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AN INITIAL ATTEMPT IN THE ANALYSIS OF LM358 AMPLIFIER IC OPERATIONS IN BLOOD GLUCOSE MONITORING USING PROTEUS

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ABSTRACT

Mostly, the glucose came from food that high in carbohydrates which we call sweet from food. The glucose is produced when acids and enzymes come break it into small little pieces. Glycogenolysis happen when the liver process glucose by change the glycogen into glucose. In Greek, glucose means sweet. Glucose is a type of sweet and use as energy in body. Blood glucose is when it in the blood. When the quantity of glucose is high in the body, a condition called a hyperglycaemia occurs due to not enough of insulin. When this condition arises, cause the patience become hunger and thirst, which is the common symptom aside than vision problem later. Average age of Malaysian that have unnormal quantity of blood glucose in body usually start at age of 40 years old. Some even early, that differ with family history and diet consume in their lifestyle. With a lot of junk food and fast food nowadays, it contributes to the blood glucose rise every day, if don't have prevention of the amount take. For adults, the normal blood glucose reading is between 90 and 110 mg/dL, which is for their that take reading after about two hours after eating. If before eating, which is around eight hours before eating, usually the normal reading is less than 100 mg/dL. If the reading is not between these values, these persons will have more than or less than appropriate value, than they have to worry for their health issue.

1.0 INTRODUCTION

Biomedical engineering is application principle of engineering knowledge and technology for problem-solving related on combination between biology and medicine for healthcare purpose (Ashok et al,2011). Biomedical instrument is application of engineering that focusing toward mechanics or device that used for measuring, evaluation and treat the system of biological. It helps to treat patient more effective. Role of an engineer in medical instrumentation is very important as they will develop and design devices, instrument or even software that will be useful in healthcare. They also need to solve problem related instrument malfunction. Blood glucose monitoring or glucometer is one of medical device that useful for determine the glucose concentration in human blood (Ashok et al,2013). It is valuable tool not only used for diabetic individuals but also physician for monitor their patient's condition or user that need to monitor their blood glucose for maintain their healthy lifestyle. In the previous article, they have developing a device that is non-invasive blood glucose monitoring system (Ashok, V. and Murugesan, G., 2017). The device helps to overcome some issue related to invasive blood glucose monitoring such as a painful feel, ability lead for non-compliance, it can cause infection, it is pricey because of the strip and sometimes may lead to skin changes (Sivaranjani et al,2018).

2.0 METHODOLOGY

Non-invasive blood glucose monitoring is based on technique of NIR optical which use the wavelength of 940nm as suitable for measuring the concentration of blood glucose. NIR light will propagated the site of measurement and will interact with molecule of glucose. The quantity of NIR light through scale site respond on concentration of blood glucose like LASER based monitoring equipment (Ashok et al,2010).

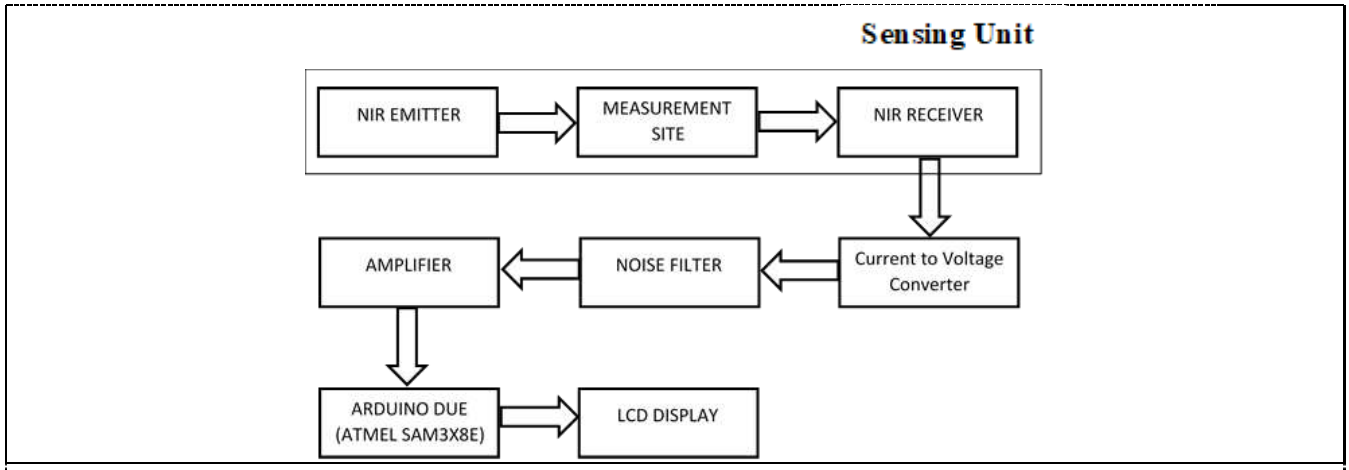

Figure 1. Block diagram of blood glucose monitoring.

Figure 2. Flowchart of the blood glucose monitoring.

Characteristic	LM358
V_{IO}	7 mV Max
CM V_I	0–28.5V*
I_{IO}	50 nA
I_{OS}	–500 nA
CMRR	85 dB Typ @ DC
$\overline{e_n}$ @ 1 kHz, R_{GEN} 10 kΩ	40 nV/√Hz Typ**
Z_{IN}	Typ 100 MΩ
A_{VOL}	100k Typ
f_t	1 MHz Typ **
P_{BW}	11 kHz Typ **
dV_o/dt	0.5V/µs Typ**
V_o @ R_L = 10k/2k	28.5 Vp-p
I_{SC}	Source 20 mA Min (40 Typ) Sink 10 mA Min (20 Typ)
PSRR @ DC	100 dB Typ
I_D (R_L = ∞)	2 mA Max

Figure 3. Performance table of amplifier LM358.

3.0 RESULTS AND DISCUSSION

These individuals' glucose levels are measured in the laboratory using an intrusive procedure, as is the analog voltage corresponding to their glucose level.

Table 1. Glucose levels using intrusive procedure.

No	Analog Voltage (mV)	Glucose Level (mg/dl)
1	499	142
2	509	146
3	519	156
4	519	157
5	548	177
6	524	159
7	543	209
8	568	133
9	573	179
10	583	224
11	592	175
12	597	187

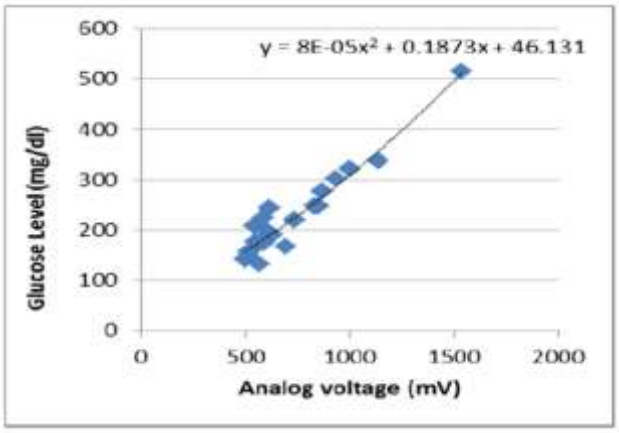

Figure 4. Glucose regression analysis of analog voltage data

Figure 4 shows a graph with the analog voltage determined at analog pin A0 of the Arduino contribute microcontroller and the related glucose concentration calculated in the laboratory using an intrusive process. By using the regression tool, the algorithm equation between analog voltage and glucose level is analyse and shown below.

$$y = (8 * 10 - 5)\, x2 + 0.1873x + 46.131$$

Where x and y represent analog voltage (mV) and glucose level (mg/dl), respectively.

The glucose level is calculated using an Arduino software for a given value. The continuous analog voltage values obtained from the photo detector when putting the finger between the NIR emitter and the photo detector are averaged and placed in an array. The glucose value corresponding to this average analog voltage is calculated by the microcontroller and displayed on LCD displays (Chia, et al 2017),(Alghamdi, et al,2021) .

The constructed system circuit diagram consists of filters and amplifiers, as seen in figure 5. The electrical current received from the photo detector is converted into voltage by connecting the anode side of the photodiode to the load resistance R4= 50k. The cut-off frequencies of the high pass filter are 2.34 Hz.

HPF cut off frequency = 1/ (2πR2C2) = 1/ [2π (68*103) (1*10-6)] = 2.34Hz

For converting the analog signal in digital values, the amplified output voltage is connected with Arduino's analog pin A0 like temperature monitor (Rahimoon et al 2020). This digital value is equal to the amount of glucose. Using polynomial regression equation, the real glucose level is calculated from this digital value. This equation consists of glucose levels obtained by intrusive measurements from the laboratory.

We use Op Amp in inverting mode, as you can see in figure 6, the input signal is wired to the Op amp inverter. The feedback between the output and the input terminal is connected to a capacitor. The field is connected to the non-inverting terminal.

At the input in figure 7, we connect an oscilloscope with the function generator. In Proteus software the above simulation is done. The +ve terminal is at ground level and the -ve terminal would hence also be grounded by simulated ground concept. The current through R1 is equal to the current through the capacitor. The waveform above is the input and the output below is the sine wave.

The supply voltage of the op-amp integrator and the saturation of the op-amp itself are limited. When designing a circuit, the gain or increase a voltage can be important to satisfy the potential voltage changes. Although small input voltages are suitable and for short periods, caution must be taken when designing circuits that retain input voltages over longer periods of time. The result is a sine wave output, depending on the value (R*C), which is referred to as the circuit time constant. The current is inverted during the negative half-cycle of the input of the sine wave. The capacitor is now linear and generates a positive contribution. The proposed process would be verified by measurement of the glucose readings using both the invasive and the proposed non-invasive methods.

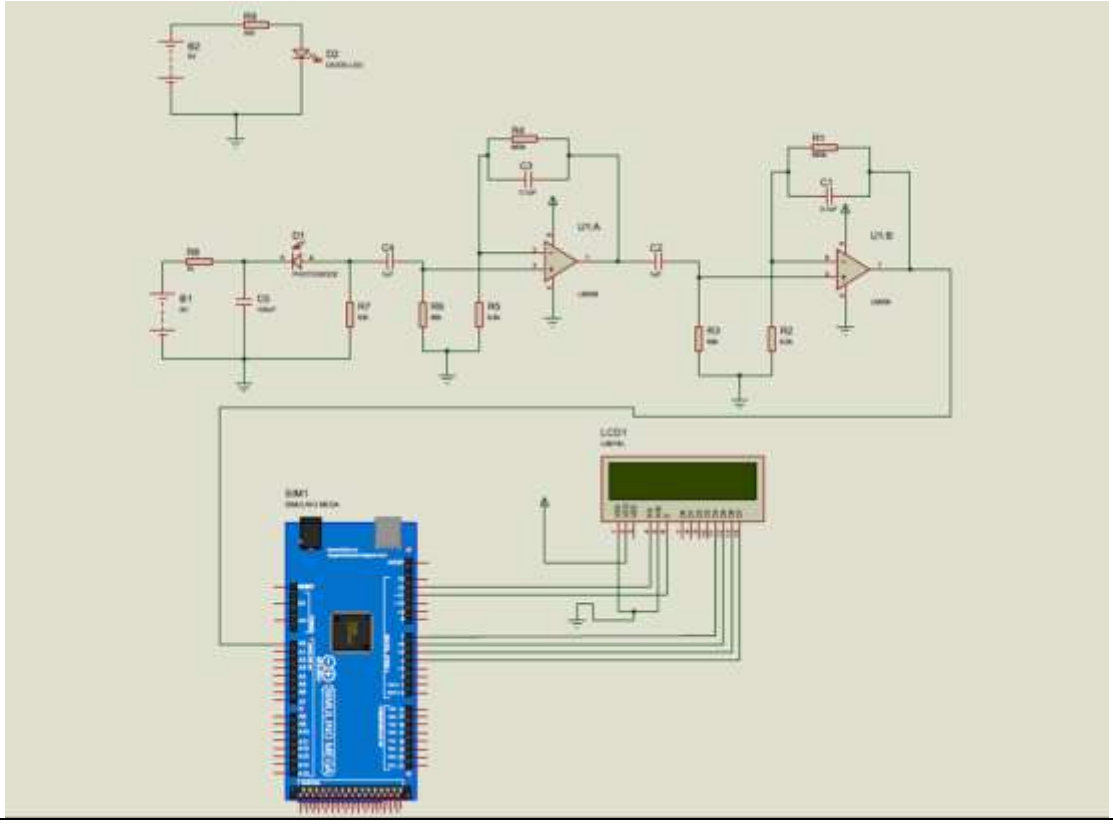

Figure 1. The designed system's circuit diagram.

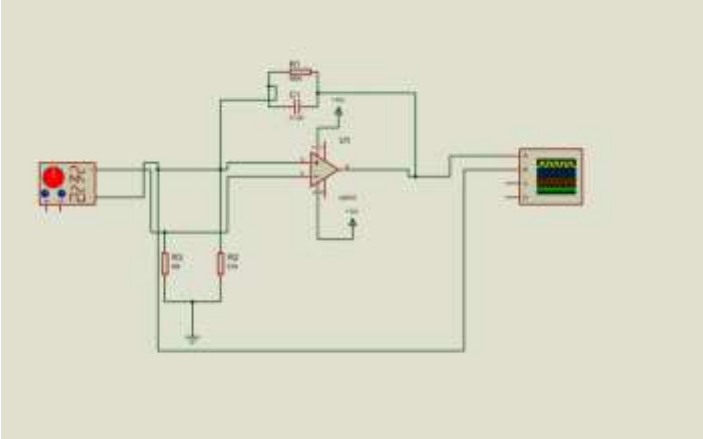

Figure 2. Simulation on HPF amplifier circuit.

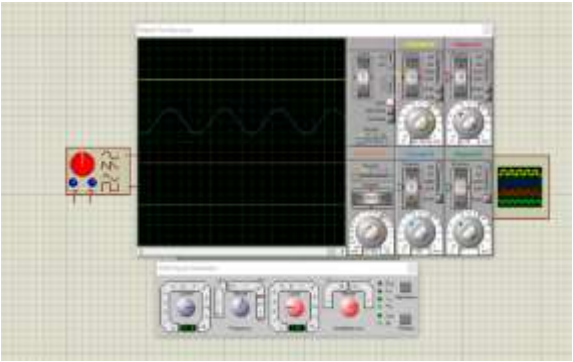

Figure 3. The output waveform for amplifier connection.

Table 2. Comparison of Results.

No	Glucose Value Obtained by invasive method	Glucose Value Obtained by Non-Invasive method	Difference
1	117	118	1
2	143	143	0
3	112	115	3
4	106	103	3
5	166	169	3
6	193	192	1
7	88	88	0
8	108	110	2
9	110	117	7
10	134	151	-17
11	245	213	32
12	299	252	47

4.0 CONCLUSION

As the conclusion we able to understand the operation and function of the amplifier in the circuit. We know how much amplifier very important and impact the whole circuit. Amplifier helps to convert from small input voltage to high output voltage that suitable to use in circuit. Next, practical problem faced in simulation is to determine the input and the output of the amplifier circuit. We also confuse on to determine which parameter that suitable act as output.

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