2023

Project Report

ENG20009

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Abstract:

This report is a reflection on the completion of an Arduino-based project with an emphasis on collaborative effort and individual contributions. The report analyses specific parts of the team's pseudocode developed by me. A risk assessment and thorough knowledge of the project and the Arduino platform.

Pseudo code:

```
Import libraries: Wire.h, Adafruit_Sensor.h, Adafruit_BME680.h, BH1750.h

Declare global variables:
- Adafruit_BME680 bme
- BH1750 lightMeter(0x23)
- String command
- int deviceAddress = 0
- String deviceIdentification = "allccccccccmmmmmmvvvxxx"

setup ():
    Initialize Serial communication at 9600 baud rate

    // BME680 Setup
    Initialize BME680 sensor with address 0x76
    If BME680 sensor is not found, print error message and halt the program
    Set temperature, pressure, and humidity oversampling levels

    // BH1750 Setup
    Initialize I2C communication
    Begin communication with BH1750 light sensor

    // SDI-12 Setup
    Begin Serial communication with SDI-12 at 1200 baud rate, 7 data bits, even parity, and 1 stop bit
    Set DIRO pin as OUTPUT and set it to HIGH to receive from SDI-12

loop ():
    If there is data available from SDI-12:
```

```
    Read the incoming byte
    If the byte is a command terminator (!):
      Call SDI12Receive function with the received command
      Reset the command string
    Else:
      If the byte is not the start bit (0):
        Append the byte to the command string

SDI12Receive(input):
  If input is "?" (Address Query command):
    Call addressQueryResponse function
    Return

  If the command is addressed to this device (first character of the input matches deviceAddress):
    If the command is "D1" (Start Measurement command):
      Perform BME680 reading
      Create a data string with temperature, humidity, pressure, and gas resistance values
      Call SDI12Send function with the data string and "data" type
      Print a message indicating the response to D1 command

    If the command is "D2" (Light Measurement command):
      Read the light level from BH1750 sensor
      Call SDI12Send function with the light level as a string and "data" type
      Print a message indicating the response to D2 command

    If the command is "R0" (Combined Measurement command):
      Perform BME680 reading
      Create a data string with temperature, humidity, pressure, and gas resistance values
      Read the light level from BH1750 sensor and append it to the data string
      Call SDI12Send function with the data string and "data" type
      Print a message indicating the response to R0 command

    If the command is "M" (Manufacturer Query command):
      Create a response string with the device identification
      Call SDI12Send function with the response string and empty message type
```

```
            Print a message indicating the response to M command

        If the command is "A" (Address Change command):
            Extract the new address from the input
            Call changeDeviceAddress function with the new address

SDI12Send (message, messageType):
    If messageType is "address":
        Print "Device Address: " followed by the message

    Else if messageType is "data":
        Print deviceAddress, "+", and the message

        Prepend deviceAddress to the message
        Set DIRO pin LOW to transmit
        Delay for 100 milliseconds
        Send the message over Serial1
        Flush the Serial1 buffer
        Set DIRO pin HIGH to receive

addressQueryResponse ():
    Call SDI12Send function with deviceAddress as a string and "address" type
    Print a message indicating the response to Address Query command

changeDeviceAddress(newAddress):
    Convert newAddress to an integer
    If newAddress is a valid address (between 0 and 9):
        Update deviceAddress with the newDeviceAddress value

        Print "Device address changed to: " followed by deviceAddress

        Call SDI12Send function with deviceAddress as a string and "address" type
```

This the pseudo code for the pass task the team did. Unfortunately, as each of the members contributed to the whole code it is hard to separate individual parts. The parts I did, I will attach them below,

```
Import libraries: Wire.h, Adafruit_Sensor.h, Adafruit_BME680.h, BH1750.h

Declare global variables:
- Adafruit_BME680 bme
- BH1750 lightMeter(0x23)
- String command
- int deviceAddress = 0
- String deviceIdentification = "allccccccccmmmmmmvvvxxx"

If the command is "A" (Address Change command):
        Extract the new address from the input
        Call changeDeviceAddress function with the new address

changeDeviceAddress(newAddress):
   Convert newAddress to an integer
   If newAddress is a valid address (between 0 and 9):
      Update deviceAddress with the newDeviceAddress value

      Print "Device address changed to: " followed by deviceAddress

      Call SDI12Send function with deviceAddress as a string and "address" type
```

This pseudocode represents the team's collaborative effort in completing the project demonstration for Group 4. Each team member made an equal contribution to the codebase. However, to ensure efficient progress, specific tasks were assigned to each member. My dedicated task involved the implementation of the 'changeDeviceAddress' functionality, it also included the installation and initialization of relevant libraries and variables. Additionally, I actively assisted the team in addressing other aspects of the codebase and provided support in the setup and troubleshooting of sensors and the board.

Risk assessment:

In this section, we will conduct a comprehensive risk assessment for the applications of the BME680 and BH1750 sensors. The risk assessment will be based on the information provided in the General Risk Assessment conducted in Week 8 of the unit. This analysis aims to demonstrate a deep and broad understanding of risk assessment principles and their application to the project work in ENG20009 - Engineering Technology Inquiry Project.

Risk Assessment No.: *1*	Date: 31/05/2023	Version No.: 1	Review Date: 01/06/2023	Authorized by: Rifai Chai

Step 1: Enter information about the task, activity or health and safety issue, including the location and the people completing the risk assessment		
Reason for this risk assessment: ☐ New task ☐ New information ☐ Change to existing work environment/task/object/tool ☐ Report of injury ☐Cyclic review ☐ Identification of a health and safety hazard ☐ Other: ____________________		
Location (including building and room): AD103	**Assessed by: Rifai Chai**	**HSR/worker representation: Rifai Chai**
Description of task/activity/issue (if necessary, observe/analyze the task being performed by different people at different times to capture variation in workflow) The core focus of this unit revolves around the development of an SDI-12 sensor and data logger, employing an engaging project-based learning approach. Students are organized into groups, each consisting of five members with designated roles and corresponding responsibilities. The project encompasses the selection of sensor pairs, offering a diverse range of options such as temperature, humidity, pressure, gas, and light intensity. These sensors are seamlessly integrated with an Arduino microcontroller, utilizing I2C or UART communication protocols. Through skillful programming, the Arduino enables efficient data acquisition and interpretation of SDI-12 commands. The evaluation phase incorporates the utilization of UART to SDI-12 and SDI-12 to USB converters. A self-contained device has been intricately designed to record sensor data and real-time clock information onto an SD card. Complementing the system's functionality is a visually appealing graphical user interface, featuring a menu-driven interface and an LCD display. This interface empowers users to effortlessly select sensors and visualize data through captivating graphical representations.		

Hazards to consider					
Sensor Integrity	The BME680 and BH1750 sensors are delicate and mishandling them can lead to damage and impairment of their functionality.	Incorrect Wiring.	Improper installation of wire ends into pins poses a risk of short circuits or damage to the BME680 or BH1750 sensors, potentially resulting in permanent damage to the sensors.	Software Failure: Addressing Malfunctio n Risks	The malfunction of the software responsible for processing sensor data can give rise to inaccuracies in measurements, false alarms, or the failure to detect critical incidents.
Personal Safety	During the laboratory sessions, it is essential for students to adhere to appropriate attire guidelines, particularly emphasizing the necessity of wearing closed-toe shoes. This precaution ensures the safety of the legs in case of any accidental object falls or impacts.	Electrical Hazard	There is a potential for electrical hazards when the sensors are connected to a power supply, including risks such as short circuits and electrical shocks.	Technical Complexity	The BME680 and BH1750FVI sensors present technical challenges related to calibration, data interpretation, and integration within the broader system.
Noise pollution	Excessive auditory stimulation resulting from the activation of buzzer sounds can potentially lead to discomfort or harm to the auditory system.	Project Management	Inadequate project management practices have the potential to result in project delays, surpassing allocated budget limits, and breakdowns in communication.	Data Loss	The possibility of SD card corruption poses a hazard that may lead to the loss of crucial sensor data.
Risk of eye damage	There is a potential risk of ocular damage associated with the exposure to high-intensity light during the testing of the BH1750 sensor.	Water damage	The BME680 and BH1750FVI sensors are vulnerable to the risk of water damage, which can lead to hardware malfunction and inaccurate measurement readings.		

Step 2: Risk rating – risk matrix and definitions

		Consequence				
		Minor 1	Disruptive 2	Significant 3	Critical 4	Catastrophic 5
Likelihood	Almost Certain 5	Moderate 5	Major 10	High 15	Very High 20	Very High 25
	Likely 4	Moderate 4	Moderate 8	Major 12	High 16	Very High 20
	Possible 3	Low 3	Moderate 6	Major 9	Major 12	High 15
	Unlikely 2	Low 2	Moderate 4	Moderate 6	Moderate 8	Major 10
	Rare 1	Low 1	Low 2	Low 3	Moderate 4	Moderate 5

Likelihood	
Almost certain:	99% probability Could occur within 'days to months'
Likely:	>50% probability Could occur within 'months to years'
Possible:	>10% probability May occur shortly but distinct probability it will not Could occur within 'the next three to five years'
Unlikely:	>1% probability May occur but not anticipated Could occur in 'five to ten years'
Rare:	<1% probability Occurrence requires exceptional circumstances Exceptionally unlikely even in the long-term future Only occurs as a '100-year event'

Consequence	
Catastrophic:	Multiple fatalities Multiple significant irreversible disabilities Systemic instances of mental health issues
Critical:	Single fatality Severe irreversible disabilities Widespread workforce stress or clusters of mental health issues affecting delivery of services and initiatives
Significant:	Long term injuries / disability Short term hospitalization and rehabilitation Workforce stress or elevated levels of mental health issues affecting delivery of initiatives
Disruptive:	Injury requiring medical treatment Sustained lost time Mental health issues impacting delivery
Minor:	Injury requiring minimal medical treatment or first aid

Risk rating priority		
Risk rating	**Action**	**Recommended action time frame**
High/Very high	Cease activity or isolate source of risk Implement further risk controls Monitor, review and document controls	Immediate Up to 1 month Ongoing
Major	Implement risk controls if reasonably practicable Monitor, review, and document controls	Within 1 to 3 months Ongoing
Moderate	Implement risk controls if reasonably practicable Monitor, review, and document controls	Within 3 to 6 months Ongoing
Low	Monitor and review	Ongoing

Step 3: Identify hazards and associated risk scores and controls						
For a task or activity, list each step or For a health and safety issue, list the potential hazards	**Who can get harmed and how?**	***Uncontrolled Risk Score (Likelihood-Consequence)***	**Controls required**	**Residual risk score**	**Implementation of controls**	**Person/s responsible**
Sensor Integrity: Risk of damage	Measurements can be inaccurate due to group members handling the sensors inappropriately.	Likely-Significant (4-3) = 12	Comprehensive protocols for the proper handling and storage of sensors.	Possible-Disruptive (3-2) = 6	A dedicated session aimed at providing training on the proper handling of sensors.	All group members
Personal Safety	All team members, leading to a physical injury.	Possible-Minor (3-1) = 3	The laboratory strictly adheres to rigorous regulations pertaining to appropriate attire.	Unlikely-Minor (2-1) = 2	Comprehensive guidance on laboratory safety protocols and the prescribed dress code is provided.	All group members
Noise Pollution	The proximity of individuals to the buzzer may give rise to auditory discomfort or potential injury.	Likely-Disruptive (3-2) = 8	Instructions on maintaining permissible noise levels in the environment.	Unlikely-Disruptive (2-1) = 4	Implementing measures to attenuate the sound intensity emitted by the buzzers.	All group members
Risk of eye damage	Personnel near the light sensor may be at risk of ocular damage, necessitating caution and appropriate safety measures.	Possible-Significant (3-3) = 9	The use of appropriate eye protection is essential to ensure the safety of individuals when working with the light sensor.	Unlikely-Minor (2-1) = 2	The procurement and allocation of safety eyewear to personnel for ensuring adequate eye protection.	All group members
Incorrect Wiring	Improper installation of sensors by students leading to instances of short circuits.	Likely-Critical (4-3) = 16	Comprehensive schematic illustrations and robust wiring methodologies to ensure secure sensor installation.	Possible-Disruptive (3-2) = 6	Development of an elaborate wiring schematic and provision of instructional sessions to ensure proper implementation of wiring procedures.	All group members
Project Management Risks	The collective contribution of all team members, which may inadvertently lead to project schedule extensions.	Possible-Significant (3-3) = 9	Thorough documentation and precise instructional	Possible-Minor (3-1) = 3	The creation of a comprehensive technical manual accompanied by	All group members

			materials that ensure clarity and comprehension.		structured training sessions to facilitate effective knowledge transfer and skill development.	
Data loss	Individuals seeking sensor data for analysis may encounter challenges, leading to the potential for inadequate or inaccurate data retrieval.	Likely-Significant (4-3) = 12	Implementation of a comprehensive data backup and recovery strategy, along with the utilization of reliable storage solutions, ensures the safeguarding and accessibility of crucial data in case of unforeseen incidents or system failures.	Possible-Disruptive (3-2) = 6	Implementation of a robust data backup scheme, incorporating systematic procedures and reliable mechanisms, guarantees the preservation and availability of vital data in the event of unforeseen circumstances or system disruptions.	All group members
Electrical Hazard	As the sensors are connected to electric power supply any electric hazard can occur.	Likely-Disruptive (4-2) = 8	It is imperative to diligently adhere to the provided guidelines and instructions regarding the proper connection of the sensors to the power supply.	Possible-Disruptive (3-2) = 6	Performing the initial connection and wiring in the presence of the tutor is strongly advised to ensure proper guidance and supervision.	All group members
Technical complexity	Professionals with technical expertise are responsible for sensor configuration and data interpretation.	Likely-Critical (4-4) = 16	Thorough documentation and precise instructional materials.	Possible-Significant (3-3) = 9	Creation of a comprehensive technical manual accompanied by targeted training sessions (in labs).	All group members

Step 4: Sign off and acceptance Your signature below indicates you have read and understood the above risk assessment and will always adhere to the controls. Should any unexpected situation been identified above, please seek assistance from your supervisor/manager contact immediately.		
Name	**Signature**	***Date***
H M Asfaq Ahmed Shihab	Shihab	01/06/2023
MD Sadman Isfar	Sadman	01/06/2023
Jack Poria	Jack	01/06/2023
Rexy Sebastian Dias	Rexy	01/06/2023

Reflective Understanding of Engineering Enquiry Project

Throughout the unit, the seminars, facilitation sessions, labs, and workshops provided valuable opportunity to acquire and apply essential knowledge for our Arduino-based project work. This section reflects on the depth of reflection, evaluation, and interpretation of knowledge received, demonstrating a complete and extensive understanding of the Arduino platform and its applications.

The seminars offered a foundational understanding of the unit, introducing key concepts related to the Arduino-based project. These sessions provided an overview of the unit objectives, emphasized the importance of effective teamwork, and highlighted the role of various components such as General-Purpose Input/Output (GPIO), ADC, memory, interrupts, and programming style in embedded system development. Reflecting on these seminars, I gained a deep understanding of the project scope and its technical requirements, enabling me to plan and execute our project effectively.

The facilitation sessions were critical in bringing us through the practical parts of the Arduino project. The sessions included step-by-step instruction on fundamental programming, GPIO configuration, interfacing with external devices, memory management, and advanced capabilities such as interrupts. By actively engaging in these sessions, I received hands-on experience with developing numerous functionalities on Arduino. This hands-on experience provided a thorough understanding of the hardware and software factors involved in designing embedded systems. It also gave information on standards for report writing such as literature review and protocols.

The laboratory classes provided a structured environment to apply the theoretical knowledge gained in the seminars and facilitation sessions. Through hands-on experimentation, we engaged in activities such as GPIO control, interfacing with analogue-to-digital converters, memory management, and implementing interrupts. These practical exercises allowed me to solidify my understanding of the Arduino platform and its capabilities. Additionally, the labs provided an opportunity for teamwork, collaboration, and troubleshooting, further enhancing our project skills. The workshops concentrated on areas of project development, such as firmware/software development, prototyping, testing, and project demonstration. These sessions went through subjects including SDI-12 connectivity, sophisticated interrupts, programming style, and installing independent embedded systems in greater depth. I received extensive knowledge about project design, development, and testing by actively participating in these sessions. With this knowledge, I was able to fine-tune our project strategy, ensuring the delivery of a functioning and well-designed product. In addition, the introduction and use of wokwi simulation was a great help which enabled everyone to design and code without any hassle.

Finally, the unit's seminars, facilitating sessions, labs, and workshops provided a well-rounded learning experience, allowing me to gain a deep and broad grasp of Arduino and its applications in embedded system development. The introspective evaluation and interpretation of the knowledge gained demonstrate my ability to adapt theoretical concepts to practical settings, as well as a thorough comprehension of the Arduino platform and its features.

Reflection on teamwork:

In terms of the unit learning outcomes for the Engineering Enquiry Project (ENG20009), this section reflects on the effectiveness of team collaboration and communication strategies employed with both the team and stakeholders.

Functioning as an Effective Team Member:

Throughout the project, the team members, including the team coordinator, demonstrated high effectiveness in their collaborative efforts, fostering strong teamwork and contributing significantly to the overall success. As the team coordinator, my role involved coordinating and facilitating the team's activities. In addition to my coordination responsibilities, I actively participated in the project's technical aspects. For instance, I was responsible for the implementation of the 'changeDeviceAddress' functionality by installing and initializing the required libraries and variables. Moreover, I provided active support in various areas of the codebase and played a crucial role in troubleshooting the sensors and the board as well as debugging the codes. Collecting the board, wires, sensors was also a part of my responsibility. As part of the team organised team meetings twice a week and assigned task between team members during the first few weeks which is mentioned in project brief. Unfortunately, one of the team members stopped showing up after third week and didn’t contribute at all, as a result the team ended up in a bad situation but thankfully because of good coordination and dedication we were able to finish the task. Through these efforts, as the team leader I ensured the smooth progression of work and made substantial contributions to the project achievement.

Communication with Teams and Stakeholders:

Clear and constructive lines of communication were established and maintained with both the team members and stakeholders throughout the project. As the team coordinator, I played a pivotal role in facilitating effective communication within the team and between the team and stakeholders. Various verbal, written, and technological approaches were employed to enhance project outcomes. During team meetings, my active engagement can be observed, sharing insightful perspectives, and attentively listening to others' ideas. Concise and well-articulated written communication, including emails and documentation, effectively conveyed important project updates and information to keep everyone informed. Furthermore, relevant technological tools were utilized, such as collaborative platforms (Microsoft teams, WhatsApp, Zoom), to facilitate seamless code and document sharing. By employing these communication strategies, efficient information exchange was ensured, fostering a cohesive and productive work environment. In addition, every week the team physically attended two meetings one on Monday and another on Tuesday to discuss progress and solve any potential problem. As a team member and the coordinator, I greatly focused on maintaining communication with the team members and the stockholders in order to make sure the project was a success. Communication is the most important aspect of a team-based project.

Overall, my role as the team coordinator and the adeptness in functioning as an effective team member significantly contributed to the successful realization of the Arduino-based project. The depth of reflection and evaluation showcased a comprehensive understanding of the project's objectives, and the interpretation of the outcomes highlighted the broader implications and impact of the collective efforts.

Conclusion:

In conclusion, the Arduino-based project completed in the Engineering Enquiry unit was a success. I obtained a thorough understanding of Arduino and successfully applied my knowledge to the project. As team coordinator, I actively contributed to the codebase, troubleshooted sensors, and managed team activities. Despite problems such as a team member's absence, we overcome them through devotion and collaboration. Clear communication tactics allowed seamless teamwork. Overall, this experience improved my skills in embedded system development, teamwork, and communication.