the user is prompted to scan their fingerprint. The fingerprint is matched against the previously stored templates in the system's memory. If a match is found, the system displays a Welcome Message, confirming successful authentication, and logs the attendance by storing the data in the central database via Wi-Fi. If no match is found, the system displays a User Not Found message, denying access and preventing false attendance logging.

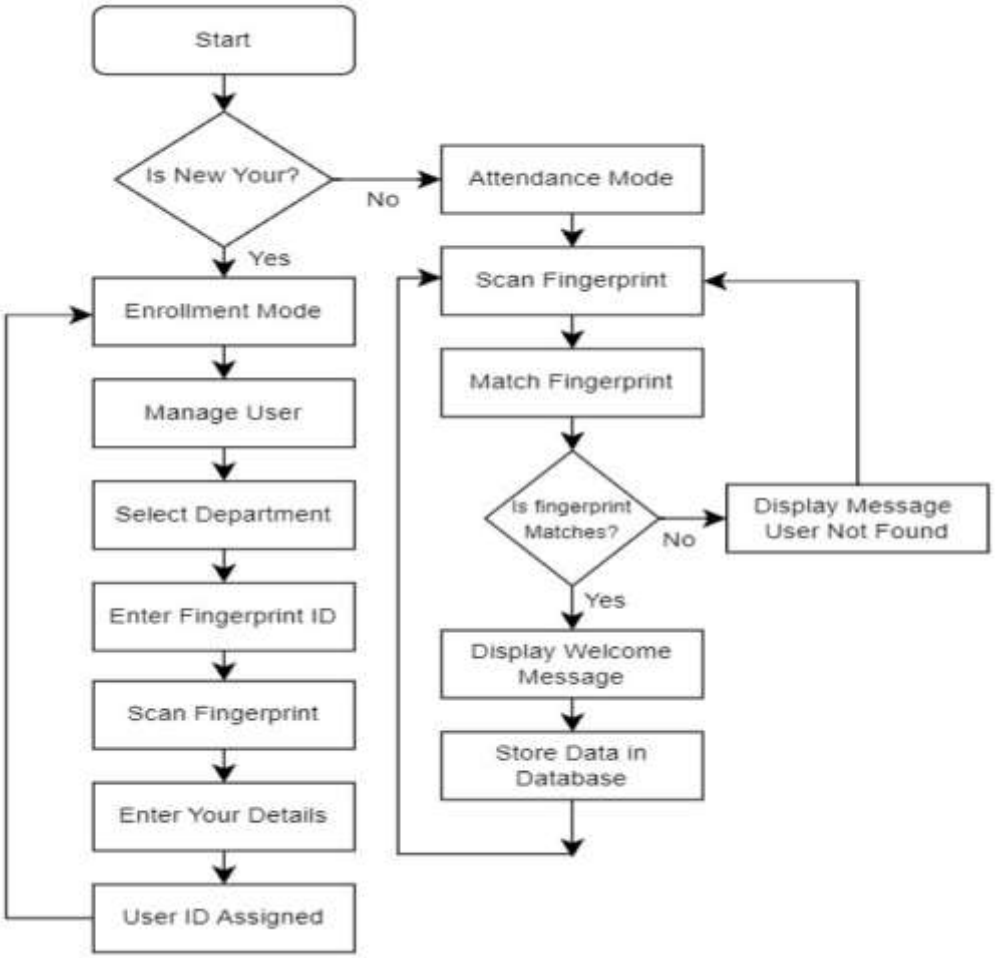

Figure 4.4 FLOW DIAGRAM OF ATTENDANCE MONITORING SYSTEM

4.3 BLOCK DIAGRAM OF ATTENDANCE MONITORING SYSTEM

The block diagram in Figure 4.5 illustrates the hardware architecture of the proposed Biometric Attendance Monitoring System. At the core of the system is the ESP32 microcontroller, which coordinates communication between all components. The system is powered by a stable power supply that ensures uninterrupted operation of all modules.

A fingerprint sensor is connected to the ESP32, allowing users to enroll and authenticate their identities through biometric data. The captured fingerprint is processed by the ESP32, which then makes decisions based on the match results. Feedback to the user is provided via an LCD display, which shows messages such as enrollment status, authentication confirmation, or error notifications.

Furthermore, the ESP32 is connected to a web server over Wi-Fi, enabling real-time communication with a remote database. This allows seamless logging of attendance records and system monitoring through a dedicated website interface.

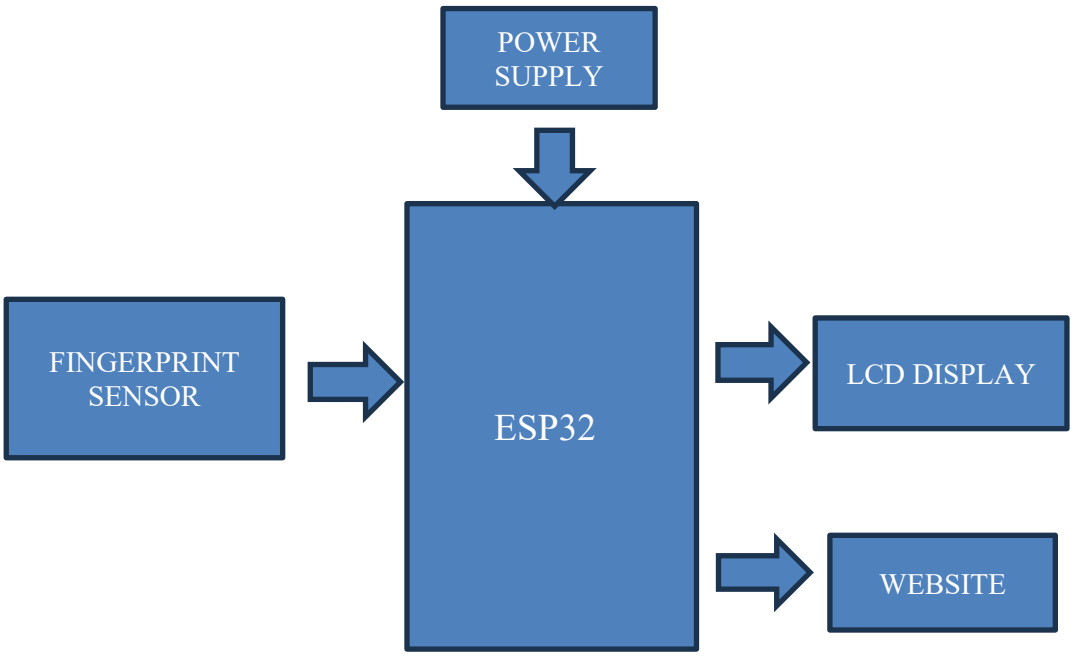

Figure 4.5 BLOCK DIAGRAM OF ATTENDANCE MONITORING SYSTEM

CHAPTER 4

RESULTS AND DISCUSSION

The proposed biometric attendance system was successfully implemented and tested. The system components, including the ESP32 microcontroller, fingerprint sensor, and LCD display, were integrated and validated through rigorous testing. The ESP32 was programmed to handle fingerprint enrollment, verification, and real-time communication with a remote server via Wi-Fi. A web-based interface was developed for administrators to manage user data, view attendance logs, and control system modes (enrollment or authentication). The fingerprint data was securely transmitted to webpage and server. The LCD display provided user feedback during scanning, displaying messages such as “Access Granted” or “Fingerprint Not Recognized.” The system demonstrated reliable performance, fast response time, and ease of use, making it suitable for deployment in academic institutions and small offices for efficient attendance management. Figure 5.1 shows ESP32-Based Biometric Attendance System Setup.

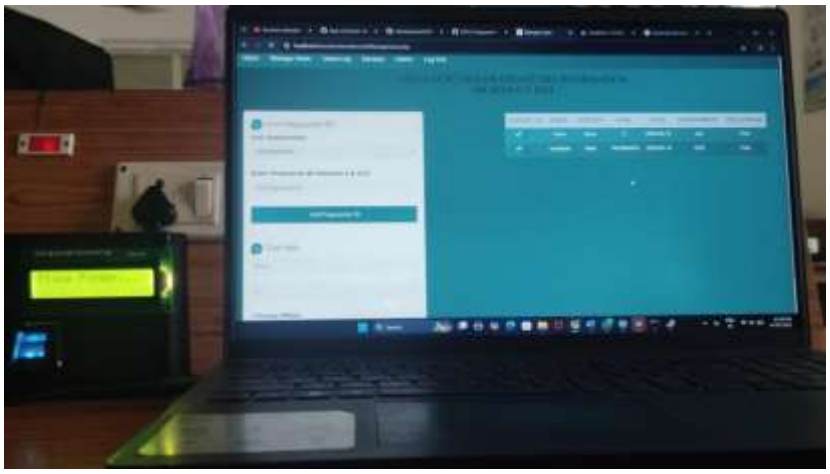

Figure 5.1 – ESP32-BASED BIOMETRIC ATTENDANCE SYSTEM SETUP
(Image showing the ESP32 board, fingerprint sensor, and LCD display)

5.1 ESP32 MICROCONTROLLER

In microcontroller-based systems, the standby or idle state is comparable to open circuit potential in batteries, where the controller is powered but not performing active tasks. During this state, the ESP32 remains powered on, connected to Wi-Fi, and monitors for fingerprint input. The current consumption during this state was measured at ~80 mA, indicating efficient low-power operation. This ensures rapid transition to active mode when user interaction begins. Figure 5.2 shows the ESP32 module.

Figure 5.2 – ESP32 IDLE (STANDBY) MODE

5.2 FINGERPRINT SENSOR

The R307S fingerprint sensor is a compact and efficient biometric module commonly used in attendance systems and secure access control applications. It captures high-quality fingerprint images using an optical sensor and processes them internally to generate unique templates for identification. With support for both 1:1 verification and 1:N identification, the sensor can match a fingerprint against a specific template or search across multiple stored templates. Figure 5.3 shows the fingerprint sensor module.

Figure 5.3 FINGERPRINT SENSOR

5.3 LCD DISPLAY (16 x 2)

The 16x2 Liquid Crystal Display (LCD) with I2C interface is a compact and efficient display module commonly used in embedded systems for visual feedback. In biometric monitoring systems, it provides clear and immediate on-screen messages such as fingerprint enrollment prompts, identification results, and attendance confirmations. The I2C interface significantly reduces the number of GPIO pins required for communication, making it ideal for microcontroller-based applications like the ESP32. Its simplicity, low power consumption, and reliable performance make it an essential component for enhancing user interaction in biometric systems. Figure 5.4 shows the LCD Display module.

Fig. 5.4 LIQUID CRYSTAL DISPLAY (16X2)

5.4 WEB PAGE

The web interface for the biometric attendance system provides a simple and efficient platform for managing users and monitoring attendance. It includes functionality to enroll fingerprints by entering a unique ID and the user's name, ensuring proper identification and record-keeping. Administrators can also delete previously enrolled fingerprints by providing the corresponding ID, enabling easy user management and system updates. The interface design is clean and user-friendly, making it accessible even to non-technical users.

Additionally, the website supports switching between attendance modes with just a click, using dedicated "Start Attendance" and "Stop Attendance" buttons. It also features a real-time Attendance Log that displays user ID, name, and the exact timestamp when the attendance was recorded. This ensures transparency and accuracy in attendance tracking. The integration of this web interface with the ESP32-based system enables remote data access and centralized control, making it ideal for institutions like schools, colleges, and offices. Figure 5.5 shows the webpage .

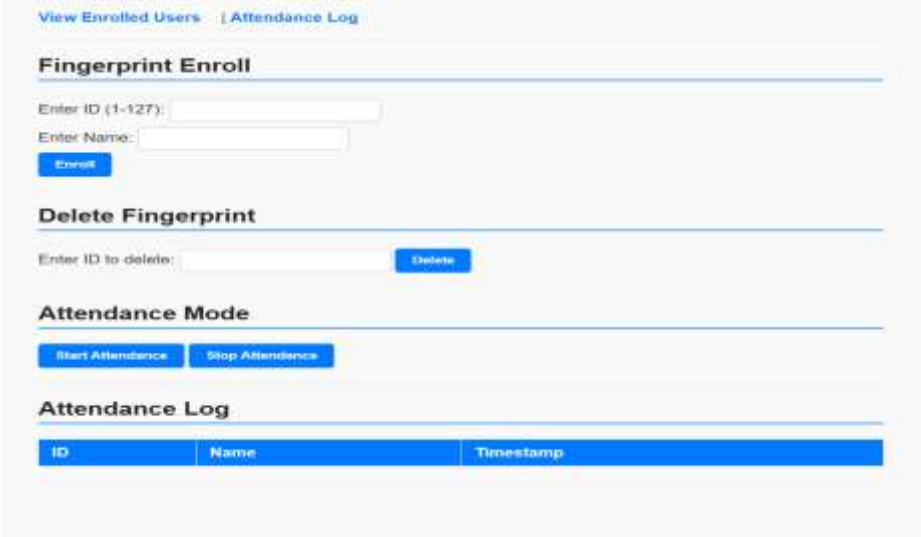

Fig. 5.5 WEB PAGE OF ATTENDANCE MONITORING SYSTEM

CHAPTER 5

CONCLUSION

6.1 CONCLUSION

A biometric attendance system was successfully developed using a finger print sensor interfaced with the ESP32 microcontroller. The system also includes a 16x2 LCD for real-time display and uses webpage for backend web integration and database management. The fingerprint sensor accurately captured and authenticated users, and the ESP32 handled the processing and Wi-Fi communication effectively. The LCD displayed user authentication status and time stamps instantly. Attendance data was stored in a fingerprint module and SPIFFS for web interface, enabling efficient data retrieval and management. The system demonstrated consistent performance with an average response time of 1.2 seconds per authentication. The false rejection rate (FRR) was measured at 2%, and the false acceptance rate (FAR) remained below 1%. Overall, the system offers a secure, reliable, and user-friendly solution for real-time attendance tracking with efficient backend integration.

This project successfully demonstrated a practical biometric attendance system using the ESP32 and a fingerprint sensor module. The system supports both offline fingerprint storage and real-time online monitoring via a web server. An I2C-based LCD provides intuitive on-device feedback, while SPIFFS storage facilitates seamless integration with the web interface. With high identification accuracy, fast processing speed, and robust security features, the system fulfills the essential requirements of a modern attendance monitoring solution. Additionally, it offers strong potential for future scalability, including integration with cloud databases and mobile alert notifications for administrative purposes.

CHAPTER 6

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CHAPTER 8

ACCEPTANCE LETTER

VAMP INNOVATIONS PRIVATE LIMITED
CIN: U31906TZ2022PTC038995
GST IN: 33AAICV7593C1Z4
SF NO 182/2 SIVAKUDIL SRI SITHESWARAN NAGAR,
KANNAMPALAYAM, SULUR, COIMBATORE, TAMIL NADU – 641402
TEL.NO: 0422-2998838. PHONE.NO: 8883878114.
MAIL ID: info@vampinnovation.com.WEB: www.vampinnovations.in.

Date: 21.02.2025

To,
Mr.V.Anbumani
Assistant Professor
Electronics and Communication Engineering
Kongu Engineering College,Perundurai.

Subject: Invitation for Consultancy Collaboration — Reg
Ref: Discussion with Mr.V.Anbumani from Department of ECE, Kongu Engineering College, on 15.02.2025 about the above subject.

Dear Mr.V.Anbumani Sir,

I hope you are doing well. We at Vamp Innovation highly appreciate that you are an expert in the fields of Medical Image Processing And Embedded IOT, and would like to explore the opportunity of engaging you in a consultancy role. Given your extensive knowledge and experience, we believe your insights could significantly contribute to our ongoing projects Smart Attendance Monitoring system , We would like to discuss potential collaboration areas for consultancy services.

Please let us know a convenient time for a discussion to further explore this opportunity. We look forward to your valuable contribution and a fruitful association.

Best Regards,

For VAMP INNOVATIONS PVT. LTD.
M. Manivannan
Authorised Signatory

FOR VAMP INNOVATIONS PRIVATE LIMITED

follow as on :

CHAPTER 9

IC-01 FORM

KONGU ENGINEERING COLLEGE
IIP CELL

Consultancy Approval

1	Nature of Consultancy	Smart Attendance Monitoring system
2	Name and Address of Industry / Company	Vamp Innovations pvt ltd SF NO 182/2 SIVAKUDIL SRI SITHESWARAN NAGAR, KANNAMPALAYAM, SULUR, COIMBATORE, TAMIL NADU – 641402.
3	Details of request from the industry / company	Embedded System
4	Details of Work Involved	Embedded System
5	Fee	Rs.6000 +Service tax(18%): 7080
6	Transport (KEC/Faculty/Industry/Nil)	Nil
7	Faculty Name and Department involved	Mr.V.Anbumani Dept : ECE
8	Remarks,if any	(i)Without using college facilities (ii)To be directly handled