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The Design and Development of Automated Daily Time Record with an Early Warning Alarm System for Lgu-Sison

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ABSTRACT: This paper presents a comprehensive study on the design and development of the Daily Time Record system for employees of the Local Government of Sison in Surigao Del Norte. The system serves as a basis for recording their time-in and time-out, which, in turn, plays a crucial role in evaluating their performance and calculating their salaries. To facilitate this process, an RF-ID reader is integrated into the computer keyboard port to capture RF-ID tags during login and logout transactions. In addition to the Time Record system, the study also focuses on the development of an automated Central Alarm system. The external central alarm is connected via a USB port with the aid of a third-party driver that converts from USB to RS232 cable converter, enabling seamless communication with the embedded systems application of the alarm system. Careful consideration was given to the power rating of the alarm siren and the driver of the high current load to ensure efficient operation. To realize the complete automation process, the implementation includes the utilization of a MYSQL database for the backend, while the front end is based on Visual Basic.net. The study's results indicate that the system's output is not only applicable to the Local Government of Sison but also serves as a suitable solution for other local government units seeking to implement an automated centralized alarm system. The system has been extensively tested and found to be compatible with most windows operating systems, making it highly adaptable and accessible across various environments

KEYWORDS: Alarm Systems, Embedded Systems, Microcontroller, RFID Reader, RS232 Standard

INTRODUCTION

The municipality of Sison is one of the 11 municipalities on the mainland of Surigao del Norte. Currently, its Local Government Unit relies on manual processes to generate employee Daily Time Records (DTRs) and activate the early warning alarm system during disaster emergencies and for time monitoring. However, this manual approach comes with several drawbacks, including human errors, time theft, and time-consuming tasks. Similarly, the manual triggering operation is prone to human errors. To keep up with current technology trends and address these challenges, the LGU of Sison aims to replace manual time card machines and handwritten attendance records with a Computerized Daily Time Records system - an Automated Daily Time Record solution.

In various industries and institutions, biometric technology is already being used to monitor employee attendance, resulting in time and cost savings while preventing time theft. Biometric technology uniquely identifies individuals through physical measurements of distinct human characteristics like fingerprints. Today, biometrics serve as an effective tool for employee attendance verification (JMaggay). As technology continues to evolve rapidly, biometrics have become a popular and trending solution.

Considering the importance of disaster preparedness, it is essential to reduce the impact of natural hazards on society. International initiatives are promoting a culture of risk prevention and early warning systems (Mohini Mohan Sawarkar (n.d)).

Given their specific needs, the researchers designed and developed an automated DTR with an early warning system tailored for the LGU of Sison. This unique system required a fusion of technologies to provide the appropriate solution. The real-time data source is the PC, and the integration of an RFID reader into the system implementation enables its exploitation. Middleware software for the database automates the entire process, connecting the embedded application to enable the high rating load for the centralized alarm system. The embedded system employs a Microcontroller connected via serial communication to the PC, employing a coding technique for effective data communication between the PC and the embedded system device.

CONCEPT OF THE STUDY

Figure 1 below depicts the comprehensive workflow of the entire study, showcasing the simultaneous development of both hardware and software components. These components are interconnected, allowing for rigorous testing and implementation to achieve the desired functional output. The outcome of this collaborative effort is the creation of an innovative system called "Automated Daily Time Record with Early Warning Alarm System." Through this visual

representation, the interconnectedness of the hardware and software aspects becomes evident, highlighting the seamless integration that culminated in the successful development and implementation of the final system.

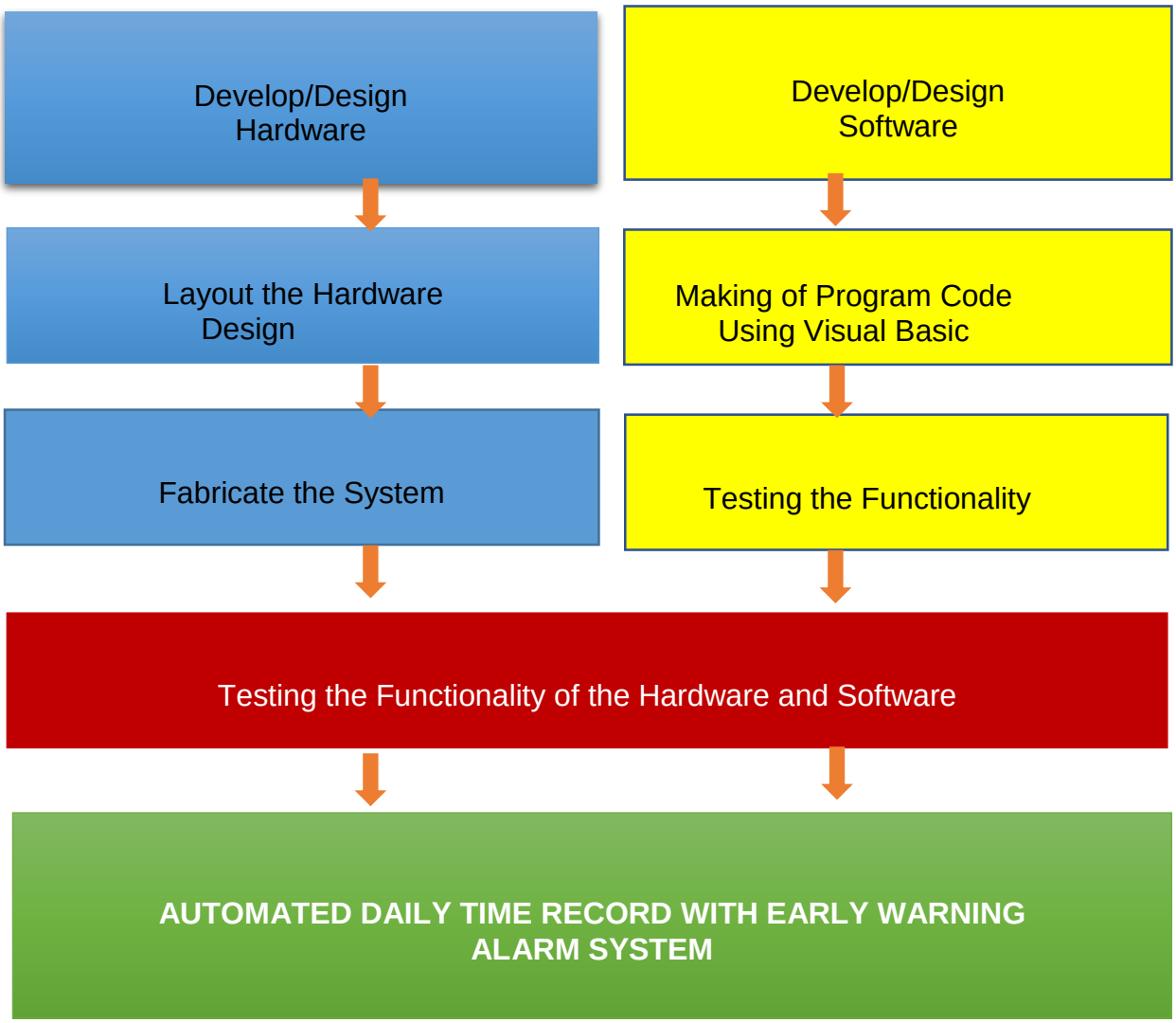

Fig 1. Concept of the Study

OBJECTIVES

The primary goal of this study is to design and develop an Automated Daily Time Record with an Early Warning Alarm System specifically tailored for the LGU of Sison.

The specific objectives of the study are as follows:

1. To design and develop an Embedded Systems-based Automated Daily Time Record for efficiently recording and managing the employees' attendance within LGU-Sison.
2. To create an automated Early Warning Alarm System Software utilizing Visual Studio as the Front-end and MYSQL as the back-end Database, enabling timely alerts and notifications during disaster emergencies.
3. To implement the system device at the LGU of Sison, enabling streamlined Daily Time Record management for employees and a Central Alarm System for prompt early warning dissemination. Through the successful implementation of this system, the LGU of Sison aims to enhance its time tracking and emergency response capabilities, improving overall efficiency and preparedness.

MATERIALS AND METHODS

The researchers took into account both software and hardware components in this study, as it entails a comprehensive software and hardware implementation. For the hardware aspects, the materials utilized in this study include the following:

Microcontroller

The central controller chosen for the hardware is the AT89C2051 Microcontroller due to its durability and ease of implementation, which aligns perfectly with the study's objective of communicating with the computer to provide accurate real-time performance data. This Microcontroller

features an onboard UART port, readily available for Serial Communication when configured accordingly. Its simplicity and few required ports for activating the alarm make it highly suitable for this application. In Figure 2 below, the schematic diagram illustrates the system's flow and the progressive development of the plan, showcasing the logical arrangement and interconnections of the components for smooth functioning and integration.

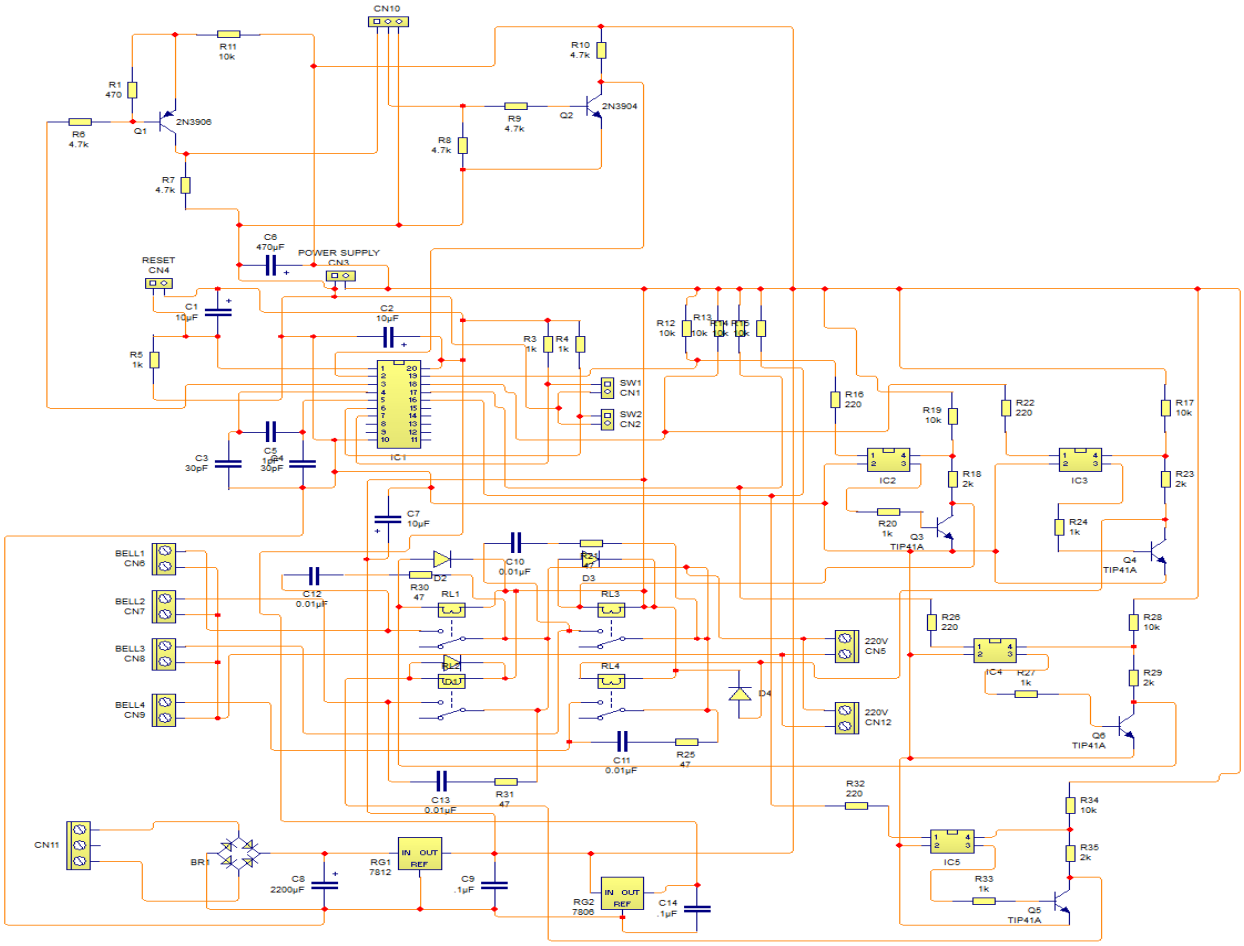

Fig 2. Schematic Diagram of the entire system

As depicted in Figure 2 above, the researchers have incorporated an isolation circuit using opto-isolators with an RC snubber to address the high current ratings of the load. This isolation circuit ensures that when turning on the higher rating load, potential feedback voltage is prevented from damaging the Microcontroller. By implementing this secure design, the entire system can effectively perform its repetitive application while safeguarding the Microcontroller, thereby extending its lifespan for prolonged usage.

Furthermore, the system's design includes a dedicated power supply circuit and a serial communication transmitter and receiver circuit diagram, ensuring efficient power distribution and seamless communication between components.

To fabricate the hardware for one (1) device, the components, materials, and parts detailed in Table 1 below are required, ensuring a well-functioning and reliable system setup. This meticulous planning guarantees that all necessary elements are accounted for, enabling the successful creation of the device with the desired performance capabilities.

TABLE 1. Parts and Materials needed for 1 device

PARTS AND MATERIALS					
NO.	**QTY**	**UNIT**	**DESCRIPTION**	**PRICE**	**AMOUNT**
1	1	PC	PLASTIC CASING	1,500.00	1,500.00
2	1	PC	SYSTEM MAINBOARD WITH PARTS	3,500.00	3,500.00
3	1	PC	RS232 TO USB CABLE	500.00	500.00

4	1	PC	HARDWARE EMULATOR MODULE	3,000.00	3,000.00
5	1	SET	ASSORTED PARTS	1,000.00	1,000.00
6	1	PC	750 AMPERES TRANSFORMER 10V,0,10V AND 16V,0,16V OUTPUT	1,000.00	1,000.00
TOTAL					**10,500.00**

According to Table 1, the total cost per device amounts to only PHP 10,500.00. This cost is highly reasonable considering the longevity of the finished product, which is expected to remain functional for many decades, thanks to the utilization of locally available parts. As shown in Figure 3 below, the components are meticulously soldered onto the PCB board.

Subsequently, in Figure 9, the system board is skillfully mounted onto the chassis, making it ready for thorough testing and eventual implementation.

Having identified the required parts and their corresponding prices, the researchers then proceeded to translate the circuit diagram into a printed circuit board (PCB), serving as the foundation for developing the main panel board, ultimately bringing the entire implementation to fruition. Figures 3, 4, and 5 below exemplify the PCB layout, thoughtfully labeled to ensure a smooth and seamless integration of components during the development process. Through these carefully planned steps and precise execution, the researchers have successfully engineered a robust and efficient system that holds great promise for achieving the study's objectives.

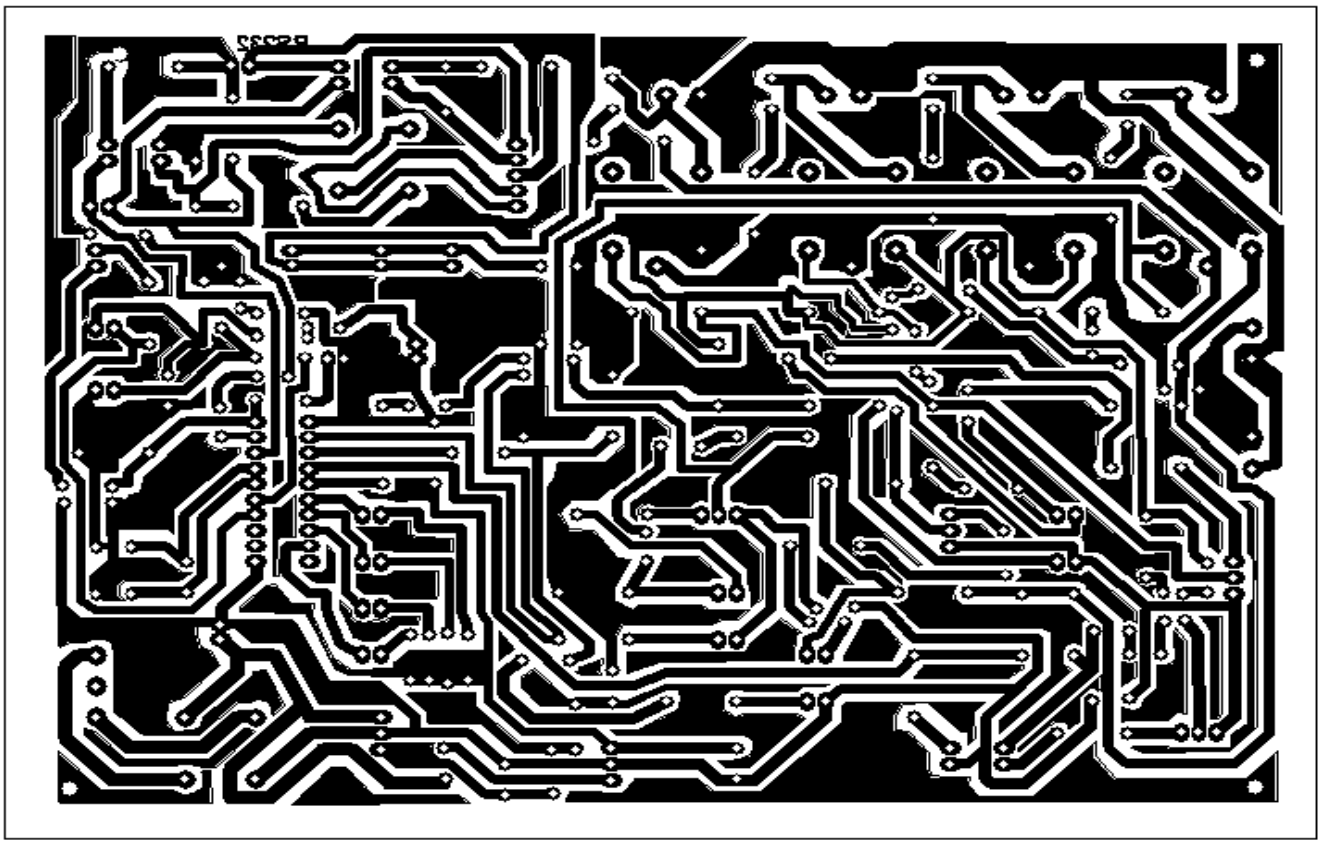

Fig 3. Mainboard of the system

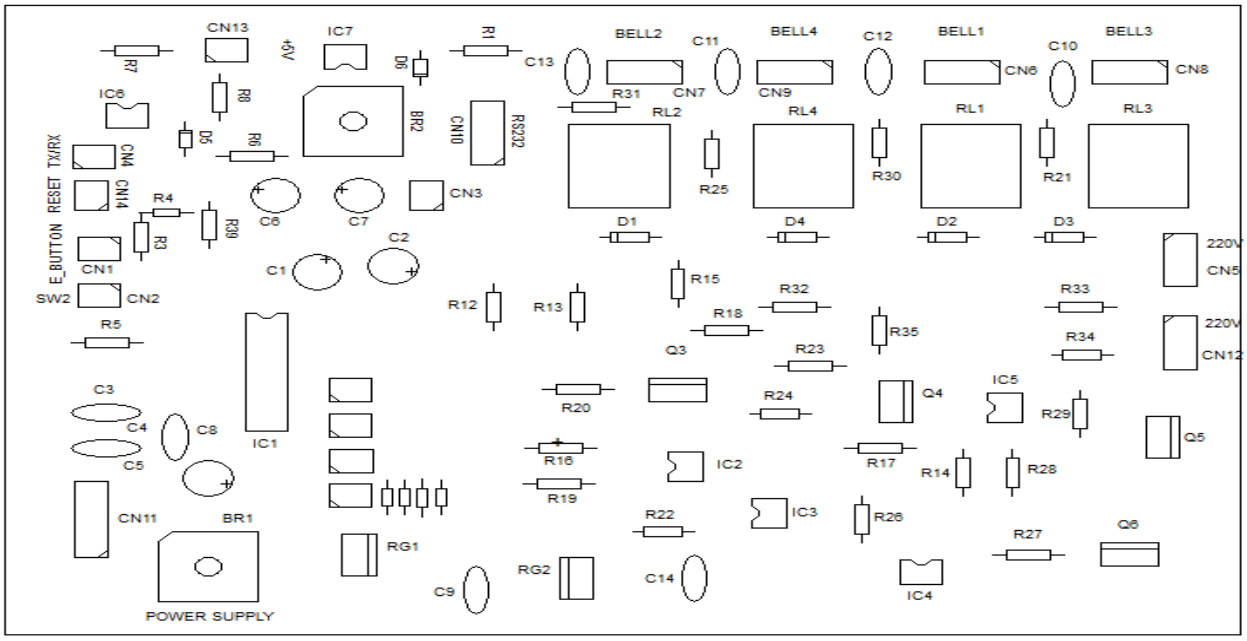

Fig 4. Label of Mainboard of the system

With utmost precision and attention to detail, the researchers meticulously positioned all the components and materials onto the PCB, ensuring a secure and permanent soldering for the final board placement. As depicted in Figure 5 below, the finished product's mainboard proudly showcases the carefully installed details, poised and ready for testing once the embedded code is programmed into the Microcontroller's ROM chip. This stage marks a significant milestone in the development process, as the fully assembled and integrated mainboard stands as a testament to the researchers' dedication and expertise in engineering a robust and functional system. With the embedded code in place, the mainboard is poised to undergo thorough testing, ensuring its seamless performance and adherence to the study's objectives.

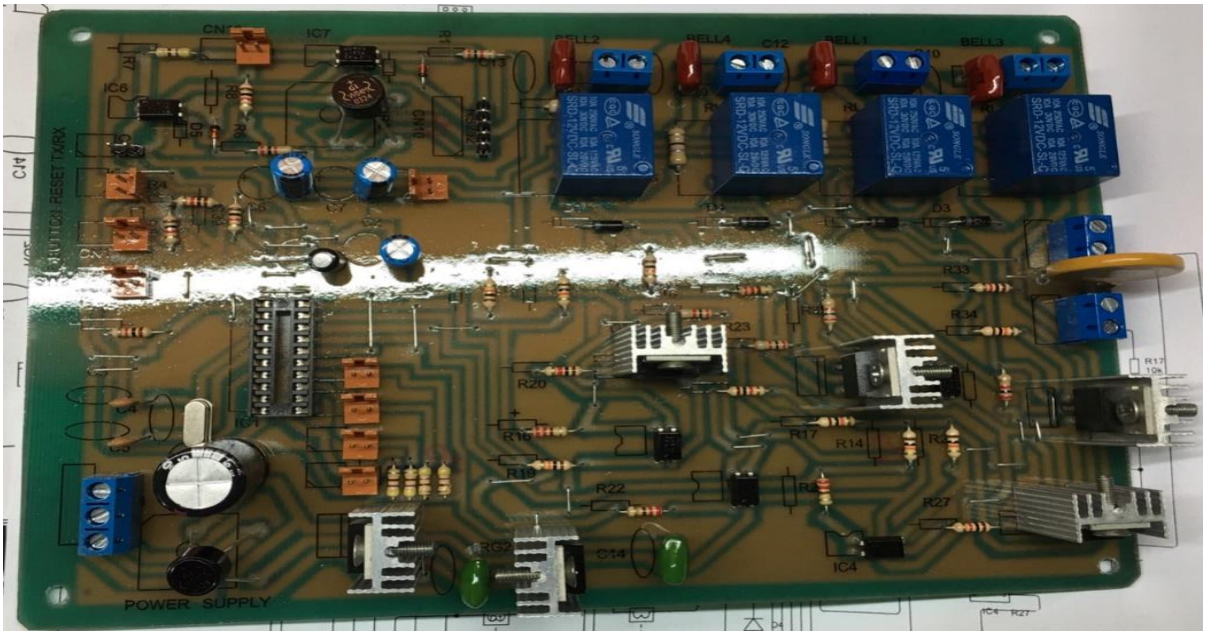

Fig 5. Mainboard with parts

Embedded Systems

To achieve the specific functionalities of the system hardware, the researchers skillfully crafted an embedded code using the assembly language of the AT89C2051 Microcontroller. For this purpose, the researchers employed the Raisonance IDE (RIDE)

compiler, which features an onboard text editor, facilitating seamless coding development. As illustrated in Figure 6 below, the Raisonance IDE environment served as the platform where the intricate embedded system code was meticulously designed and fine-tuned. This coding process is instrumental in configuring the Microcontroller to perform the desired tasks efficiently and effectively, bringing the entire system to life and ensuring its successful implementation in fulfilling the study's objectives. The researchers' adeptness in crafting this embedded code showcases their expertise in developing a robust and functional system, which is crucial for the overall success of the study.

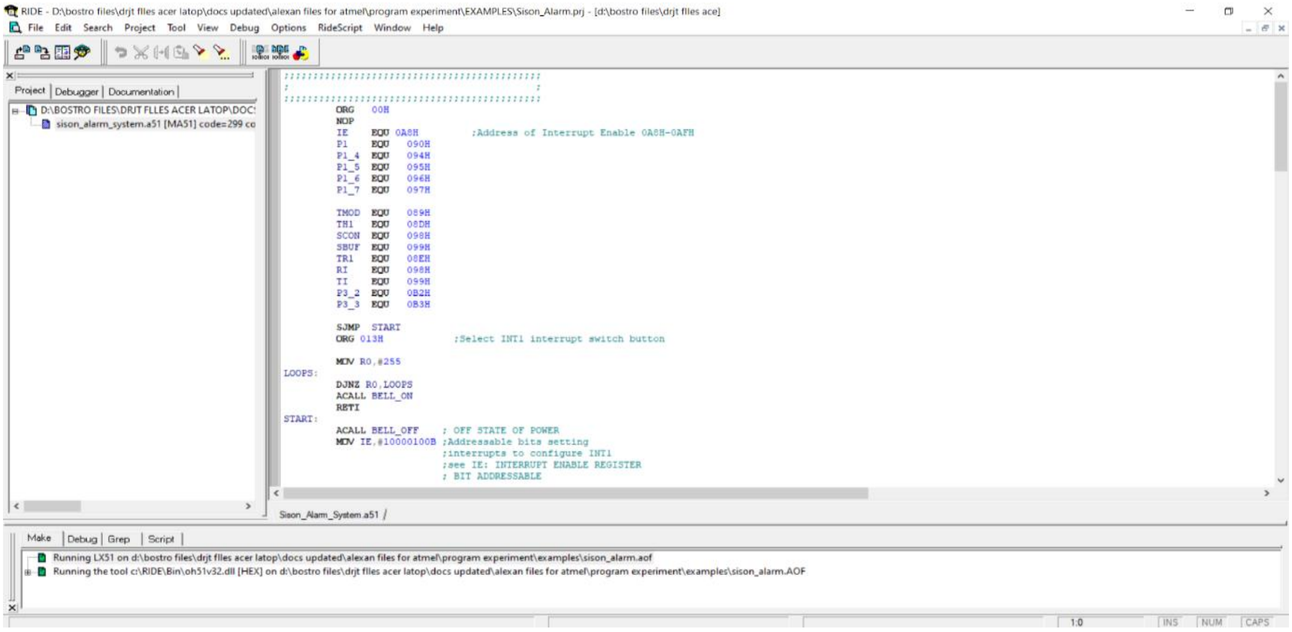

Fig 6. Raisonance IDE Environment

For successful implementation of the embedded system, a software and hardware emulator becomes essential to load the embedded code onto the Microcontroller chip. Figures 7 and 8 below illustrate the software and hardware emulator provided by Alexan Electronics. These emulators play a crucial role in facilitating the programming process, allowing the researchers to test and validate the embedded code before it is deployed onto the actual Microcontroller chip. The software emulator enables thorough code simulation, ensuring its accuracy and functionality, while the hardware emulator provides a reliable platform to connect and program the Microcontroller chip. Together, these emulators serve as indispensable tools that streamline the development and testing phases, ensuring a seamless and successful implementation of the embedded system in accordance with the study's objectives.

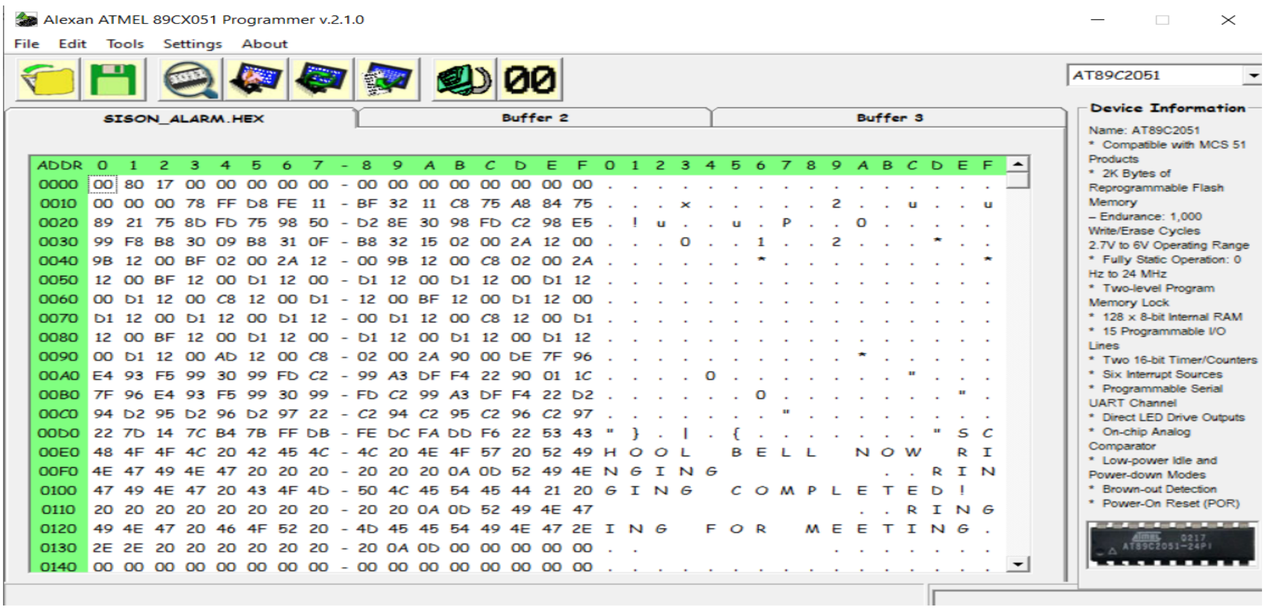

Fig 7. Software Emulator

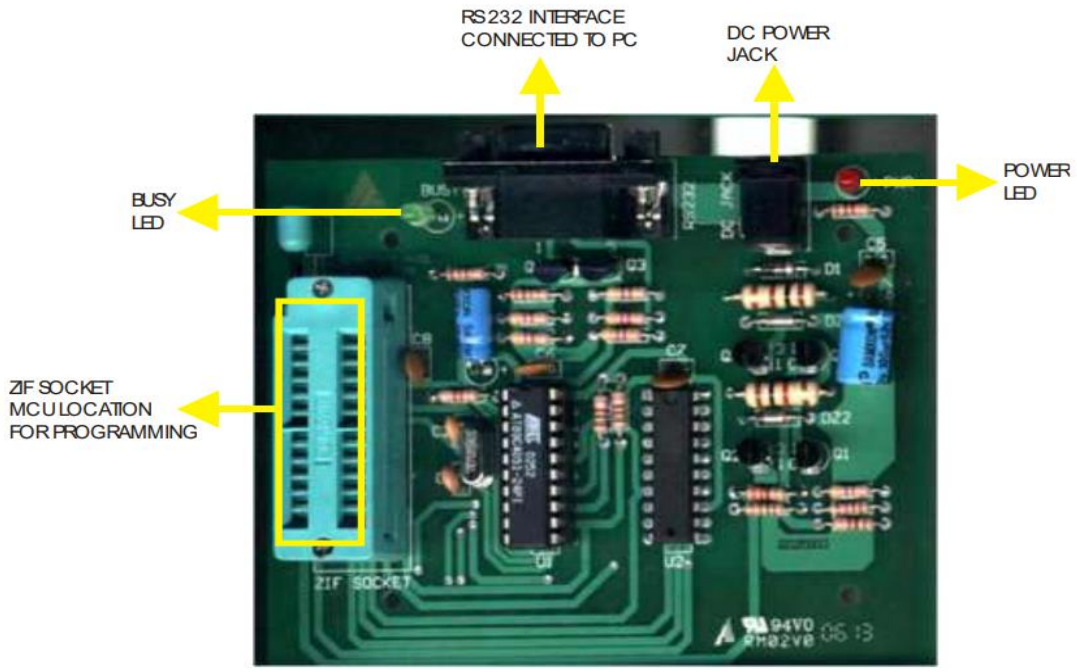

Fig 8. Hardware Emulator

Software Implementation

Front-End Software

The researcher utilized Visual Studio for the front-end development, incorporating graphical user interfaces (GUI) for various application forms. To secure the system, a password is required for accessing the application. Figure 9 displays the login form of the system.

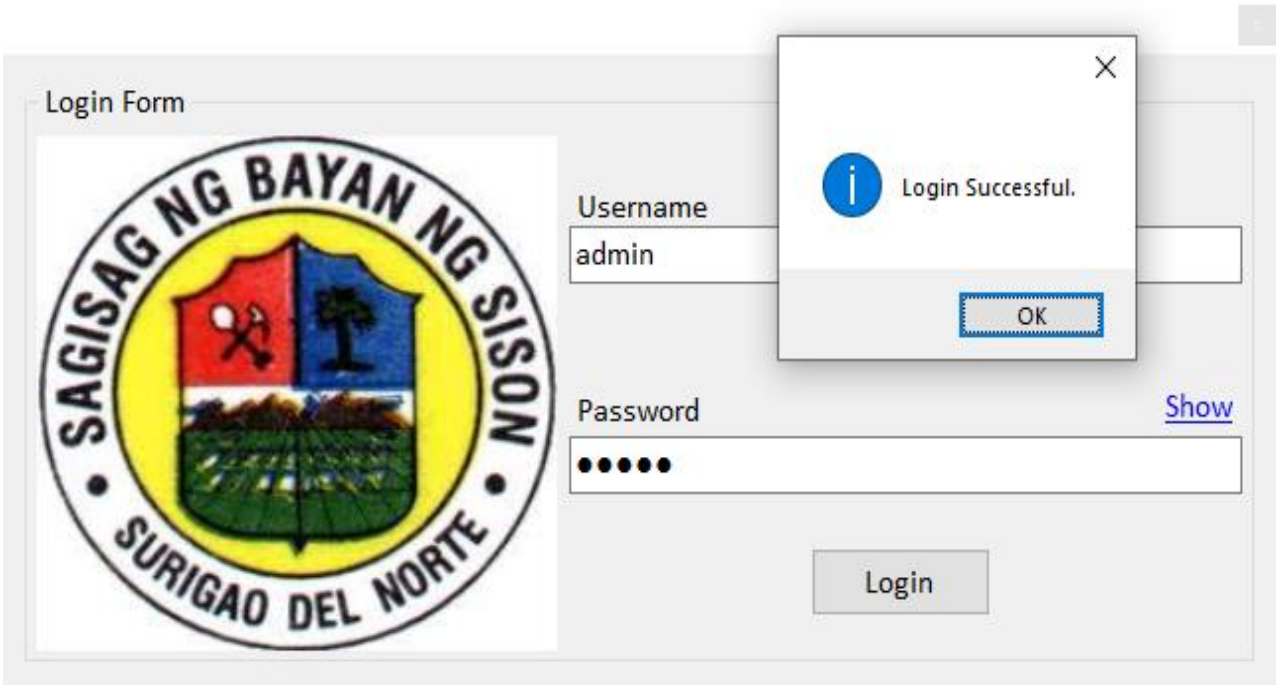

Fig 9. Login form

The logo in Figure 9 is customizable, allowing users to change it as needed. This flexibility makes the system ready for commercialization, as long as the core application remains unchanged. Thanks to its dynamic development, this system is highly versatile and adaptable. Once the user logs in successfully, the main form, depicted in Figure 10 below, will be displayed, granting access to the system's primary functionalities.

Fig 10. Main startup form.

Upon selecting the Settings menu bar, three menu items (Logo, Alarm, and LGU/Barangay name) will be presented. This system's flexibility empowers the end user to easily modify the LGU/Barangay name, the Time of Alarm, and even the Login Logo according to their preferences. For instance, clicking on Alarm will reveal a screen resembling Figure 11 below, where adjustments can be made. Furthermore, users can conveniently change the logo within the system, as demonstrated in Figure 12 below, providing them with seamless customization options tailored to their specific needs and preferences.

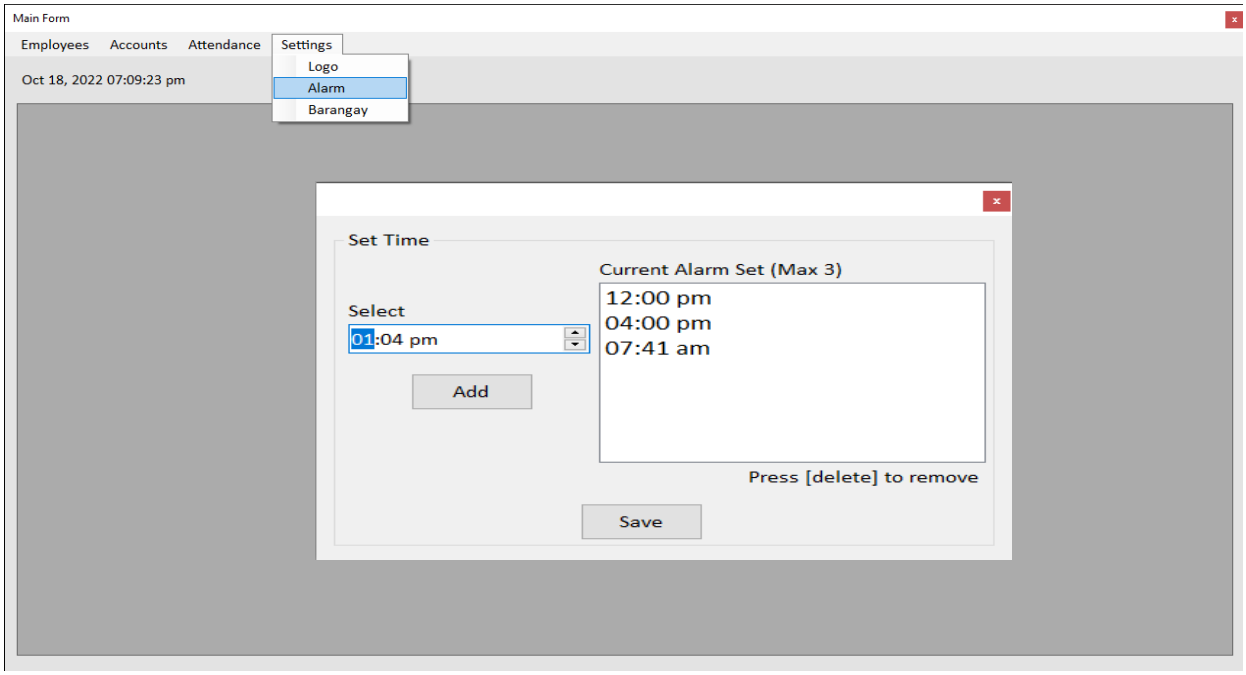

Fig 11. Alarm Settings

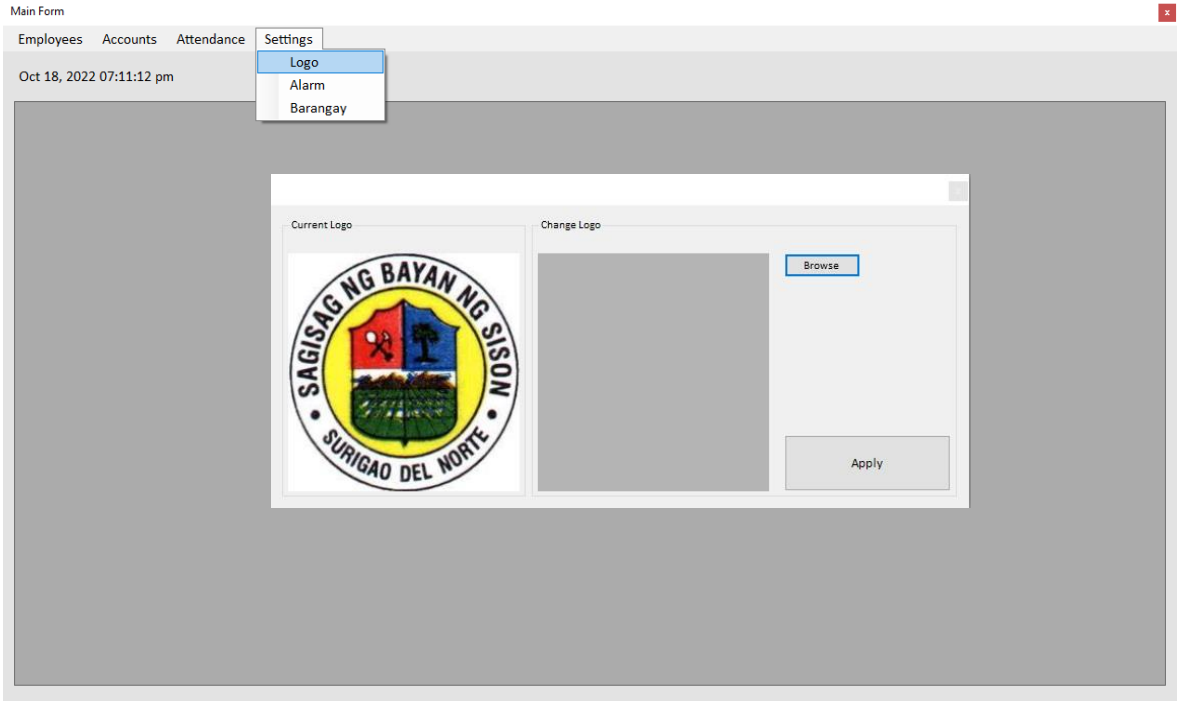

Fig 12. Change Login Logo Option

By selecting the Attendance menu item, a screen akin to Figure 13 below will be presented, showcasing the employee details, along with their login and logout status. Additionally, under the Accounts menu item, users can choose to add an account to the system's user login. Clicking on this option will lead to a screen similar to Figure 14 below, where account details can be conveniently managed and modified. These user-friendly interfaces ensure smooth navigation and efficient management of employee attendance and user accounts within the system.

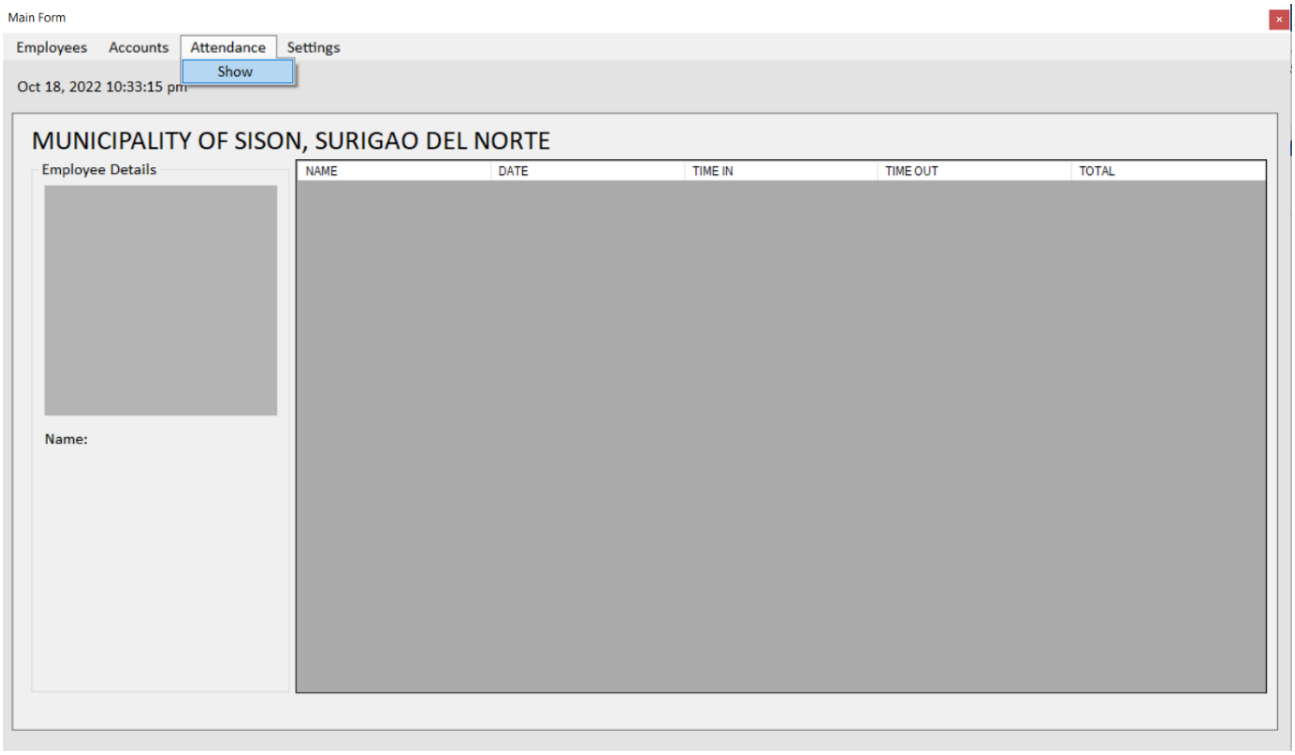

Fig 13. Attendance Display Screen

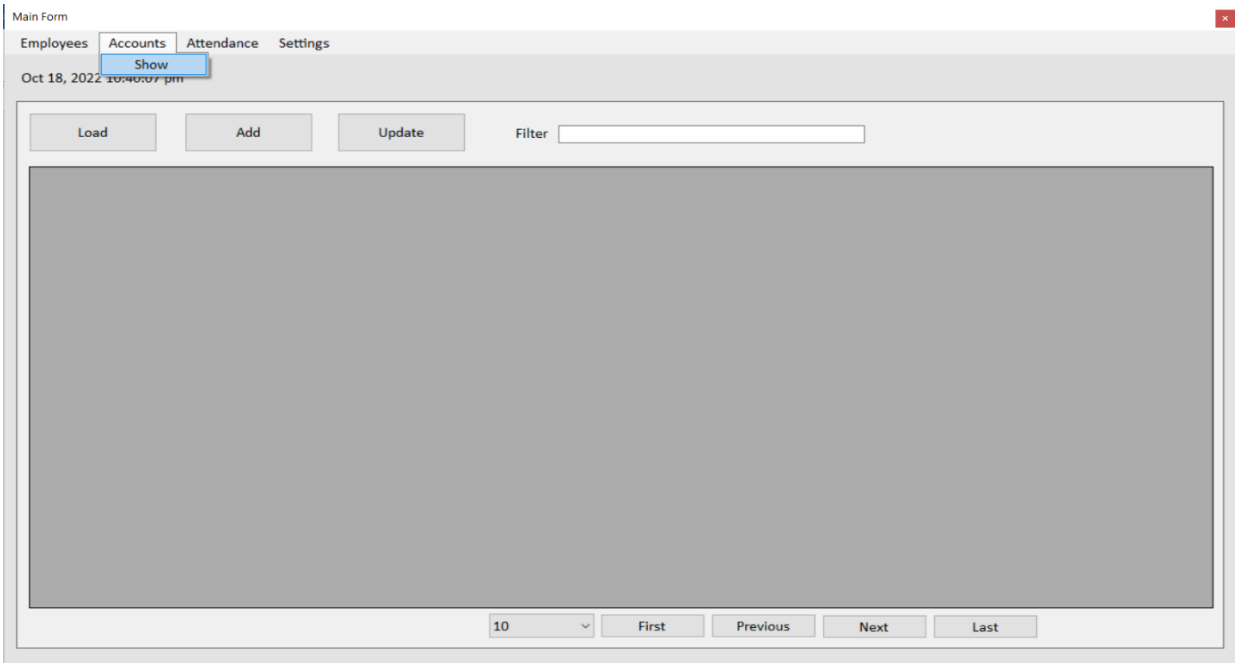

Fig 14. Accounts Display

The Accounts menu bar, illustrated in Figure 14 above, presents three options (Load, Add, Update) upon selection. These essential option buttons facilitate loading, adding, and updating data as needed. Similarly, under the Employees menu item, a screen resembling Figure 15 below will be displayed, offering corresponding options and button functions as shown in Figure 14. This cohesive design ensures a seamless and user-friendly experience, enabling efficient data management and editing capabilities within the system.

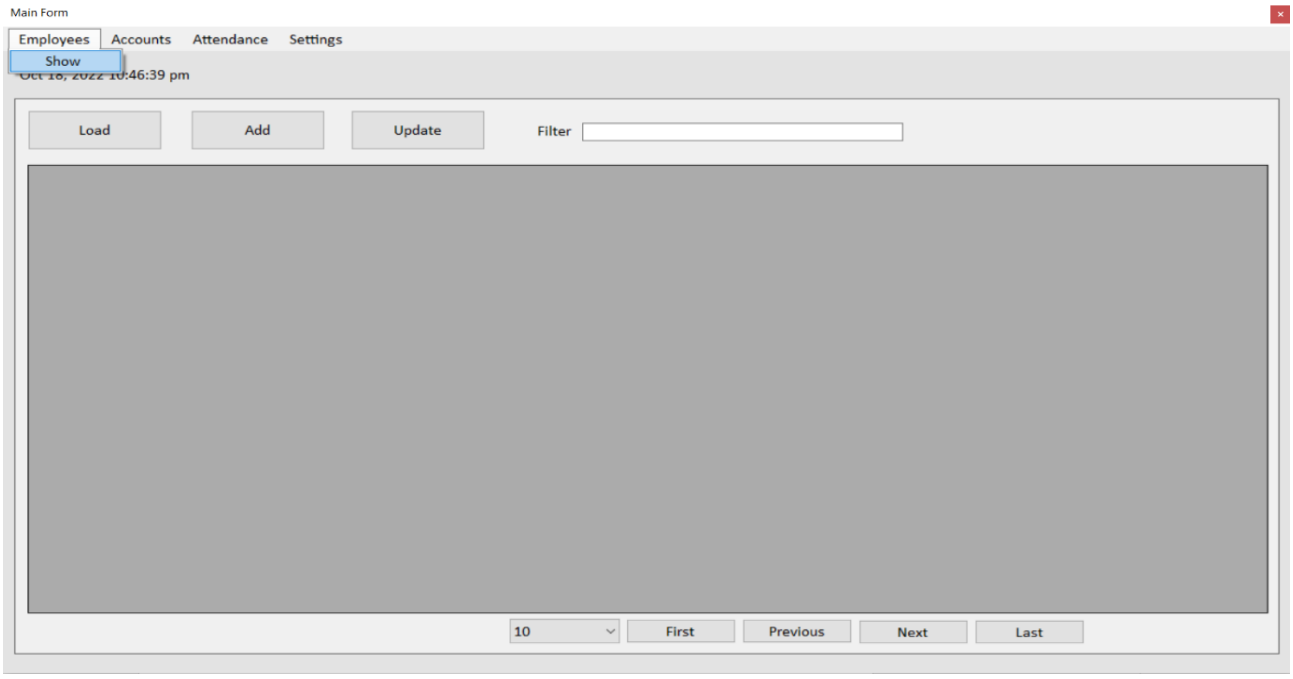

Fig 15. Employees Option Menu

Back-end Software

For the back-end of this system implementation, MYSQL was employed with XAMPP Control Panel v3.3.0, as demonstrated in Figure 16 below. This powerful combination provides a robust and reliable foundation for data management, ensuring seamless interactions between the front-end and back-end components of the application. With MYSQL and XAMPP, the system can efficiently handle data storage and retrieval, enhancing its overall performance and functionality.

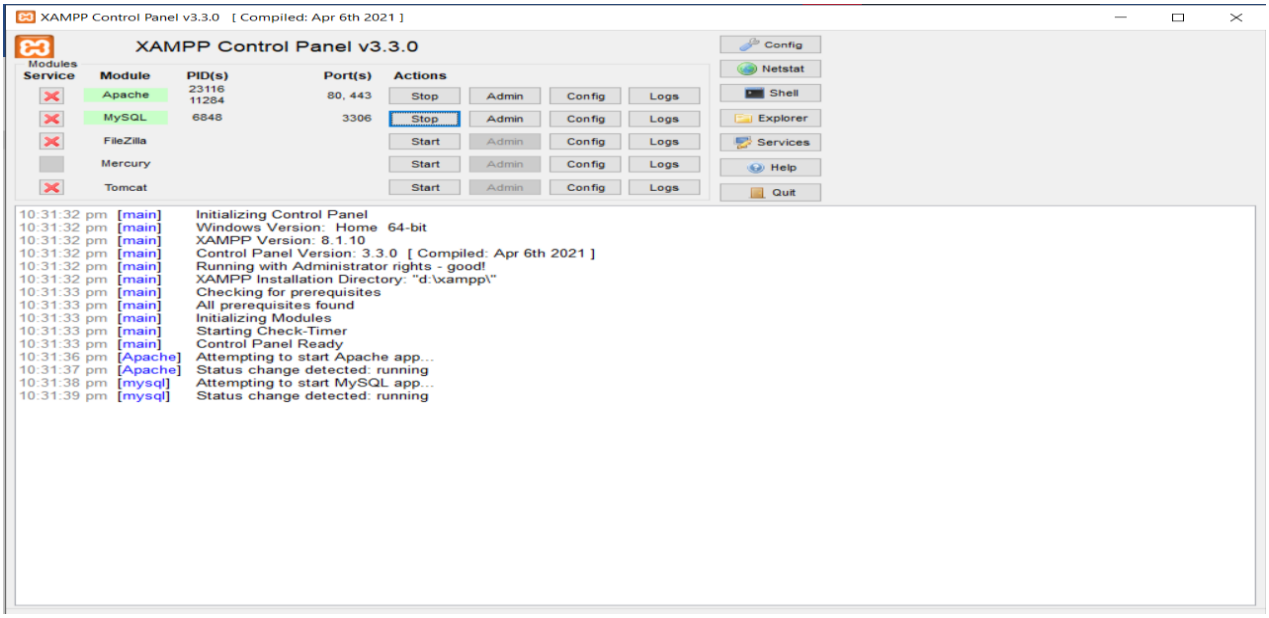

Fig 16. XAMP Environment Control Panel

To activate the database implementation under PhpMyAdmin when MYSQL is activated, the XAMPP Control Panel becomes essential. By clicking "Start" at the MYSQL Control, a display similar to the one shown in Figure 17 will appear. This step ensures that the MYSQL database is up and running, enabling seamless data management and interactions within the application. The XAMPP Control Panel serves as a convenient and user-friendly interface to manage the various components required for the smooth functioning of the database and associated services.

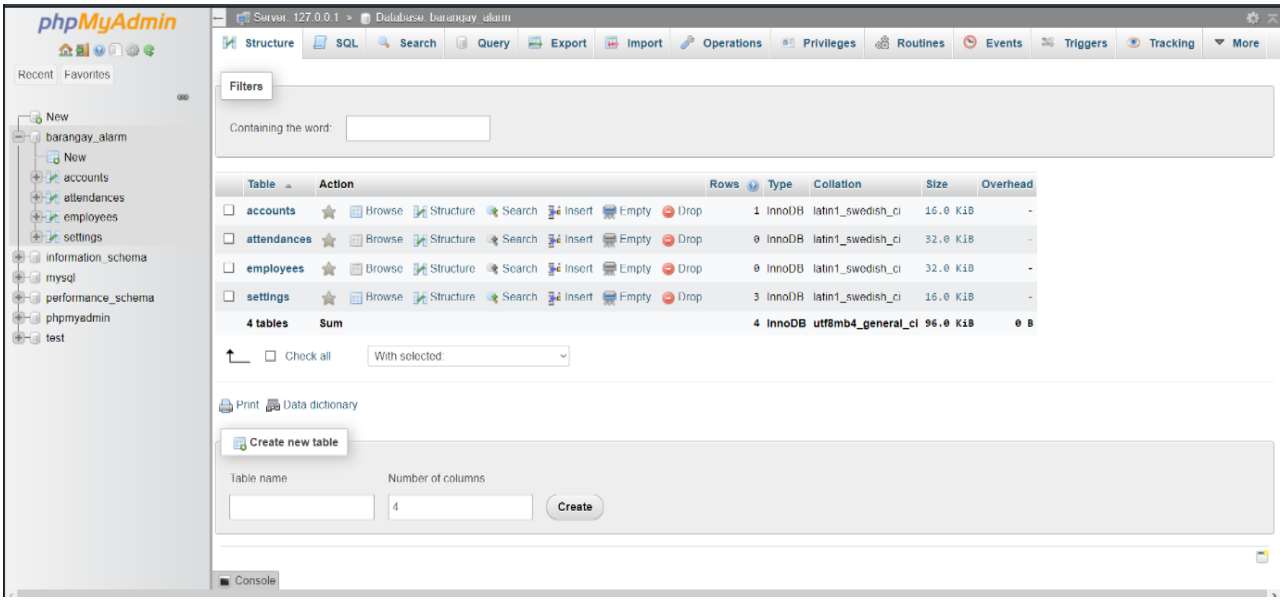

Fig 17. PhpMyAdmin Database Environment

RESULTS AND FINDINGS

The researchers successfully unveiled the study results, incorporating the desired functions requested by the Municipality of Sison. Consequently, the entire system for automating attendance acquisition and the central alarm of the LGU of Municipality of Sison was seamlessly interconnected and tested for functionality, as depicted in Figure 18 below.

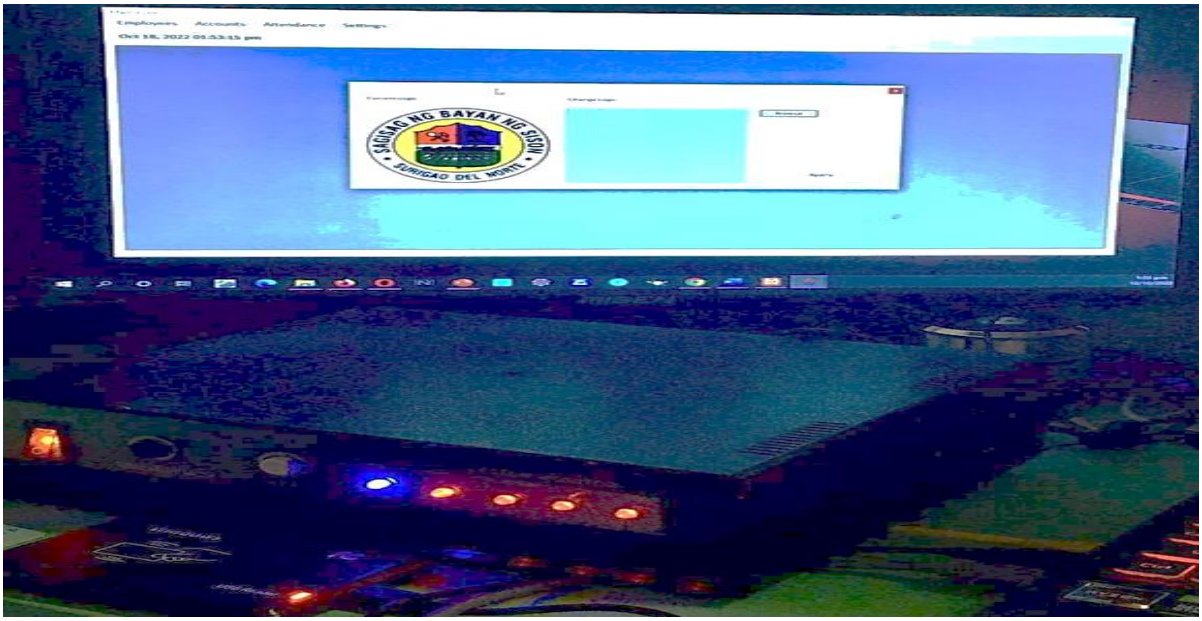

Fig 18. Output of the Study

The main screen for acquiring attendance is showcased in Figure 19 below. This screen provides a comprehensive display of employee details. Within the main form's menu bar, various functional options are available, including Employee, Accounts, Attendance, Settings, and Manual. These menu choices are designed to cater to the specific needs of the LGU's system administrator. During the standby mode of the system for login and logout transactions, a standby display is presented, similar to the one depicted in Figure 19 below. This user-friendly interface ensures efficient attendance tracking and easy access to essential system functionalities.

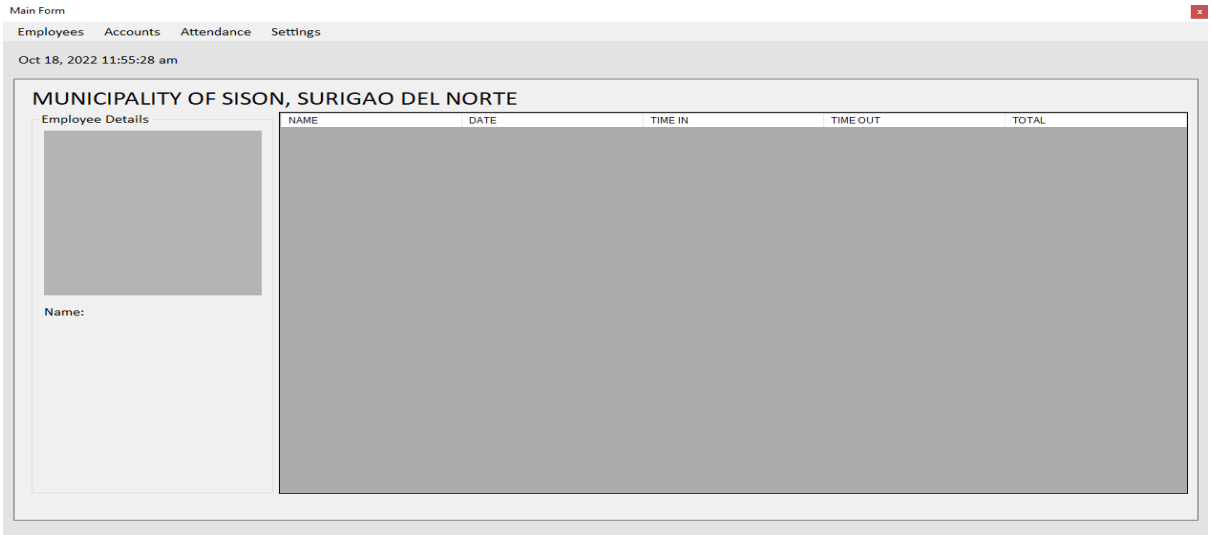

Fig 19. Login/Logout Standby Screen for Attendance

Throughout the system's testing and implementation phase, accurate communication between the PC and embedded systems was achieved, thanks to its designed interference filtering during data transmission. The testing transmission accuracy is summarized in Table 2, affirming the system's precision and readiness for implementation. Additionally, Table 3 demonstrates the system's

compatibility with various Operating Systems, utilizing Oracle Virtual Box for multiple installed operating systems on the homeoperating system, with others as guest operating systems. As a result, the system is fully compatible with most Windows operatingsystems and Ubuntu Linux, ensuring its widespread usability and effectiveness.

TABLE 2. Peer-to-Peer Communication Result from PC to Embedded System

No. of Trials	Desktop PC Alarm Trigger Time	Embedded Systems Functionality
1	8:00 AM	Enabled
2	12:00 N.N.	Enabled
3	5:00 P.M.	Enabled
4	8:00 AM	Enabled
5	12:00 N.N.	Enabled
6	5:00 P.M.	Enabled
7	8:00 AM	Enabled
8	12:00 N.N.	Enabled
9	5:00 P.M.	Enabled
10	8:00 AM	Enabled

TABLE 3. Testing Environment Compatibility

Operating Systems	Compatibility	Functionality
Windows 7	YES	YES
Windows 8.1	YES	YES
Windows 10	YES	YES
Ubuntu Linux	YES	YES

CONCLUSION AND RECOMMENDATIONS

In conclusion, the researchers have successfully addressed the specific needs of the LGU of SISON by developing an integrated solution for employee attendance and the Central Alarm system. The implementation of this automated system effectively replaces the manual processes previously in use, streamlining operations and enhancing efficiency. The study's primary objectives, aimed at automating and optimizing the entire process, have been achieved with positive results.

The study's outcomes demonstrate the system's functionality and its ability to deliver the desired output as per the stated objectives. Moreover, its compatibility with various operating systems, including most windows versions and Linux, ensures its adaptability for diverse users.

RECOMMENDATIONS

To ensure continuous improvement and refinement of the system, the researchers encourage user feedback and active engagement from the LGU of SISON and its staff during the actual implementation. User feedback will play a pivotal role in identifying areas that require enhancement and further development, thus ensuring the system remains effective and meets the evolving needs of the organization.

In addition, the researchers recommend conducting regular updates and upgrades to keep the system up-to-date with the latest technological advancements. This proactive approach will not only enhance the system's performance but also future-proof it against potential issues and challenges.

Furthermore, exploring the possibility of incorporating biometric technologies for employee attendance verification could provide an added layer of security and accuracy. Biometric systems, such as fingerprint or facial recognition, have proven effective in preventing time theft and ensuring precise attendance monitoring.

Collaboration with IT experts and professionals in the field of automation and system development may also prove beneficial. Leveraging external expertise and insights can lead to further improvements and innovations in the system, taking it to the next level of functionality and user experience.

In summary, the successful implementation of this automated system marks a significant milestone for the LGU of SISON, ushering in a new era of streamlined operations and improved efficiency. By continuously embracing user feedback and seeking opportunities for enhancement, the organization can ensure the sustained success and impact of the system for years to come.

ACKNOWLEDGEMENTS

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