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Design and Implementation of Microcontroller-Based Class Schedule and Information Display System

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ABSTRACT

Advancement in the technology of optoelectronics information presentation has helped to shape the way information has been and is being delivered in recent times. Traditional means of conveying information such as billboards, paper prints in academic institutions may not be ideal with the advancements in technology. Most institutions of higher learning still display their class schedules on paper prints on large notice boards, and class schedules are still pasted on the walls of classrooms which can be damaged easily. The students need to be reminded which course they are to have at intervals. The knowledge of optoelectronics, computer programming languages, and wireless communication protocol was leveraged to create a microcontroller system capable of displaying class schedules on light emitting diodes connected in arrays. The system's frame work was first drafted, to give a broad view of the system This was followed by a structural decomposition of the system which broke the entirety of the system into sub functional units. The wireless communication module relied majorly on baud rate for serial communication. A sending data using the android device using a wrong baud rate created invalid characters when sent to the display board.

1. INTRODUCTION

A schedule is a plan that gives a list of events or tasks and the times at which each one should happen (Collins, 2020). For academic institutions, each department has a specific schedule and each level for that department has its own schedule. For a level in the department, it is still difficult for some students to keep track of the lecture time and course to be taught. The time strikes 10 am on a Tuesday morning and the student has to search a printed paper in their jotter or go to a large notice board may be some distance away

from their class to gain access to the schedule just to ascertain which of the course he/she is having now. This can be very inconvenient especially if it has to be done every time a class changes.

Communication is a very good tool in any organization or institution to help convey vital information across space and time using various technical means (Mala et al., 2016). There are a lot of ways to send information across to the public and one of these means is a notice board. A notice board is an example of such media a very essential device in any institution or organization (Nivetha et al., 2013). The advancement in technology in recent times has led to the need for an electronic display system. This system can display texts, graphics and so on. An electronic display system (board) unlike traditional means or notification media such as prints and woods and paints utilize electronic hardware and software to display messages and texts to the audience and is not boring or monotonous in nature. The display system can use liquid crystal display (LCD) or light emitting diodes (LED) (Mala, et al., 2016). The LED after much advancement has been modified to form an array of LED arranged in rows and columns such that when voltage is passed correctly with the help wired connections, will display certain characters to the screen.

The aim of this study is design and implement an electronic class schedule to enable students know what courses they are to have at an instant in time and also get other relevant information as regard to the class such as course registration or submission of assignment or test announcement.

2. MATERIALS AND METHODS

2.1. Power Adapter

This power source is simple 9 V, 1 A power adapter design specifically for Arduino devices. All the components used in this system operate in the voltage range of 3.3 V to 5 V and current range of 750 mA to 1 A. The power adapter is capable of providing these electrical quantities to the individual components. However, the microcontroller board was responsible for delivering power to the components connected to it.

2.2. Arduino Microcontroller

The control unit consists of one of the members of the **A**lf-Egil Bogen and **V**ergad Wollan (AVR) microcontroller family: Arduino UNO R3. The Arduino Uno is a microcontroller board based on the ATmega328. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analogue inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button (Agarwal, 2019). This is where the program for the control part of the project is written using C programming language. Figure 1 shows the Arduino Uno R3 board whose main function is to provide power supply and data to modules connected to it. The ribbon cable connects the P10 board to the microcontroller using connectors.

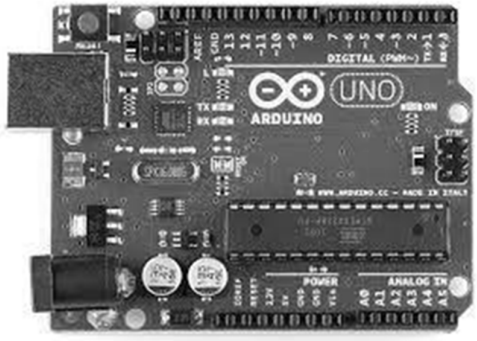

Figure 1: Arduino Uno R3 microcontroller

2.3. P10 Dot Matrix Display Board

The display unit is the interface through which the class can see the desired information. A P10 dot matrix display board was used in this design. The benefits of using the P10 DMD board was to reduce the amount of time it would have taken to solder the individual LEDs. The P10 board did not need the creation of an external row and column driver circuitry, less wires were used, good viewing angle and a life time of up to 8years. The mean time between failure is about 5000 hrs (208 days). The single P10 board which contains 32 by 16 light emitting diodes, 10 mm apart off-centre was cascaded with another P10 board to increase the number of characters to be displayed at a time. Using a 5 by 7 font, and a total of 64 LEDs on both boards, the system was able to display 8 characters at a time. Figure 2 shows the schematic diagram for connecting the ribbon cables to the Arduino board while Figure 3 shows the P10 dot matrix board.

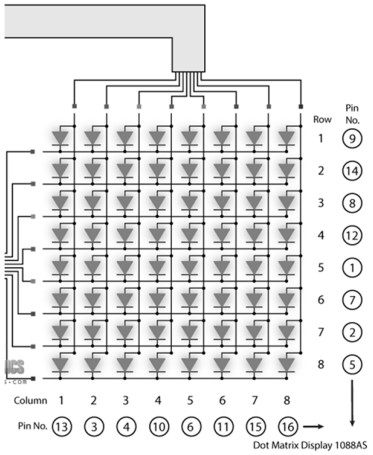

Figure 2: Internal structure of the dot matrix display

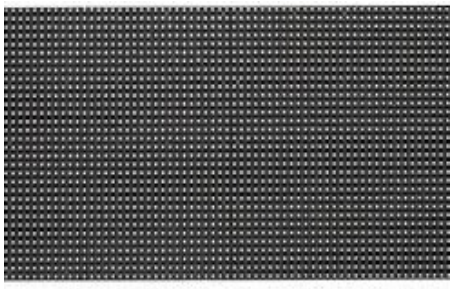

Figure 3: P10 dot matrix display board

2.4. Ribbon Cable

Figure 3 shows the ribbon that was used. The ribbon cable (also known as multi-wire planar cable) is a cable with many conducting wires running parallel to each other on the same flat plane. The ribbon is connected to a dual inline connector which enables the ribbon to be connected to male connectors on the dot matrix board. The function of the ribbon is to send power and data communication signals from the Arduino board to the dot matrix display board. The characters displayed on the board are only made possible by using this ribbon. The pinout diagram for connecting the ribbons to the Arduino is shown in Figure 5.

Figure 4: Ribbon cable and dual in line connector

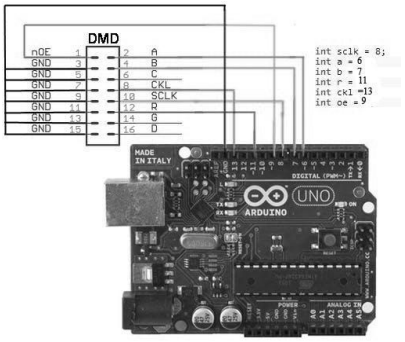

Figure 5: Pinout diagram of the ribbon connector to the Arduino board

2.5. RTC DS3231

A real-time clock (RTC) IC module is a small timekeeping device that opens all sorts of possibilities for Arduino projects. Once set with the current time and date, an RTC provides accurate time and date data on request (Boxall, 2013). The real time clock module enables the system keep track of time even if there is loss of power to the arduino board. The DS3231 was the clock module used in the project. It is able to keep track of time with the help of a complementary metallic oxide semiconductor (CMOS) battery. Figure 6 shows how the RTC s connected to the Arduino board.

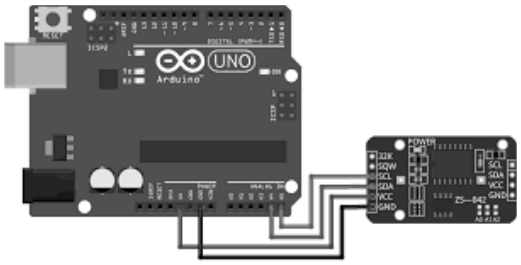

Figure 6: Connecting the real time clock to the arduino board

2.6. Wireless Protocols

These are rules that govern how devices communicate with each other wirelessly. There are various protocols for standard communication in the field of electronics and digital transmission. The Institute of Electrical Electronics Engineers (IEEE) is the body responsible for setting up these standards. There are several wireless protocol standards approved by the IEEE. The wireless protocol used in this study is the bluetooth. The bluetooth wireless technology is a wireless communication system which is intended to replace the cables connecting electronic devices. The features of this technology are robustness, low power consumption and low cost (Okonye and Enukpere, 2019).

2.6.1. Bluetooth module

The wireless communication module used in this work is the HC-05, a Bluetooth module which can be connected as master and slave mode. It has a range of 10 meters, 2 pins for transmitting and receiving serial data. The transmit and receive pins on the Bluetooth module are connected to the receive and transmit ports on the Arduino board. Figure 7 shows the schematic diagram of the bluetooth module connected to the Arduino board. The android application used is the arduino bluetooth controller. This application acts as a virtual serial monitor interface with the Bluetooth module to transmit texts and also receive texts from the arduino board.

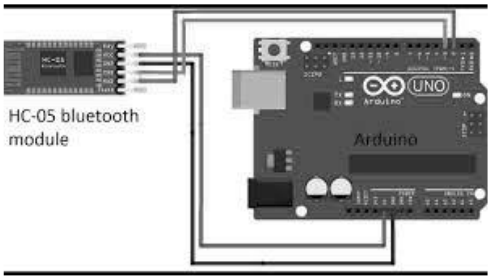

Figure 7: Connecting the Bluetooth module to the Arduino board

2.7. Arduino IDE Compiler

The environment was written in Java and based on processing and other open-source software. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio. (Diptanuprasad et al., 2017). The Arduino integrated development environment is the official software introduced by Arduino.cc, that is mainly used for writing, compiling and uploading the code in the Arduino Device. The open-source Arduino software makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. Almost all arduino modules are compatible with this software that is an open source and is readily available to install and start compiling the code on the go.

2.8. Principle of Class Schedule System

Figure 8 shows the flow of events of the whole system. It also shows clearly the various subroutines or functions that are designed to allow for easy debugging and code management. The system first, displays a welcome message and initializes all parameters. The system then waits for any incoming serial port communication and when there is none, it moves to the date time display function which displays the day of the week, the date and the time. When the date time function is run completely, the course display function is called from the check day function and this is where the actual information of the course for a particular day of the week and time is sent via the ribbons to the display board.

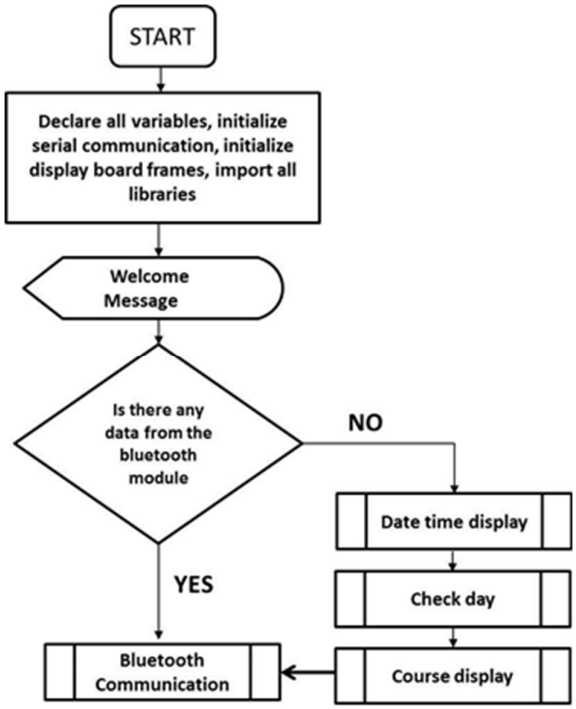

Figure 8: Flowchart of the electronic class schedule system

2.8.1. Bluetooth communication function

The Bluetooth communication is a subroutine or function in Figure 8 is the first function that is run first to ensure that if there exists any data transmitted from the android application, that said data is displayed before the system proceeds with the main display. When the system is turned on, the serial communication port on the arduino board listens for data that may be transmitted from a serial communication device (in this case the android application) via the receive pins of the arduino board connected to the transmit pins of the Bluetooth module. If a string of characters is received, it is stored as a string and the systems displays the contents of the received strings on the dot matrix display board. The Bluetooth function uses this same

method to receive and transmit characters or strings. The duration of the display is a function of the length of the string passed from the android device.

2.8.2. Date time function

The date time function of the system is shown in Figure 9. The function checks first if there is any data on the serial port, if there is, it switches control the Bluetooth communication function. If there is no data being transmitted on the serial communication port, it displays the date time, time and day of the week.

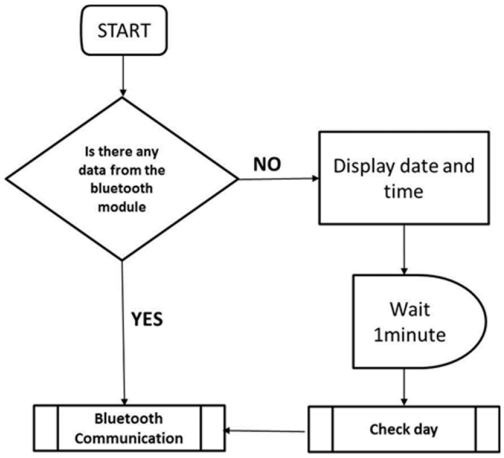

Figure 9: Flowchart for the date time function

2.8.3. Check day function

The check day function is run next. This function displays nothing to the board but helps determine the day of the week and calls the courses for that particular day of the week as shown in Figure 10.

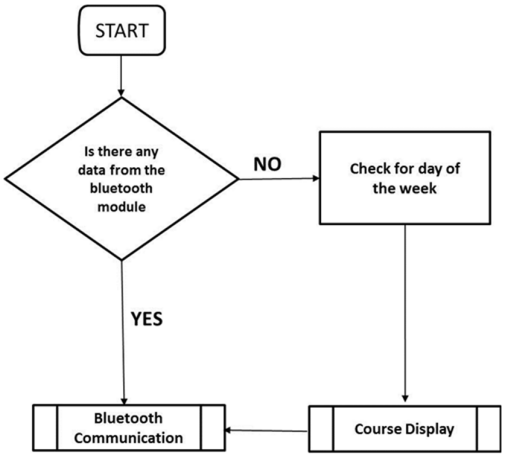

Figure 10: Flowchart for the check day function

2.8.4. Course display function

The last function is the course display function. This is the function that checks the specific hour and minute for a particular day and prints the course accordingly to the dot matrix display. And the whole process goes back to check for Bluetooth serial communication before going back to the start of the date time function.

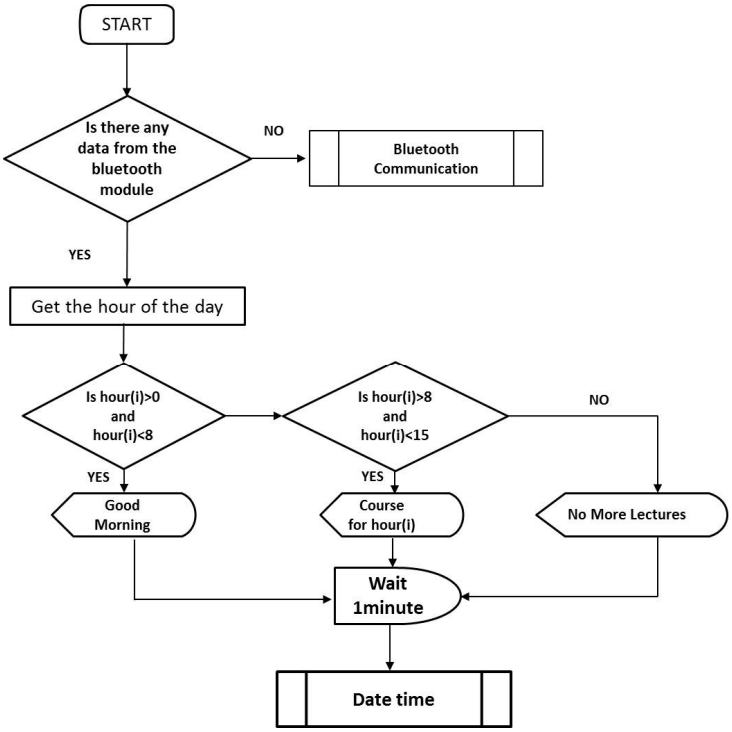

Figure 11: Flowchart of course display function

3. RESULTS AND DISCUSSION

The results of the test showed that the display system worked according to design. The welcome message displayed correctly on the display board as shown in Figure 12. The date and time were displayed correctly as shown in Figure 13. The courses were displayed on the board was according to day and hours of the day as shown in Figure 14. Messages sent to the display via Bluetooth were received 30 seconds and displayed accordingly as shown in Figure 15 after being sent. This is because the Bluetooth subroutine can only be activated after the delay function has finished running. The delay function was set to 30 seconds and no interrupt can occur during a delay function execution. The range of the Bluetooth device was 9.8 meters.

Figure 12: Welcome message on the dot matrix display board

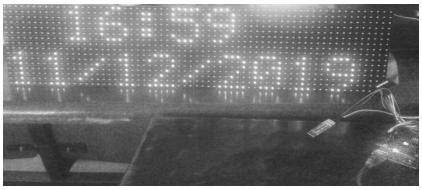

Figure 13: Date and time test display

Figure 14: Course display test as a result of the time of day

Figure 15: Bluetooth test display

4. CONCLUSION

The need for an improved class schedule system cannot be overlooked. The contribution by this project is to ensure that students can now with ease know the course of a particular hour, any day of the week. The system was designed with a certain level of flexibility which was a new addition to the display. Since the courses and their durations are bound to change, an array was created for both time and courses which if there be any need for future modifications to the schedule, only the contents of the array need be changed instead of changing the courses and duration for each day of the week. The work improves on existing dot matrix display system by using P10 boards which required no external row and column drivers, cascading of boards to extend visual clarity is simply by a connection of a ribbon to another board increased view distance to 15 ft. It should also be noted that when uploading codes to the arduino boards, the pins 0 and 1 are default transmission and receiver pins and as such the channel for receiving and transmitting characters from/to the Bluetooth module should be assigned to different pins, usually pins 2 and 3**5.**

5. ACKNOWLEDGMENT

The authors wish to acknowledge the assistance and contributions of the Fona Erhabor (Department of Electrical Electronics Engineering, University of Benin), who helped with instruction manuals on the P10 dot matrix display boards and real time clock module for this research.

6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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