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DEPARTMENT OF MECHATRONICS AND ROBOTICS

MEC104 2023-24

Final Group Project Report

Group Number: B36

Name	Student ID	Contribution Description for ALL Group Projects	Percentage (%)	Signature
Yukun.Zheng22	2251625	ALL	25%	
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Shengyang.Xu	2252795	ALL	25%	

Please record the **overall** contribution percentage of each member, including **ALL** the group works on **LED soldering, Smart Car, Digital Clock and Open Project**. Examples can be found on the slides of Open Project & Group Report.

Leave the following marking form blank.

Group Marks	
Feedback Comments	

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Abstract

Manufacture is advancing rapidly under the wave of digitalization and smart industry. Since the advent of 3D-printing, 5G technology and robotics, manufacture is stepping into the efficient automation stage. The future of manufacture lies in the international trades and booming of advanced automatic system. Under such industry vision, college students have to enhance four core capabilities to adapt to the industry, which are experimental skills, teamwork spirit, innovation, and English fluency. And group work assigned by MEC104 perfectly illustrates these requirements in future manufacture through smart car, digital clock, and open project.

Contents

Part I – Smart Car Racing (Optional)

i. Background

Past decades have witnessed the integration of advanced technologies into transportation systems. In line with this trend, our team has been assigned the task of creating a smart car, a project that not only aligns with the current technological advancements but also positions us at the forefront of the next generation of transportation solutions. This task presents an exciting opportunity to contribute to the ongoing innovation in this dynamic field. The main purpose of this project is to train the soldering skills of students and instruct them to explore the stunning landscape of manufacture by working on groups. Through this project, students can have a preliminary impression of embedded system which will be beneficial for their further journey of study.

ii.Requirement

- ✧ Learn and practice skills of soldering
- ✧ Rehearse the capability of constructing the car from a given diagram
- ✧ Trouble shooting and problem solving
- ✧ Teamwork and professional report writing skills

iii. Idea Development && Experiment

✧ Hardware

1. Arduino Nano Development Board
2. Arduino Nano controller
3. Impact switch
4. IR tracking sensor
5. IR speed sensor
6. Micro switch
7. Emitter; receiver
8. Wheel

✧ Software

- Basic function test (6 tests)

1. LED test
2. Keys
3. Impact / collision switchers
4. IR tracking sensors
5. Motors
6. IR speed sensors

- Black line tracing race

Here is the flowchart outlines our design of codes for black line tracing race.

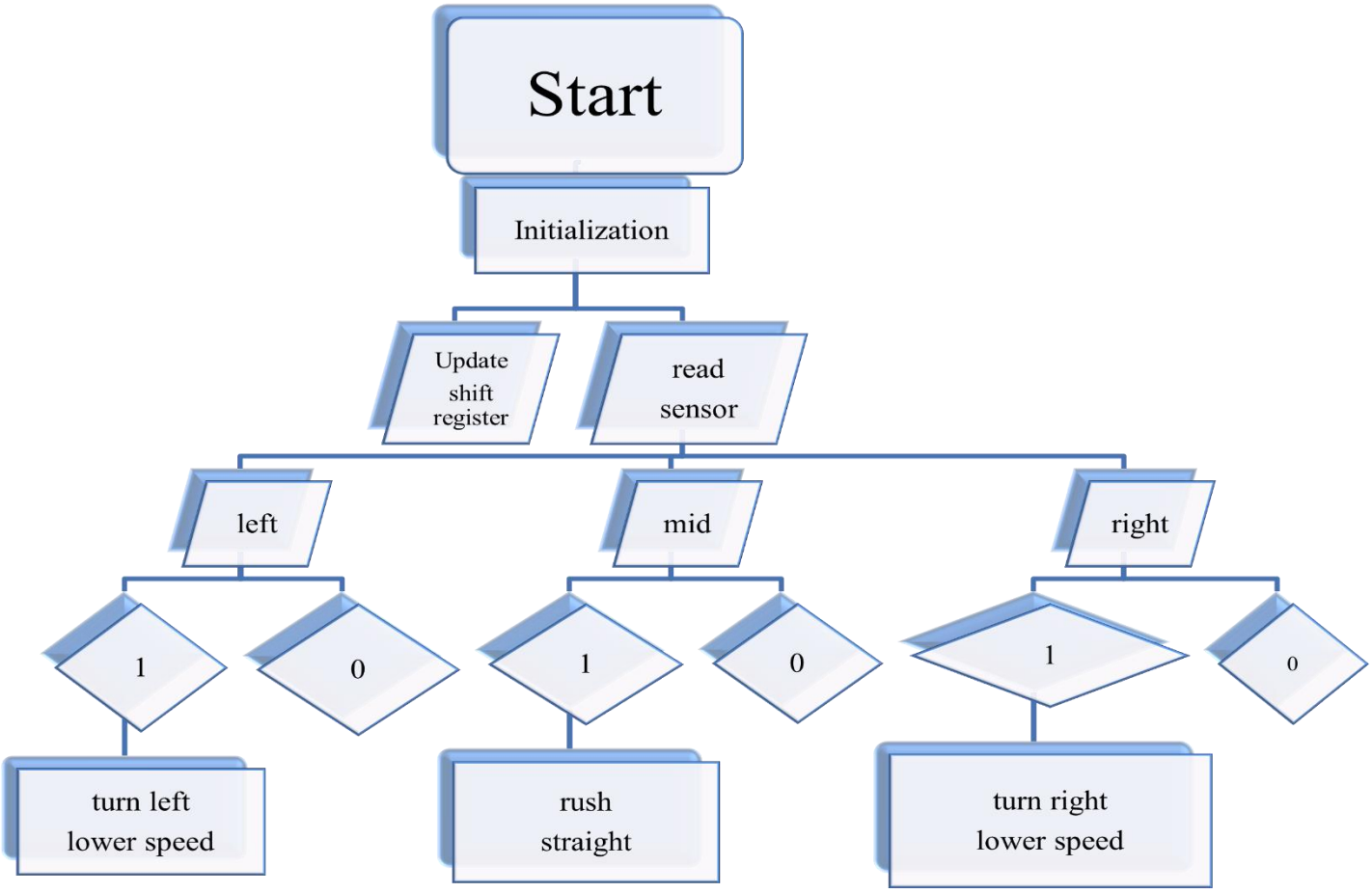

Fig.1. Flowchart of black line tracing race.

iv. Conclusion

In summary, we've finished the basic functionality test and scored 22 seconds in the black line tracking race through our endless endeavor. Undoubtedly, this experience has laid a solid foundation for our continued interest in the field of smart vehicle engineering and has prepared us to tackle more complex problems with increased confidence and expertise. Also, the valuable team work spirit we've learnt can benefit us in the long term.

Part II – Digital Clock

i.Background

In today's information and digital age, time management and control become particularly important. However, with the increasing popularity of digital products today, although there are many digital clock products on the market, how to apply these advanced digital technologies to the design and production of clocks to make them more intelligent and personalized has become the challenge we face. Based on this, we put forward the idea of digital clock project.

The core objective of the project was to design a digital clock that combines modern technology with traditional timekeeping functions. The project is not only a simple product production, but also a process that combines theory and practice, innovation and tradition. Through this project, students are required to gain an in-depth understanding of the design principles of digital circuits, master the production methods of electronic products, and cultivate our innovation ability and teamwork spirit.

ii. Requirement

- ✧ Design a Two-Digit Timer based on the principle of One-Digit Timer
- ✧ Pause and Reset
- ✧ Simulate the circuit on Tinker CAD
- ✧ Build the circuit on bread board

iii.Idea Development

✧ Hardware

1. Arduino Nano Development Board
2. Arduino Nano controller
3. BCD-7 Segment Decoder
4. LED
5. Bread board
6. Resister

✧ Software

- Basic function test (3 tests)

1. Counting test
2. Pause test
3. Reset test

- Design for Pause && Reset

The initial state of the switch is assumed to be "ejected" (high). When the key is pressed, the status changes to "Pressed" (low level). This code mainly controls the pause and continuation of the program by detecting the level state of the pause button. In this code, if the user presses the pause button, the program will enter a waiting state and continue to output waiting information through the serial port. Only when the user releases the button (the

button state goes back to high) and the digitalRead(PAUSE_PIN) == LOW condition no longer holds will the program exit the loop and continue with the subsequent code.
The reset function also assumes that the initial state of the button is "up" (high). When the button is pressed and converted to low level, the reset logic is triggered. This code handles the function of the reset button. When the reset button is pressed, the program resets the counter to 0 and immediately updates the digital display.

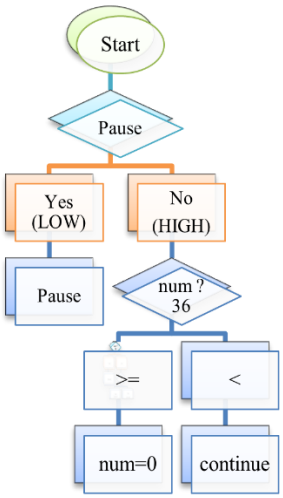

Fig.2. Pause.

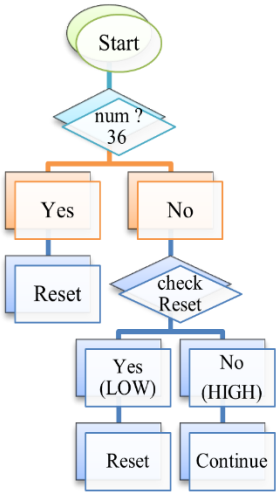

Fig.3. Reset.

iv.Experimental process

- Coding

It is worthwhile to present our explorations during the design. Initially, we were intended to control our buttons only by two states, which were pressed and non-pressed. But it came to us that the buttons did not function as we've ever expected. I even asked my program to Artificial Intelligence for assistance, but not worked. The breakthrough did not occur until I pressed the button unconsciously, what hit me was that the button also contained a state called "ejected state". However, how to manage the new state became the core problem we've puzzled. At first, Yaoran. Xu 22 proposed a method by regulating a state variable in the setup function, and we just needed to check the state of it. Despite his wonderful brainstorming, it is impossible for us to utilize one global variable "state" to control the output of buttons. Later according to the hint provided by TA, we've overcome it.

- Circuit building

We built the circuit successfully thanks to the wisdom of our team members Yiming. Liang 22 and Shengyang. Xu 22.

v.Conclusion

In summary, we successfully finished the task of designing a digital clock by our team work after countless testing and modification of our codes and circuit structure. Through this experiment, I have a deep understanding of the basic principle of digital clock and its design process, but also master the related hardware connection and programming skills. Regarding hardware, we command the methods of transferring a circuit diagram to the real bread board. Considering software, we've learnt how to program to create an interface between the Arduino and computer, providing a robust basis for us in the next section—open project.

Part III – Open Project

i.Background

Global warming has become one of the hottest topics in 21th century. The main reason of such phenomenon lies on the excess carbon emission in routine. China, also known as a big country with the most carbon emission, is taking initiative to promote the concept of green life domestically, and launch relevant societal educational activities regarding to it. Local government respectively focus on urban greening without hesitation. For each family, the balcony is utilized as an alternative to keep several green plants by many people. However, it occurs to most families that they do not have the time to take care of the greenery because of the busy work and life, leading to the death of the plants due to the absence of care. Motivated by this, we make up our mind to design a automatic watering system to help them manage their plants.

ii.Requirement

- ✧ Design an automatic watering system
- ✧ Read temperature, humidity
- ✧ Make response to water under conditions
- ✧ Build circuit on bread board
- ✧ Simulate circuit on Tinker CAD

iii.Idea Development

✧ Hardware

1. Arduino Nano Development Board
2. Arduino Nano Controller
3. Temperature and Humidity (DTH11)
4. Mini LCD screen 128 x 64
5. Relay
6. Soil Moisture sensor
7. Water pump && Pipes (purchased by ourselves)
8. Acrylics storage container (purchased by ourselves)
9. Soil (purchased by ourselves)
10. Plants && Flowers (purchased by ourselves)

✧ Software

- Basic function test (5tests)

1. Temperature showing on serial monitor test
2. Temperature showing on LCD test
3. Moisture showing on serial monitor test
4. Moisture showing on LCD test
5. Water Pump working test

- Flowchart of design

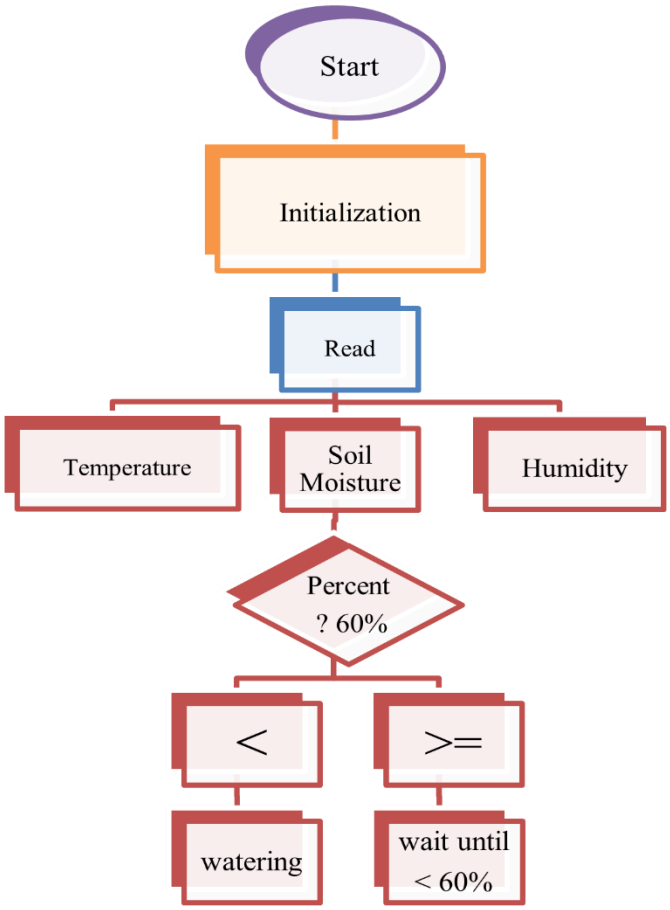

Fig.4. Irrigation system.

iv.Schedule

- ✧ Task overview

1. Part 1: Read and display temperature and humidity on LCD
2. Part 2: Read and display soil humidity on LCD and feedback to pump

- ✧ Lab attendance

1. **May. 3th**
2. **May. 6th**
3. **May. 10th**
4. **May. 17th**

- ✧ Task distribution

1. **Hardware group: Yiming. Liang 22; Shengyang. Xu 22**
2. **Software group: Yukun. Zheng 22; Yaoran. Xu 22**

v.Experimental process

- ➢ **Lab session 1 (May. 3th)**

Our target for this section is finishing connecting the circuit and displaying the temperature and humidity on the LCD. Firstly, we use Tinker CAD to draw the simulation circuit as below. Then, our hardware group started

building the circuit to the bear board. At the same time, software groups began coding according to the instructions. After both groups complete their tasks, we load the program to the Arduino. However, it occurred to us that nothing happened regardless of non-error reporting on Arduino IDE. Shengyang. Xu 22 proposed that the occurrence of this situation might be due to the incompatibility of this type of LCD and the head file 'Adafruit ST7735'. After our brief negotiation, we agreed with his brainstorming, and searched on Google to find more information about LCD. Abruptly, **Yaoran. Xu 22** jumped up from the chair and told us may be 'u8g2' head file can match our demand. Although we were not sure whether this method works, we attempted and compiled again, only to find none changes. The time went by unconsciously, which approached the end of our first lab. I wrote a program based on 'u8g2' head file to test the LCD for the purpose of checking the validity of our assumption. Fortunately, it worked, a message 'hello world' appeared on the screen of LCD! Admittedly, we did not finish the task of printing out temperature and humidity on the screen of LCD. However, we still made a progress of printing put the defined words on LCD.

- **Lab session 2 (May. 6th)**

Considering the incomplete task left from the last section, our target for this section is to display the humidity on the LCD. After modulating our program slightly, we wanted to display it on the LCD and loaded. However, it didn't work again. Since we have utilized the 'u8g2' library and correctly programed it, but why there wasn't anything appeared on LCD? **Yiming. Liang 22** reported a fact to us that the light bulb of DHT11 did not brighten at all. We attempted to validate the linking of DHT11 to the circuit built on bread board, and we've found nothing inappropriate. Trapped in the bottle neck, we reached TA for assistance, and the breakthrough occurred. The simulation diagram we've drawn of DHT11 and was different from the real equipment. To be specific, the 5V pin linking between Arduino and DHT11 in the picture is not the same as what we were given, leading to the inadequate voltage supply to DHT11, so that was the reason why the LED on DHT 11 did not brighten. Leveraging this opportunity, we optimized our circuit design and made DHT11 work successfully. And this time, we did not directly display the information on the LCD, but chose to display them on the serial monitor first by utilizing 'Serial in'. Finally, we successfully presented the real-time temperature and humidity on the serial monitor near the end of the lab. In summary, regardless of some progress, the task of displaying information on LCD was procrastinated to the next lab.

- **Lab session 3 (May. 10th)**

We were going to finish the task of displaying the information on the LCD screen. Initially, we changed the basic structure of our program from 'Serial-in' to 'Print-out'. But, nothing displayed on LCD. **Yaoran. Xu 22** suggested that there was another method for printing called 'u8g2.print', and the main issue for 'u8g2.drawstr' which was the way we've adopted before could lie in the memory of buffer regions, and the incompatibility of the font-type. That meant it was troublesome to include all the constrain conditions for this program. Then, we tried 'u8g2.print' which could alleviate the influence brought by large dynamic memory of buffer. However, the LCD kept its status as before. In this desperation, **Shengyang. Xu 22** reminded that was there a possibility that something has been printed, but just we could not see. Luckily, his words proved correct, and we wrote 'u8g2.setContrast(100)', and found something happened. However, this time was a mixed blessing. The good news was that there was something printed on the LCD, while the message it sent was random codes with errors. When we were reexamining our program, I noticed that the message on Arduino IDE showed that we had a large dynamic memory allocation. Then, I deleted some libraries and made our code more simple. Fortunately, we've succeeded with temperature, moisture printed on LCD! After a short break for celebrating our success, then we moved to the Part 2, and finished linking the Soil Moisture Sensor and Relay to Arduino and bread board till the end of this lab.

- **Lab session 4 (May. 17th)**

Recalling the last session, we have successfully printed the information on the LCD. So, this lab required us to build the sealed environment by the materials we've bought on the internet (Acrylics storage container && Pump && Pipes) first, then ensured the functionality of watering flowers under a particular bound of soil moisture and ultimately recorded our video. Regarding the "infrastructure" of our "room", we've prepared two acrylics storage container, respectively for storing water for pump (smaller one), and setting the soil and plants (larger one), and we adhered the smaller one to the inner walls of the larger one by hot melt adhesive provided by the lab. When it comes to the functionality test, we were once trapped on the validity of our program. Despite the correct logic, what bothered us was the maximum permittable output length of characters of one line and the total permittable number of lines on LCD to manifest the information. Also, what we explored was that the LCD we've utilized can permit at most 6 lines and one line can store at most about 18 characters. Thus, we revised our code by merging the temperature and moisture together in one line and modulated our definition of the coordinates of information presenting under the upper bound "u8g2.setCursor(0, 60)", finding the pump working as our expectation (when soil-moisture is under 60%, then watering and vice versa). Last but not least, we selected a lawn near AS building to blend our system with enchanting sunset and coziness, and then began our video recording.

vi.Conclusion

In conclusion, we successfully completed the task of designing an automatic watering system which echoes the vision of this module. As described in the preceding session, the process of our experiment was largely arduous. We continually made mistakes and learned from them, accumulating experience that ultimately led to breakthroughs under each sessions. But the thrill after making a periodic progress by our wisdom and teamwork could not be replaced by anything. To be honest, we've never imagined we could collaborate to create such a system by our hands in the beginning. However, it was our persistence and teamwork spirit that converted the impossibility to possibility. No one either complained about the hardships of the experiment, nor did anyone give up in the halfway. Everyone in our team supported each other during the toughest times, and that's how we achieved success. Perhaps this is what growth is all about in our life and also where the significance of this module (MEC104) lies in.