ENG 20009 - Engineering Technology Inquiry Project Semester 1 2023

Final Project Report

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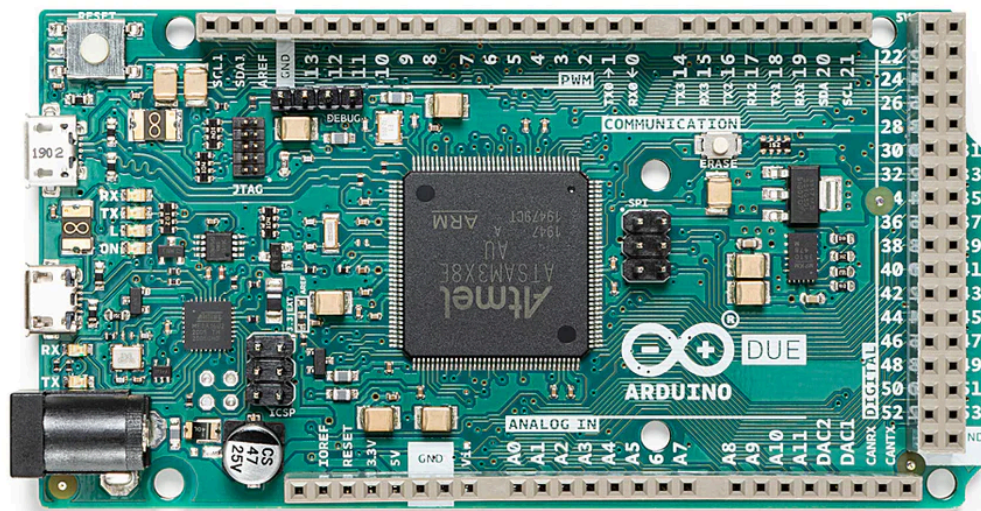Tutor and Time : Khanh Ha Nguyen, Thursday 12.30-2.30pm

Figure 1 : Arduino Due (https://store-usa.arduino.cc/products/arduino-due)

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FlowChart / PseudoCode

Pass Task

Presented in Figure.1 is the flowchart, and in Table.1 is the pseudocode.
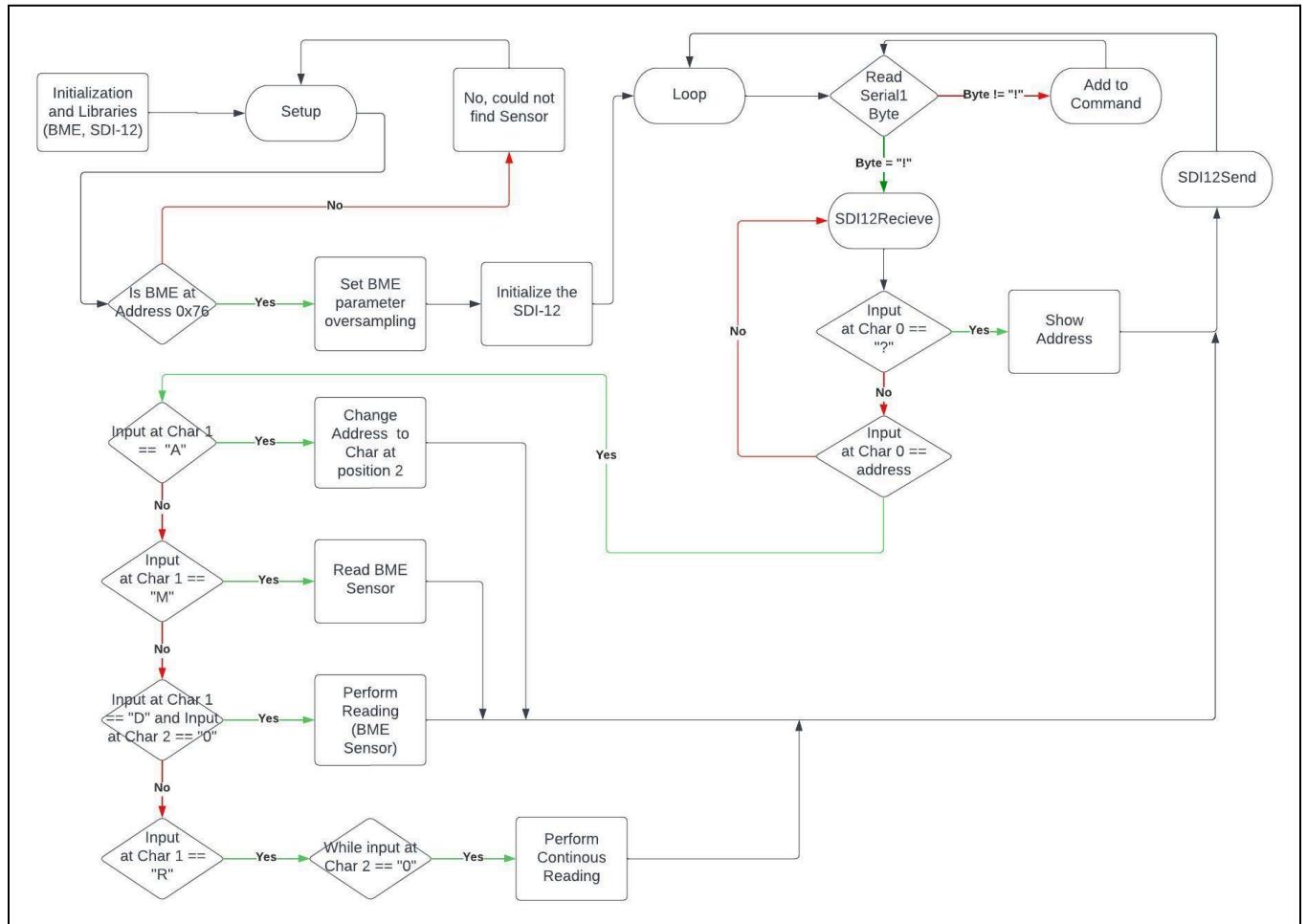

Figure 1. Flowchart of Pass Task

```
Include libraries
       Wire.h
       Adafruit_Sensor.h
       Adafruit_BME680.h
Define SEAPRESSURELEVEL ()

BME680 Setup;
BME680Address = 0
SDI12 Setup
Define DIRO 7
Command string, used in Loop;
```

```
SDI12Address = 0
deviceIdentification = "BME680 Sensor"

setup(){
Start serial monitor

If BME is not at address 0*76 {
        Print to Serial "Could not find Valid BME680 Sensor"
        While Serial
}
Set oversampling for the BME680 pressure, humidity, temperature and gas resistance
bme.setTemperatureOversampling(BME680_OS_8X)
Etc…

Start SDI12 UART serial monitor
        Set DIRO pin to OUTPUT
        Set DIRO to HIGH so it can receive data
}
loop(){
        Integer for the byte
        If SDI12 communication is available {
                Byte = Serial1.read()
                If byte == 33 //!
                        SDI12Recieve(command)
                Else
                If byte does not equal 0
                        Command = command + the new byte
                }
}

SDI12Receive (String input){
Convert device address to string
If input at position 0 == "?"{
        SDI12Send(address);
}
If input at character 0 == address {
        If input at position 1 == "A" {
                SDIAddress = input as position 2 . convert to integer
                Address = input at position 2, convert to string
                SDI12Send(address)
        }
        If input at position 1 =="M" {
                bme.beginReading()
                Delay 3 seconds
                bme.endReading()
                SDI12Send(address + String of seconds it takes to get measurement and total
sensor parameters)
        }
        If input at position 1 == "D" and input at position 2 == "0"{
                SDI12Send (address + converts all to string (bme.temperature) + etc….
        }
        If input at position 1 == "R"
                While input at position =="R"
                        If input at position 2 == "0"{
                                SDI12Send(address + string(bme.temperature) + etc…
                        }
                        Delay 3 seconds
                        Integer for byte
                        If serial1 SDI12 UART is available{
                                Byte = serial1.read()
                                If the length of the input is > 0
```

```
                                }
                                        Break;
                                }
                        }
                }
}

SDI12Send (string message) {
        Print message to serial monitor
        Set DIRO pin to LOW so SDI12 can send data
        Send message over SDI12 serial port
        Flush serial port so message is sent
        End serial port to reset it
        Begin serial port again
        Set DIRO pin to HIGH so it can receive data again
}
```

Table 1. Pseudocode of Pass Task

Below in Figure.2 is a better made flowchart for the pass task, with an easier to understand structure, the writing is blurred however :
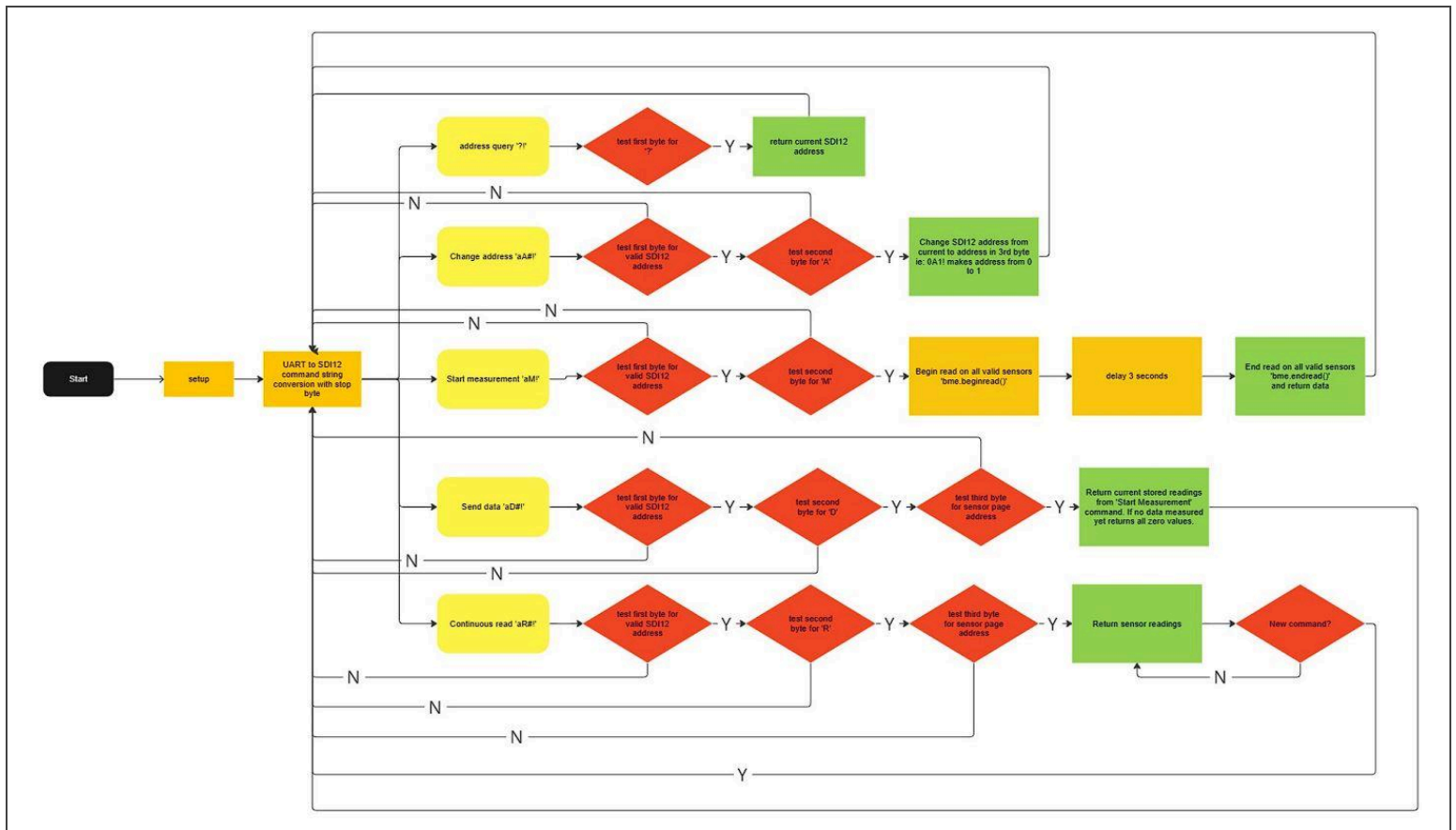
Figure.2 Another Flowchart for the Pass Task

Credit Task

The following is a flowchart for the Credit Task, obviously in the actual code the SSD and BME680 sensor is not fully functioning but the idea is still the same.
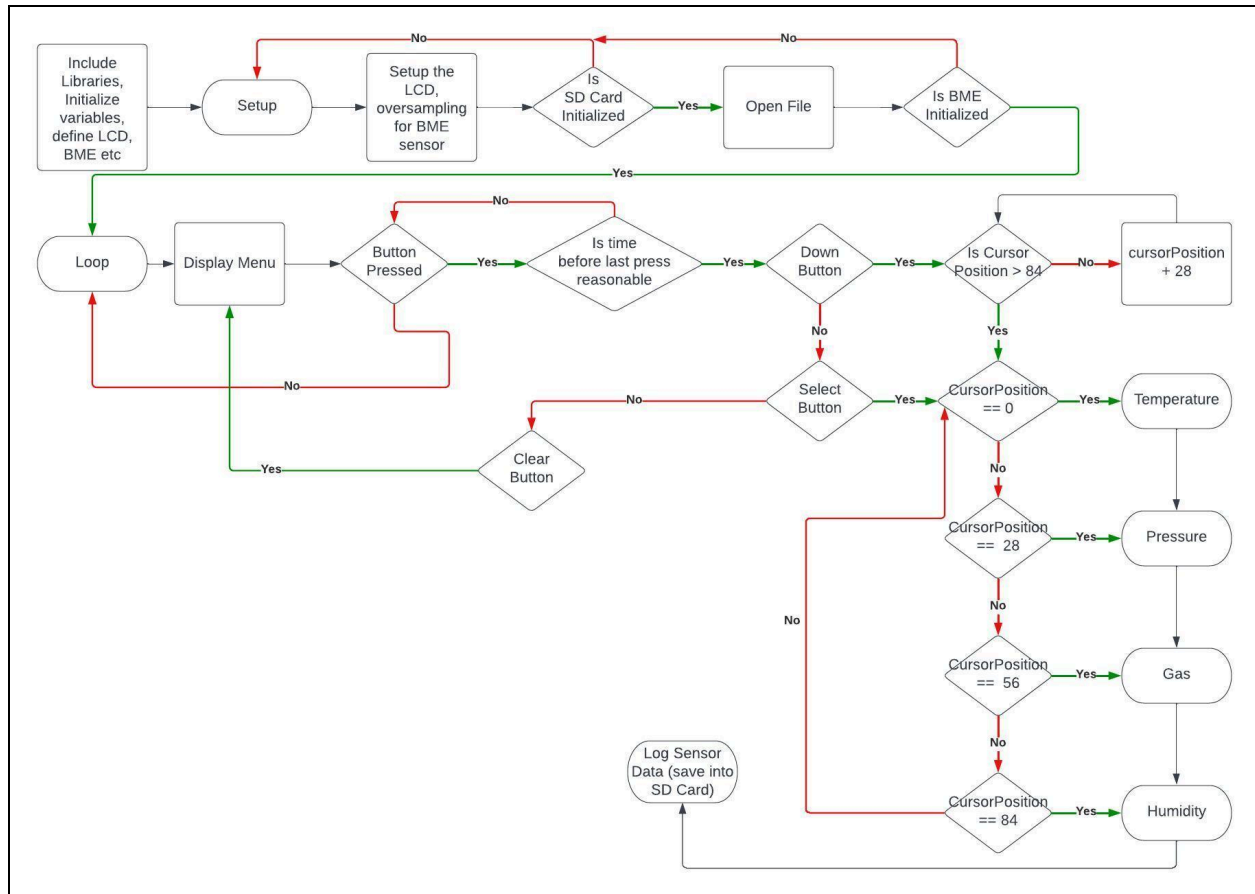
Figure 3 : Flowchart of Credit Task

It should be noted that the SDI12 communication has not been implemented yet. In theory it would tie in with the pass tasks use of a continuous measurement with the SDIRecieve and SDISend function so the computer can translate the data from the sensor.

Risk Assessment

The following is a General Risk Assessment on the Application of Pressure Sensors in Medical Devices and Surgeries. The most important part is the identification of hazards, which when considering the use of BME680 sensor paired with an SDI12 in the medical field is plentiful. For each hazard, it lists who is affected and how, as well as control measures which could be used to make it less of a risk / hazard.

It should be noted how the risk matrix works: numbers are calculated, the uncontrolled risk score and the residual risk score. Both are calculated using the risk identity matrix, which takes into account the chance of it happening, how severe the consequences could be and the priority to fix it. The higher the score the worse the risk / hazard is. Obviously this is subjective but when considering medical application the risks are much higher across the board.

The following is a link to the PDF of the actual General Risk Assessment, but below is a summarization of the document including all important information :
(https://drive.google.com/file/d/1ke6M2lV2mGiSCtt7WKMdkqvU4f6d5Ccd/view?usp=sharing)

In general it should be noted that all the hazards will only affect patients. Here is a list of the hazards discussed :

Hazard / Risk	Uncontrolled Risk Score	Residual Risk Score
Sensor Drift / Inaccurate Readings	22.5	8
Tissue Damage & Complications	12	10
Dislocation of the Device and Mechanical Lifespan Issues	11	10
Delivery & Removal Procedures	9.5	8
Infection Risk	17	13

Table 2. Hazard / Risk Scores

When considering the above results it really shows the importance of creating a General Risk Assessment, the best example of this is for Sensor Drift and Infection Risk, as both drop heavily once countermeasures have been implemented. Looking at the other hazards, they were not high level threats to start, so finding a way to lower their result is very difficult. It should be noted that the BME680 is not practical for taking in body measurements at all, nor does the SDI12 program have the ability to receive data wirelessly. Due to human lives being at risk, the actual consequences of any of these happening is very high, and that is very difficult to lower unless there are great advancements in technology which reduce the rarity of it occurring to near 0.

Knowledge Reflection

When beginning this project, I thought I was capable of completing the Pass, Credit and having an attempt at the Distinction task. I believe the weekly tasks during the 1st 7 weeks of semester was a good indication of how I would perform in the final project. I sat around credit and completed some of the distinction tasks. I took long notes on all the content we learnt every week, trying to get a thorough understanding of each topic.

Moving onto the final project, I would say I was slightly confused about the SDI12 but took the time to research and summarize all the information I could find. For the pass task I researched all of the functions and what they were supposed to do. I believe I have great knowledge of how the communication of the SDI12 works in tandem with the arduino and computer.

When looking back at my understanding of the Credit task I definitely underestimated how difficult it was going to be. I knew I had ideas of how it could be achieved but I struggled a lot trying to get a process to work in the program as a whole. I knew how to debounce the button, create a menu and display data. But to be able to make the menu interactive with the buttons, as well as have a graphical display was going to be a challenge. Considering the SD card, I believe with a few slight tweaks mine would've worked, as I don't think it was very complicated, the library only had a few useful functions for what we needed to do. Getting the menu to be interactive was a very difficult challenge, when I eventually figured it out I was really happy with myself. I spent around 6hrs getting that to work. I started with a scrolling menu that would go from sensor to sensor, but in the end I thought using the "<" to indicate which option it was on was more effective. I then went home and implemented the SD and BME680 sensors which in theory I thought would work but didn't when we tested it the morning before the demonstration. I also understand that I would've needed to implement the SDI12 function we created to send and receive the data from the sensor.

Looking at the other topics, my ability with the LCD was not great, I had used the SSD1306 throughout the semester so learning how to use the TFT was quite a challenge, but I know if I had more time, using its ability to have different colors on the graph would've been great. I also think I have a rough understanding of how I would have created a graphical representation. By mapping the BME sensor data into a y function, and having it plotted against the RTC (real time clock) it could've worked, but this is all in theory and would've been a large challenge.

Moving on to the distinction task, I never got to attempt it, but I had a few ideas and know I could've used external interrupts for the push buttons, using an Interrupt service routine to refer to the select, down or clear. I could've also used a timer interrupt for getting continuous measurements, this would've been helpful when graphing the sensor data.

In my honest opinion I think I have a good understanding of most of the content but ran out of time. I believe I'm good at coming up with ideas but have trouble getting them to function with the program or getting multiple ideas to actually work together. I definitely need to continue practicing my code, another group in our class had the HD tasks done and their code was pretty brilliant. I have a lack of understanding object oriented programming which they used to simplify their code, making it much shorter while having more functionality.

Looking at the Arduino Due, I spent time looking at the wiring configurations we were given, it was not much of a challenge as the guide was good, I went through the weekly resources given on the SDI12 as well as the wiring with our entire group so we all had a good understanding, I am also doing the Electronics Design unit this semester so I had prior knowledge.

Teamwork Reflection

Below is a list of the teammate characteristics that I believe fit me and examples of why :
  1. Initiator
During the project I was always pushing myself to think of new ideas that I would share with everyone. It is why I ended up doing the credit task by myself, and bounced a few ideas off of others to get the

program fully functional. I made sure not to wait or be stagnant with the work, attempting it as soon as I had the time.

2. Information Seeker

Whenever there is a problem I am always looking for new information, and when I am confused about something or have a misunderstanding I will reach out to other members or look for external resources to make sure I have a proper understanding.

3. Information Giver

Any resource I thought was helpful I would share it in the group's discord, this included links to function ideas for the SDI12, any ideas I had personally for the code and all my notes. I was always willing to give as much info as I could.

4. Summarizer / Clarifier

I always restated any information we had, I have a few summaries of the codes to make it easier to understand. I thought it was important to make everything we had as easy to understand as possible. My notebook was both a collection of ideas, but it also contained succinct summaries of all of the required content that I could always refer to or show others if they needed any clarification.

For the entirety of the project I was happy with my participation, the only thing I really wish I did better was to be more encouraging to the group, I think we kept a realistic goal but I wish we pushed a little bit harder to get the credit task completely finished, as I thought my code was really close. I also sometimes tended to topic jump a little bit, throwing out a lot of ideas but not exploring them properly, this might've confused some team members.

Moving on I think it is important to talk about the Task Division. As a group we decided it was beneficial to work on all the tasks as a collective, everyone searched for information, and any ideas were to be shared and discussed in our team meetings. I was at every team meeting we had, there were definitely some communication issues. I think before the last 2 weeks we could've had a better plan, and used our time more efficiently if we were all working together. I would often ask questions in discord with delayed responses which could be frustrating, in the end it worked out however. We had many team meetings in weeks 11 & 12 where everyone would work together on the task. When it came to the pass task everyone contributed, especially with debugging to make sure the program worked too 100%. I took initiative to attempt the credit task, I got pretty far with it but ran out of time in the end.

I thought I really pushed myself to be a good team member for this task, I tried to nurture a good environment, where all ideas were valid and when we met up a lot of work was done efficiently and effectively while still keeping a positive attitude. I am a known introvert, but tried to speak up more often, sharing my ideas with the group and being helpful when I could. I think no one in our group was an extrovert, which definitely helped as there was no one sucking up all the attention, I think everyone felt like they had a role and were important to the task. In future however I think I would still struggle if I was in a group full of extroverts, as I tend to shy away if I feel like I am not being listened to and just work independently. I thought honesty was really important in our group as well, our positions, what we thought was achievable and our personal skills. By doing this it made everyone more willing to participate, and stopped the group from having any conflicts.

Looking at my communications with the stakeholders, being teachers or coordinators I thought I did an acceptable job. I tend to avoid asking for help from them, but whenever I was in class I would clarify anything I was confused about, as well as talk about future ideas and how they could be implemented. Making sure to really listen and get my ideas out properly.