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EXPERIMENT REPORT

Measuring and Analysis of Blood Glucose Levels using AS7263 NIR Spectroscopy Sensor

24AIM113 & 24AIM114

Introduction to NN, CNN and GNN

Analog system design

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Objective:

The objective is to create an experimental setup to try and map the analog output of AS7263's 860nm channel to the corresponding blood glucose level.

Pre-Requisites:

While glucose absorption peaks around 950 nm, there are secondary harmonic oscillations at <850 nm range too.

We will be using the 'W-860 nm' channel of the AS7263 NIR sensor because it has the 860 ±20 nm wavelength capability and can capture the intensity differences caused to due glucose molecule's secondary harmonic vibrations at the 850 nm range.

Experimental Setup:

Apparatus:

1. Arduino UNO
2. AS7263 NIR spectroscopy sensor
3. 250 mL beaker
4. Weighing scale with a least count of 0.01g (10mg)
5. Glass spatula
6. Glucose
7. Distilled water
8. Non-plastic-coated paper cups

To simulate blood (& glucose), we created ten 100 mL sample glucose solutions marked: 70 mg/dL, 90 mg/dL, 130 mg/dL, 150 mg/dL, 170 mg/dL, 190 mg/dL, 210 mg/dL, 230 mg/dL, 250 mg/dL and 280 mg/dL.

Once we created the sample solutions, we poured each of them in a separate non-plastic-coated paper cup.

Hardware Assembly:

Library overview: Before we got started, we downloaded and installed SparkFun's *AS726X* Arduino library in the Arduino IDE.

The AS7263 NIR spectroscopy sensor was connected to the Arduino UNO in the following manner:

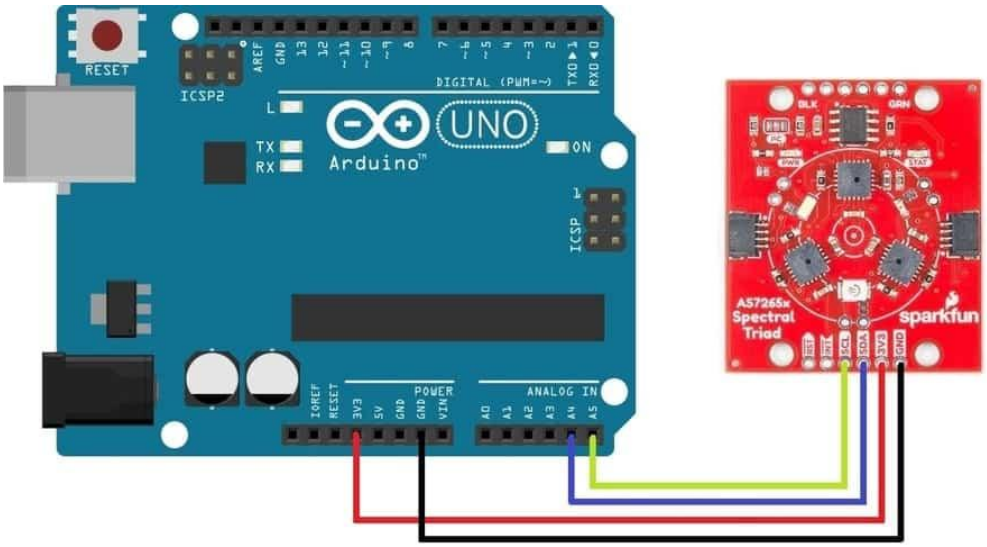


Fig. 1: Circuit diagram

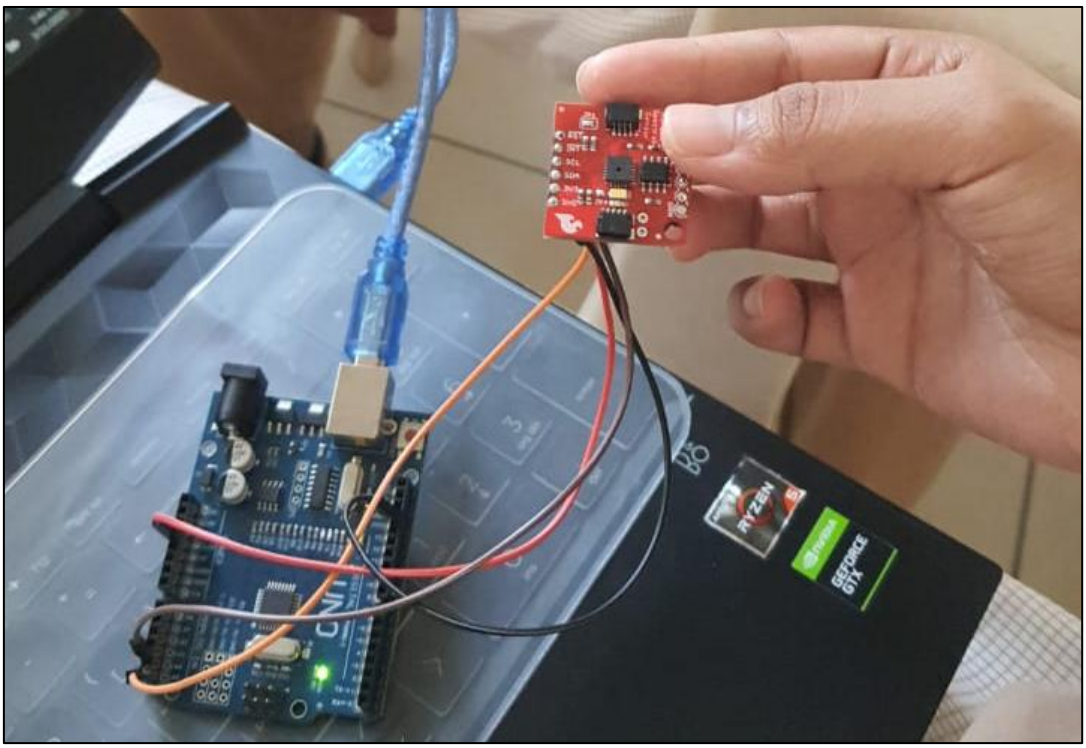


Fig. 2: Hardware assembly

Experiment Assembly:

Once the hardware was assembled, we placed the AS7263 sensor close to the paper cup filled with the glucose solution in such a way that the NIR LED and photodiodes were facing the wall of the cup.

NOTE: We discovered that the readings had an improved and consistent accuracy when the sensor was placed ~1cm away from the wall of the cup.

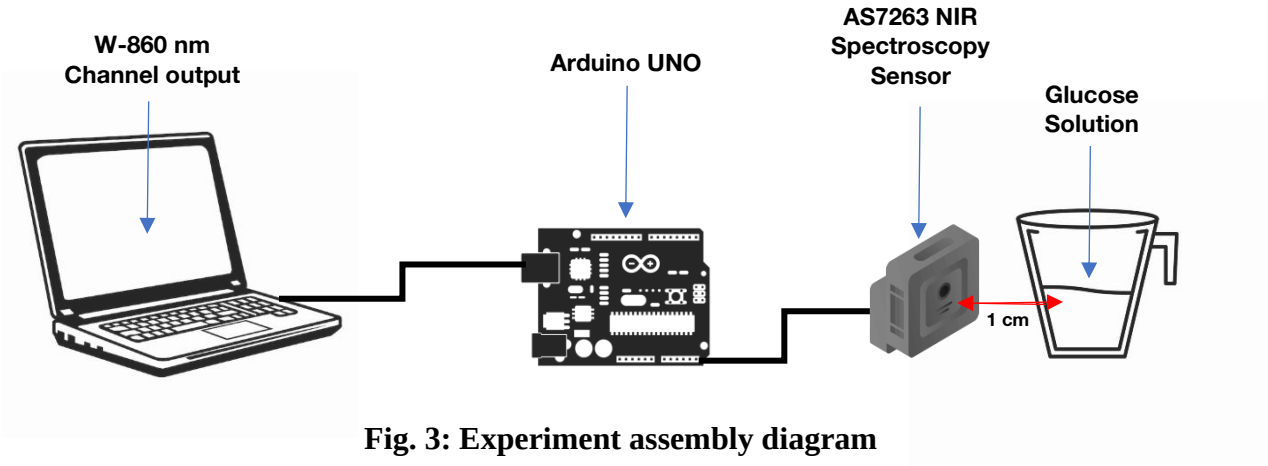


Fig. 3: Experiment assembly diagram

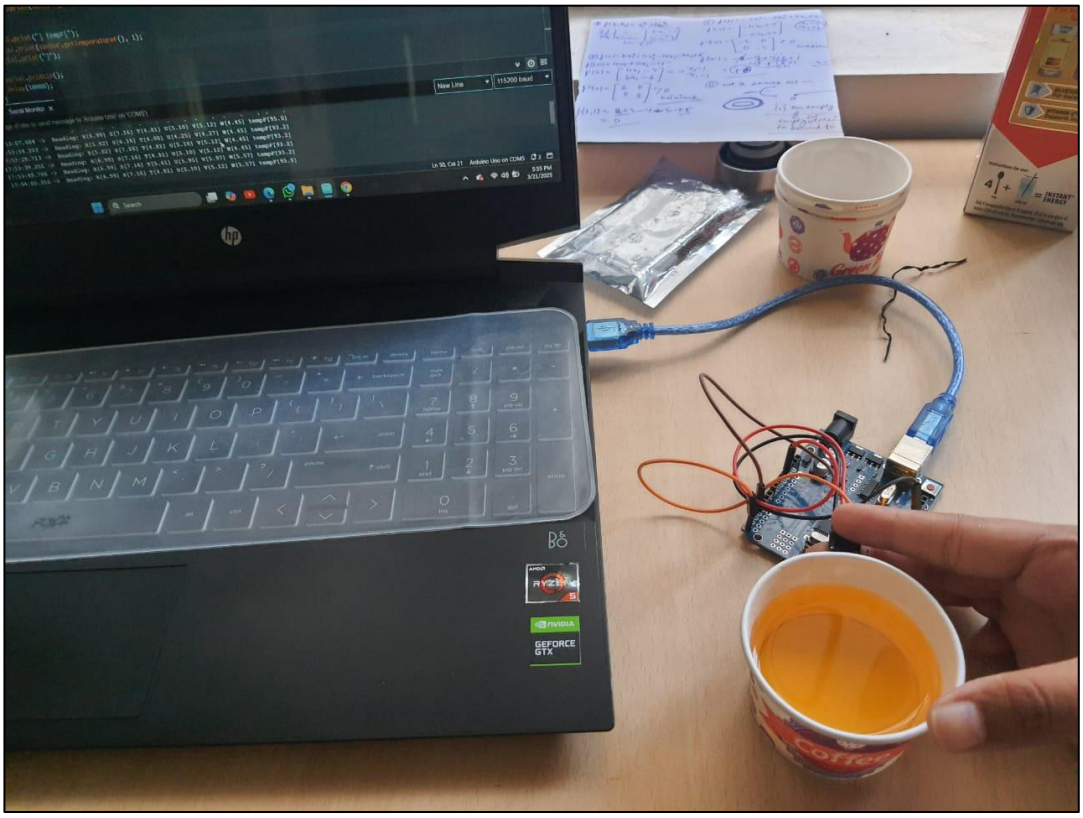


Fig. 4: Experiment assembly

Code:

The C code was written in Arduino IDE, and the `takeMeasurements()` and `getCalibratedW()` functions from the *AS726X* Arduino library were used to access the W-860 nm NIR channel and get its readings.

```
#include "AS726X.h"
AS726X sensor;

void setup() {
	Wire.begin();
	Serial.begin(115200);
	sensor.begin();
}

void loop() {
	sensor.takeMeasurements();
	if (sensor.getVersion() == SENSORTYPE_AS7262) {
		Serial.print(" Reading: V[");
		Serial.print(sensor.getCalibratedViolet(), 2);
		Serial.print("] B[");
		Serial.print(sensor.getCalibratedBlue(), 2);
		Serial.print("] G[");
		Serial.print(sensor.getCalibratedGreen(), 2);
		Serial.print("] Y[");
		Serial.print(sensor.getCalibratedYellow(), 2);
		Serial.print("] O[");
		Serial.print(sensor.getCalibratedOrange(), 2);
		Serial.print("] R[");
		Serial.print(sensor.getCalibratedRed(), 2);
	}
	else if (sensor.getVersion() == SENSORTYPE_AS7263) {
		Serial.print(" Reading: R[");
		Serial.print(sensor.getCalibratedR(), 2);
		Serial.print("] S[");
		Serial.print(sensor.getCalibratedS(), 2);
		Serial.print("] T[");
		Serial.print(sensor.getCalibratedT(), 2);
		Serial.print("] U[");
		Serial.print(sensor.getCalibratedU(), 2);
		Serial.print("] V[");
		Serial.print(sensor.getCalibratedV(), 2);
		Serial.print("] W[");
		Serial.print(sensor.getCalibratedW(), 2);
	}

	Serial.print("] tempF[");
	Serial.print(sensor.getTemperatureF(), 1);
	Serial.print("]");
	Serial.println();
	delay(10000);
}
```

Procedure *(for 110 mg/dL sample)*:

1. We first weighed out 0.11 grams of glucose (110 mg) in a weighing scale.

Fig. 5: Measured amount of glucose

2. We mixed the taken amount of glucose into 100 mL of distilled water in a beaker.

3. A required amount of glucose solution was then poured into the paper cup to fill it.

Fig. 6: Prepared glucose solution

4. The sensor was placed close to the paper cup filled with the glucose solution in such a way that the NIR LED and photodiodes were facing the wall of the cup.

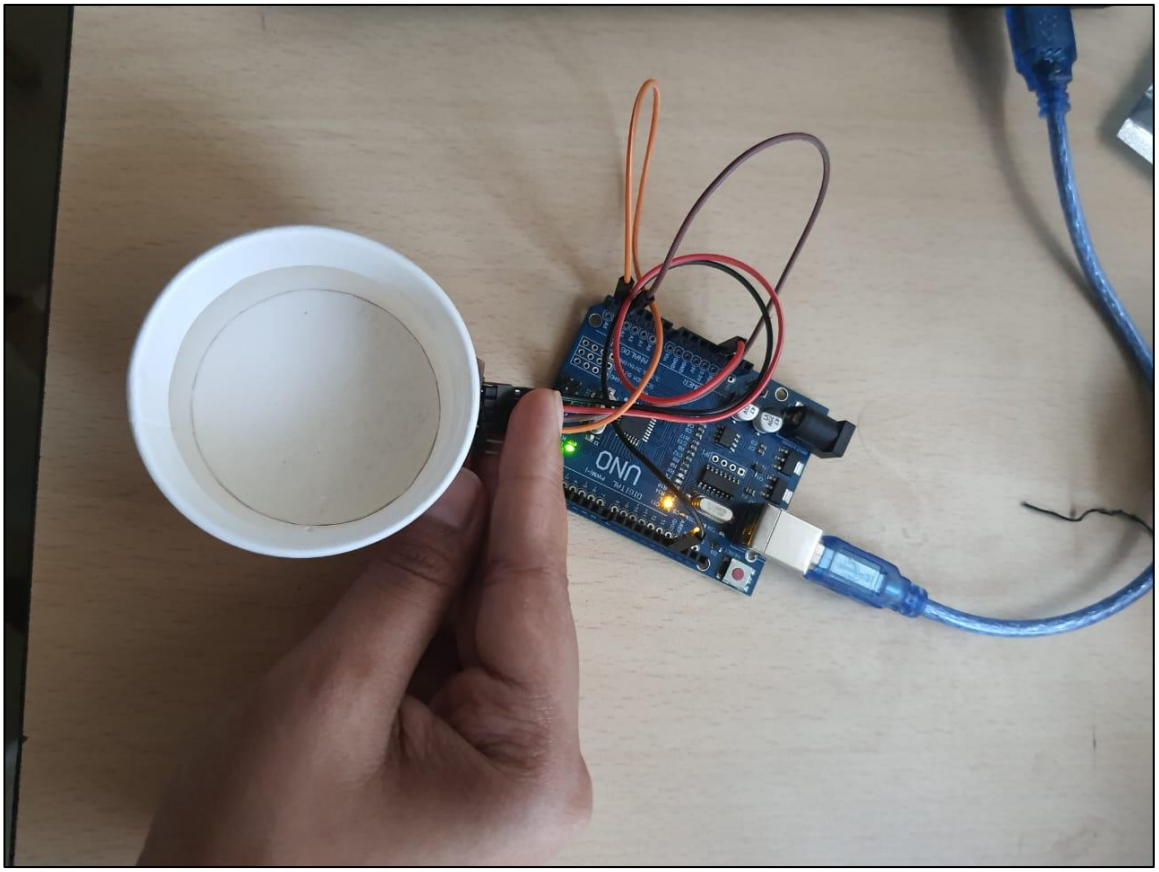


Fig. 7: Sensor placement

5. Once the sensor was calibrated, we took note of the readings of the W-860 nm channel from the Arduino IDE serial monitor.

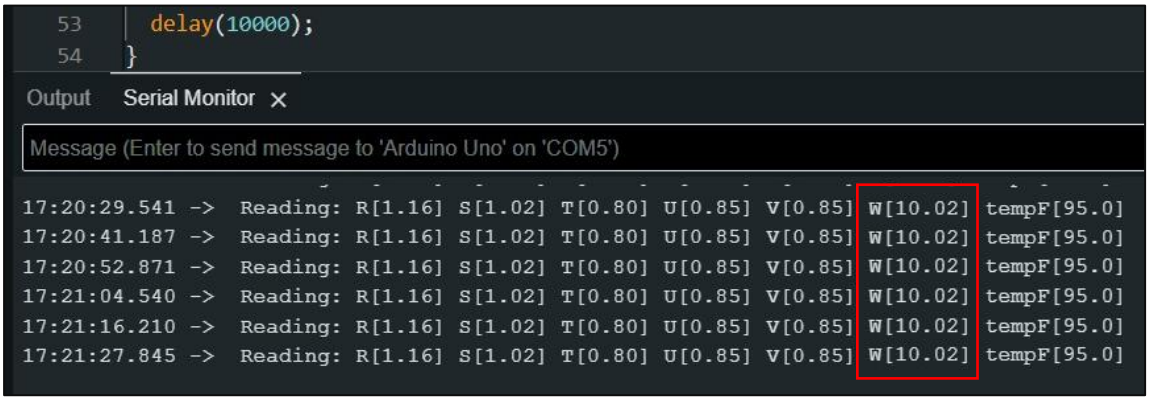
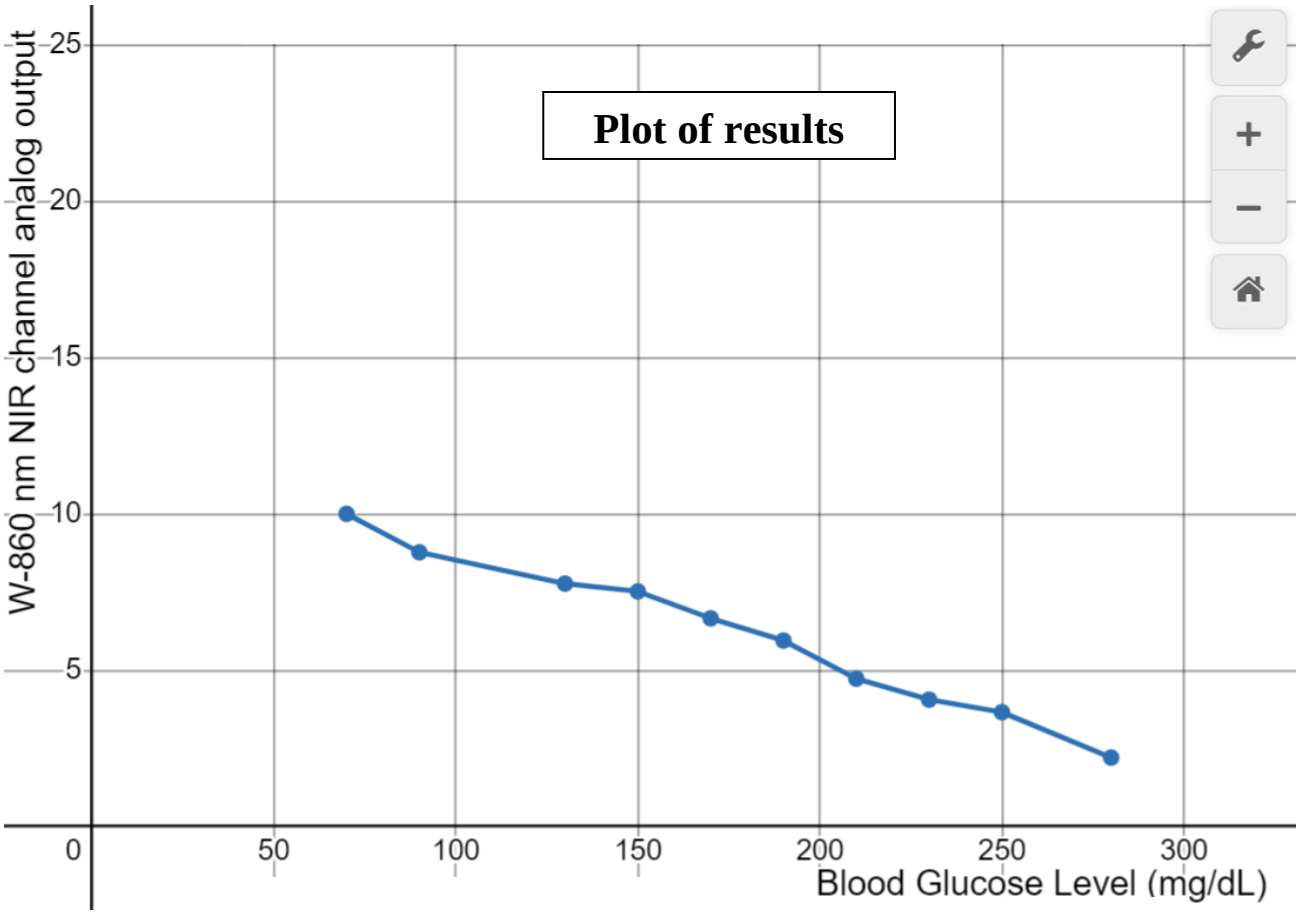


Fig. 8: Serial Monitor output [W: 10.02]

Results:

S. No.	Blood Glucose Level	Amount of glucose in 100 mL of distilled water	W-860 nm NIR channel analog output
1	70 mg/dL	0.07 g	10.02
2	90 mg/dL	0.09 g	8.49
3	130 mg/dL	0.13 g	7.79
4	150 mg/dL	0.15 g	7.54
5	170 mg/dL	0.17 g	6.68
6	190 mg/dL	0.19 g	5.97
7	210 mg/dL	0.21 g	4.45
8	230 mg/dL	0.23 g	4.08
9	250 mg/dL	0.25 g	3.68
10	280 mg/dL	0.28 g	2.23



Conclusion:

i. We have successfully performed the mapping of known glucose samples to output intensity of NIR sensor at W-860 nm channel.

ii. Having mapped the two values, we have plotted the values. The points will be further used for curve fitting and neural network training.
