LAB REPORT 6: DAQ INTERFACING WITH MICROCONTROLLERS

GROUP 1

MCTA 3203

SEMESTER 1 2024/2025

MECHATRONICS SYSTEM INTEGRATION

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ABSTRACT

This experiment demonstrates the use of an Arduino-based Data Acquisition (DAQ) system to collect sensor data and transfer it to the PLX-DAQ software for logging and analysis. The setup involves interfacing various sensors with the Arduino to measure physical parameters, such as temperature, humidity, or light intensity. The Arduino processes the sensor readings and communicates the data to a PC running PLX-DAQ, which logs the data in real-time for further analysis. This experiment highlights the integration of low-cost hardware and software for simple, yet effective, data acquisition and visualisation in a laboratory environment.

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1. INTRODUCTION

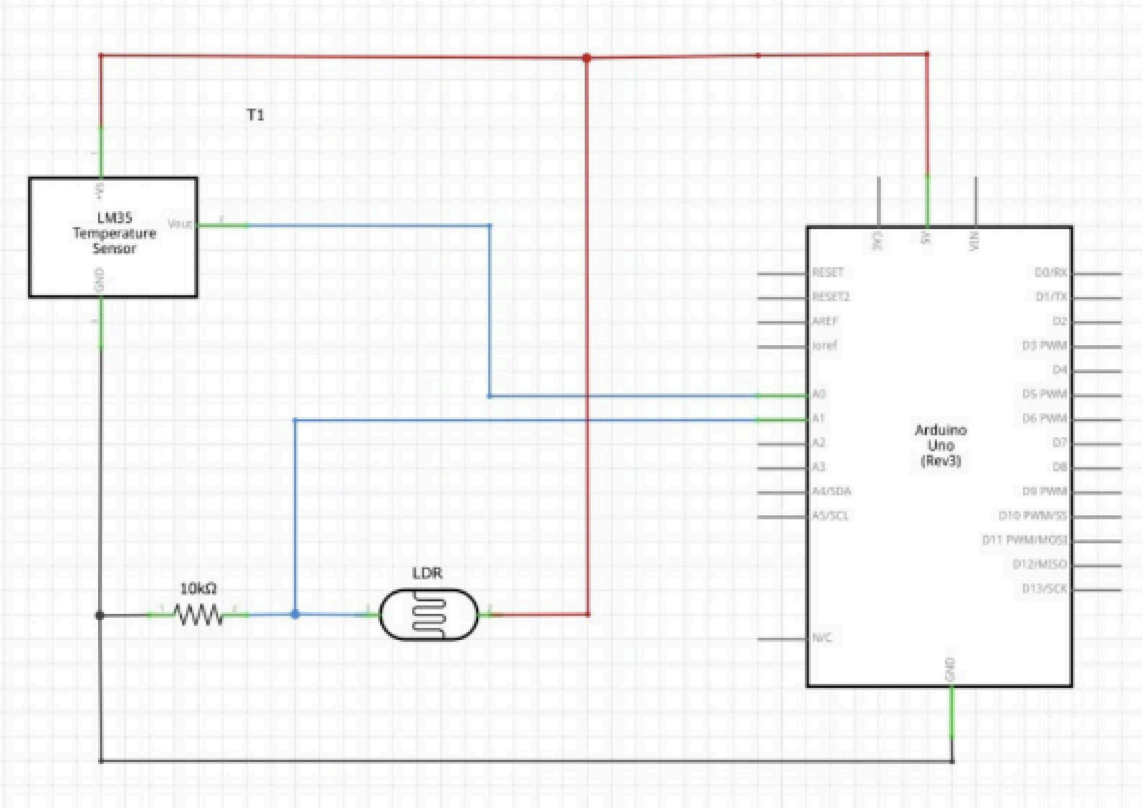
In mechatronics, principles from mechanical, electrical and computer engineering are combined into creating intelligent systems which are capable of performing tasks by providing high precision and efficient results. In this experiment, one of the essential components which is also fundamental in engineering fields including automation, robotics and control systems, is explored. This process, known as data acquisition (DAQ), functions to capture, collect, measure and tabulate the data received from physical processes or phenomena, covering temperature, light intensity, pressure and more. It consists of hardware and software components that work together in converting the real-world signals into digital data that can be analysed or visualised on a computer.

Particularly, in this experiment, the operation of the DAQ system is observed through the measurement of light intensity and temperature obtained by the Light Dependent Resistor (LDR), a type of sensor whose resistance changes based on the amount of light that it receives. An Arduino microcontroller is used, in this case, to read the received signal from LDR, convert it from analog to digital form, and transmit the data to the computer for documentation and analysis. The software, PLX-DAQ is then used to tabulate and visualise the data, at the same time allowing access to real-time monitoring.

2. MATERIAL AND EQUIPMENT

- PLX-DAQ
- Arduino Board
- LDR
- LM35
- Jumper Wires
- Resistor
- Breadboard

3. EXPERIMENTAL SETUP



4. METHODOLOGY

PROCEDURES:

a. After constructing the circuit, launch Arduino IDE and write code that allows Arduino to read analog signals from the LM35 and LDR and convert it to digital.

b. Complete the example code below. (Alternatively, you may write your own code from the start).

c. Verify the code and upload it to the Arduino board.

d. Launch the PLX-DAQ spreadsheet. Ensure the correct com port is selected and generate the output from the sensors in the spreadsheet.

e. In your report, write the comments to explain each line of the codes and produce meaningful excel plots from the sensors' data.

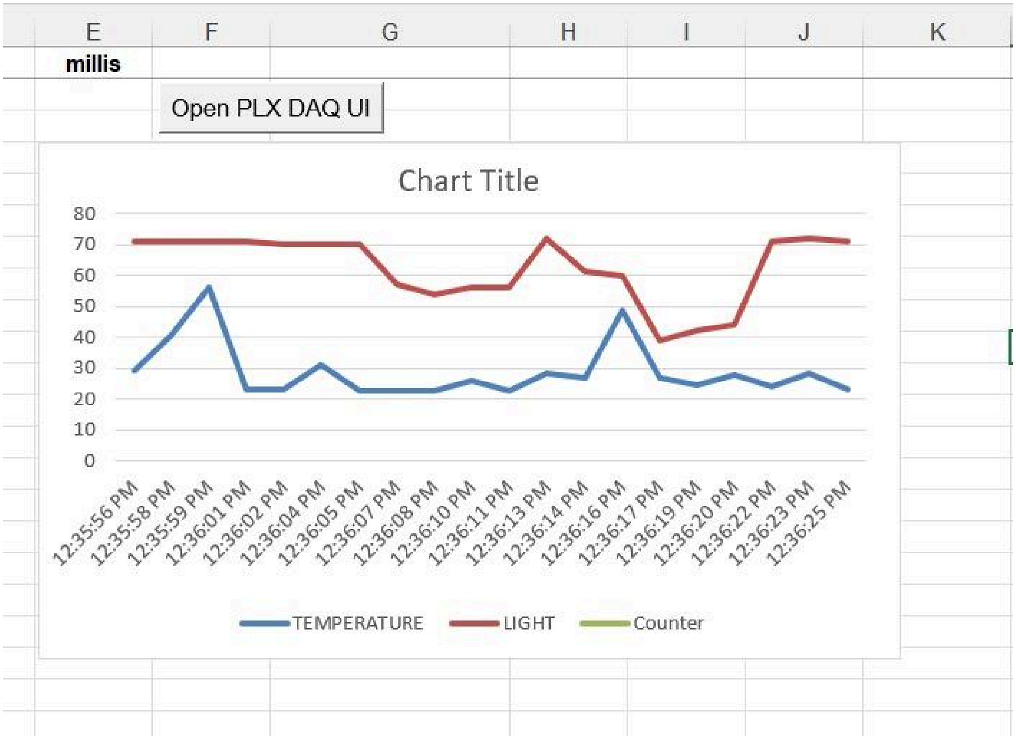
5. DATA COLLECTION

	A	B	C
1	CLOCK	TEMPERATURE	LIGHT
2	12:35:56 PM	29.33	71
3	12:35:58 PM	40.57	71
4	12:35:59 PM	56.21	71
5	12:36:01 PM	22.97	71
6	12:36:02 PM	22.97	70
7	12:36:04 PM	30.79	70
8	12:36:05 PM	22.48	70
9	12:36:07 PM	22.48	57
10	12:36:08 PM	22.48	54
11	12:36:10 PM	25.9	56
12	12:36:11 PM	22.48	56
13	12:36:13 PM	28.35	72
14	12:36:14 PM	26.88	61
15	12:36:16 PM	48.88	60
16	12:36:17 PM	26.88	39
17	12:36:19 PM	24.44	42
18	12:36:20 PM	27.86	44
19	12:36:22 PM	23.95	71
20	12:36:23 PM	28.35	72
21	12:36:25 PM	22.97	71
22			

6. DATA ANALYSIS

The collected data highlights the effectiveness of the Arduino-based DAQ system in real-time monitoring and analysis of environmental parameters like temperature and light intensity. The temperature readings demonstrate significant fluctuations, including a spike to 56.21°C, showcasing the sensor's sensitivity to changes and its ability to capture anomalies. Meanwhile, the light intensity data remains relatively stable, with minor drops, indicating controlled conditions with occasional disruptions. This reflects the system's capability to log multi-sensor data simultaneously and continuously. The integration of low-cost hardware and software, such as PLX-DAQ, makes the system an accessible and affordable solution for real-time data acquisition, particularly for laboratory or educational purposes.

7. RESULTS



8. DISCUSSION

The results demonstrate the effectiveness of the Arduino-based DAQ system in capturing and logging real-time data from the LM35 temperature sensor and the LDR light sensor. The system detected even minor fluctuations and changes reflect the system's ability to detect environmental changes accurately. The observed variations are consistent with real-world conditions and highlight the sensitivity of the sensors to changes in temperature and lighting.. Overall, the experiment confirms the Arduino-PLX DAQ system's capability as a effective solution for real-time data logging and analysis.

The experiment may encounter several sources of error that can influence the accuracy of the sensor readings. The Arduino's 10-bit ADC introduces quantization errors due to its limited resolution, which can affect the precision of the digital values obtained from the analog signals. Electrical noise from the environment or the circuit itself may also interfere with the sensor readings, leading to inconsistencies. Additionally, both the LM35 and the LDR may require proper calibration to ensure accurate measurements, as deviations from factory specifications or environmental factors can impact their outputs.

The setup also has inherent limitations. The dynamic range of the sensors is restricted, meaning the LM35 and LDR can only measure within specific temperature and light intensity ranges, potentially missing extreme values. Furthermore, the data logging speed of the Arduino and PLX-DAQ may limit the real-time analysis, especially if higher sampling rates are required for rapidly changing conditions. These factors collectively affect the overall reliability and scope of the experiment.

9. CONCLUSION

To conclude, this experiment successfully showcased the integration of an Arduino as a microcontroller-based Data Acquisition (DAQ) system to collect and analyze data from sensors, specifically the LDR and LM35. The findings indicated that the Arduino effectively captured analog signals from the sensors, converted them into digital data, and transmitted this information to a computer using the PLX-DAQ software. This setup allowed for real-time monitoring and logging of temperature and light intensity, demonstrating the efficiency and versatility of microcontrollers in practical applications. The results supported the hypothesis that microcontrollers can serve as effective DAQ devices, highlighting their significance in scientific research and education. Through this experiment, we were providing a foundation for more complex data acquisition tasks in future projects.

10. RECOMMENDATION

For future experiments, several improvements can be made to enhance future iterations. First, consider using higher-resolution sensors or microcontrollers with better analog-to-digital converters (ADCs) for more accurate measurements. Additionally, optimise software by exploring alternative data logging software that may provide additional features and user interfaces compared to PLX-DAQ. Implementing more robust circuit designs to reduce noise and improve signal integrity during data acquisition is also advisable. Thorough documentation of each experiment step, including detailed comments within the code, will aid in understanding and facilitate troubleshooting. Overall, lessons learnt from this experiment include the importance of hands-on experience with DAQ systems in developing practical skills in electronics and programming. Future students should focus on understanding both hardware connections and software functionalities to maximise their learning outcomes in similar activities.

11. REFERENCES

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APPENDICES

task6_DAQ.ino

```
// Declare global variables
float tempCelc;       // Temperature in Celsius
int ldr_value;        // Raw LDR value
int ldr_percent;      // Mapped LDR value in percentage

void setup() {
  // Initialize serial communication
  Serial.begin(9600);

  // Send headers to the serial monitor
  Serial.println("CLEARDATA");
  Serial.println("LABEL,CLOCK,TEMPERATURE,LIGHT");
}

void loop() {
  // Read temperature from LM35 (connected to A0)
  int lm_value = analogRead(A0); // Raw analog value from LM35
  float tempMilliVolts = (lm_value / 1023.0) * 5000; // Convert to millivolts
  tempCelc = tempMilliVolts / 10.0; // Convert millivolts to Celsius

  // Read light intensity from LDR (connected to A1)
  ldr_value = analogRead(A1); // Raw analog value from LDR
  ldr_percent = map(ldr_value, 0, 1023, 0, 100); // Map LDR value to a percentage (0-100%)

  // Send data to the serial monitor
  Serial.print("DATA,TIME,");
  Serial.print(tempCelc); // Print temperature in Celsius
  Serial.print(",");      // Add a separator
  Serial.println(ldr_percent); // Print light intensity in percentage

  // Wait for 1.5 seconds before the next reading
  delay(1500);
}
```

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to our lecturers, Dr. Wahju Sediono and Dr. Zulkifli bin Zainal Abidin for their invaluable guidance in this experiment. Their expertise in the mechatronics field and encouragement have been a big support in the successful integration of our system. Not forgetting our teaching assistants in the lab for helping us indirectly.

To add, we also wish to extend a special thank you to our fellow team members for their collaboration and hard work during the course of this project. Their contributions were pivotal in driving our efforts forward and enhancing the overall quality of our work.

STUDENTS' DECLARATION

Certificate of Originality and Authenticity

This is to certify that we are **responsible** for the work submitted in this report, that **the original work** is our own except as specified in the references and acknowledgement, and that the original work contained herein have not been untaken or done by unspecified sources or persons.

We hereby certify that this report has **not been done by only one individual** and **all of us have contributed to the report**. The length of contribution to the reports by each individual is noted within this certificate.

We also hereby certify that we have **read** and **understand** the content of the total report and that no further improvement on the reports is needed from any of the individual contributors to the report.

We, therefore, agreed unanimously that this report shall be submitted for **marking** and this **final printed report** has been **verified by us.**

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