Table of Content

ISSN 2229-5518

Design and Development of Multifaceted Intravenous Therapy Monitoring System

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Executive Summary`

The design in this context is the implementation of a transceiver incorporated with an embedded system, used in monitoring the level of liquid, blood in the drip bags. Once the liquid in the drip bag has gone below the expected value, the system will automatically notify the control room by reporting its operational services and which wards to be attended to, through wireless medium. Other extension system services were included, where computer was interfaced with the system, using computer virtual imaging to access the intravenous system

Key Words: intravenous, virtual imaging tech, wireless, computer interface

Introduction

Health factor is a critical and dynamic phenomenon which should be a critical subject matter backed up by strong policies from both government and private institutions, because health is life.

The number of mortality rate (date rate) increases geometrically which is very alarming as time elapses due to the nature of exposition of weak human metabolic process to these negative elements (disease, accident and war). This element has affected lives negatively, to the extent, leading to a number of ratio, where patient outnumber the health workers in terms of population censors, most especially in an intravenous therapy administration, and this makes the work to be complicated. Health workers cannot attend to patient at the same time in a complex situation, especially when the number of doctors are outnumber by patient, sometimes due to the complexity of the environment, the nurse forget to remove the drip mouth needle from the patient Tissot et al (2009), when drip are administered thereby resulting to blood flow reversal into the drip bag. This negative impact has compounded a stronger force against the driving strength of the health workers, thereby reducing their efficiency geometrically.

This subject matter needs to be address with a strong policy, by creating a platform where high sophisticated technology will be initiated to aid and to save life without prejudice.

With the above information, an intensive research findings were carried out, which brought about the fabrication and development of the multifaceted intravenous therapy monitoring system. The system was developed to monitor volumetric measures of drip solution using wireless programmable computer interface system to make health duties easier and smooth. The device monitors the level of liquid and blood in the drip bag, once the liquid in the drip falls below an expected value, the system sends a distress information in form of data wirelessly to the reception room which can cover a radius of 100m, indicating the ward that needed the attention of a doctor through virtual imaging process in the computer, if after a period of second there is no response the system will automatically short down the drip terminal to stop blood reversal into the drip bag in order to save life. This will help and give health staff an opportunity to attend to other obligation while the device overlooks over the affair of liquid/ blood drip monitoring.

1.1 Problem Statement

To administer drip by health workers in terms of number is a difficult task especially in a complicated situation. (War and sporadically outbreak of disease).

Sometimes to administer a right dosage of liquid is not precise or accurate.

Sometimes doctors are faced with the challenges of number and time factor.

1.2 Significant of Study

Administration of patient by health workers is not an easy task, due to rising number of patient to health workers, sometimes, the number of patient in the hospital may outrun the number of health staff(2), this makes the work to be more complicated. In addition, due to its complication as mention, health workers cannot attend to patient at the same time, especially when drip and other medical administrative are administered. Sometimes, due to the complexity of the environment the nurse forgets to remove the drip mouth needle from the skin Tissot E etal (2009), due to this complexity:

a. The system improvised a medium where a health worker can communicate with he/her patient without physical contact.

b. The system can monitor several wards at the same time, with less human intervention.

c. The system can give report about the drip operation in reference to the dose to be administered and other extension services through wirelessly medium about $100m^2$ radius.

d. The system has standby power inverter to avoid interruptible of power supply to keep the system running for 24 hours

e. The system can project a virtual imaging in the computer, through computer interface technique, showcasing the real operation in respect to the intravenous administration to monitor the patient at distance.

7. The system can select precise fluid that should be infused into the body

1.3 Aim and Objective

Aim

Is to develop programmable transceivers that can able to exchange data between two points through wireless medium, while monitoring the liquid from the drip bag.

Objective

To administer assistance to patient with less intervention of health worker.

To enhance virtual enclosure with a contagious infected patient in order to reduce physical contact.

To make sure that an accurate dose of the liquid was administered to the patient.

To reduce input of human factor as it creates an opportunity for other obligation to be attended to, in order to reduce time constrain.

2.0 Literature review

A Novel System Design for Intravenous Infusion System Monitoring for Betterment of Health Monitoring System using ML-AI

In the era of digital world, every field requires intelligent of operation as the population of the world follows the growing exponential curve, The people were suffering from different chronicle and non-chronicle disease at the rate directly proportional to growth rate of population, also the availability of hospital and medico to help people is not adequate, as per the survey by AYUSH on doctor required in a village is 1:1000, ie., one doctor can serve the population of 1000 and it's also in align with recommendation made by WHO[7]. But the support from the clinical assistant, is not defined exactly anywhere which makes a tough situation where a medico have to maintain a records of minimum 1000 patient and more or less the requirement of maintain large data which is observed from different patient is getting more difficult in the growing population rate. Here is the point where we required support from technology to support health care domain. The two different vertical fields which have different strength on different scale operation should be combined. The harmony between these two vertical sectors will strengthen the effect greater than the effects created by individual vector sectors. This novelty should support the code of conduct of medicine, such as efficient, effective & safety. So reediting the name of health monitoring might be redesign the medical application and devices with enabled wireless communication and artificial intelligence (AI) [14,15] which is also one of the fast rapidly growing fields. The applications which is designed to support the medical system or medical diagnosis should be adopted to base code of medical, such as safety, agility and versatile on decision making. So the system should maintain those principles to make an effective and efficient system. The most common issue happen at the medical is injection and following the fluid therapy [4]. Most of the time identifying the exact fluid and inject it to the veins is taken care with caution and it should be monitored continuously. The entire process which is known as intravenous Infusion (IVs) in medical field [6]. The observation from the physical parameters during this infusion gives the support in understanding the response from the human body and also leads for continuously monitoring if required it gives a caution to the medico. The drug which is penetrated to the veins through this IVs is effective and it passes all the nutrient content to the entire physical system as it is connected to the centralized veins. However the IVs has a certain drawbacks such as problem with drip changer, dust particles in fluid and reused infusion needle etc., so the monitoring of patient reaction during the period of IVs could help to avoid the issues related to air embolism, venous reflux and reverse osmosis of blood. The most used fluid in IVs is saline, iyile and atah. The major objective on focusing IVs is through the automated system and decision making system which helps to reduce the complexity [10] such as when to remove the IVs, Time alert when the trip is completed to avoid reverse osmosis and to make a proper therapeutic intervention also the inadequate knowledge of IVs and fluid therapy is force caution of mortality and sickness. This paper brings out the decision on imparting the [12] AI to the medical field and modifies classic practice present now and this design mainly focusing on effective usage of IVs through how to uphold the fluid levels such as blood, drug, metabolic and electrolytes. This paper organized as survey followed by working principle and the importance of implementation of monitoring system and analysis results based on machine learning algorithm to take decision.

3.0 Methodology

3.1 Theory of Operation

The system has a load cell sensor which act has a transducer to convert the weight variation in the drip bag into electric pulse, the electric pulse was fed into load cell integrator, the load cell integrator has the ability to detect and amplify any little variation in the electric pulse and delivered it to analogue to digital converter(ADC), the ADC convert the analogue signal to digital signal, the digital signal was fed into the micro controller, the micro controller will act on the information received due to its configuration of its algorithm in the chip which will be fed to the decoder, the decoder decodes the information and fed it to the radio module through RS232. The radio module transmit the discrete data to the receiving radio module which fed the encoder, the encoder simplify the encrypted information and delivered it to RS232 which was received and fed to a microcontroller, the microcontroller due to its nature of algorithm, the microcontroller interpreted the information and displayed it on a liquid crystal display as it activated the buzzer. Also the output of the RS232 was interfaced with the computer to access the virtual imaging complex algorithm in the computer, which response in respect to the data received from the RS232.

The power inverter was developed by creating a frequency generating circuit in which the output was fed into the driver to boost the current through the current gain of the drivers, the output of the driver was fed to the power amplifiers, the output of the power amplifier was fed to the transformer, the transformer increased the alternative voltage to 220ACV, the inverter was interfaced with a microcontroller to monitor all parameters and execute instruction as commanded.

3.2 Material Aid

The compiler used MIDE Compiler

Programmer used TOPWIN

Software language used Assembly language

3.3 key Component specification

3.31 AT89C52

Core Processor 8052

Data Bus Width	8bit
Maximum Clock Frequency	24MHz
Program Memory Size	8KB
Program Memory Type	Flash
RAM size	256B
Number of Programmable I/O	32
Number of Timer	3
Supply Voltage Range	4V to 6V
Package	PDIP- 40

3.32 AD9410 ADC

54db with 99MHz analog input

500MHZ analog bandwidth

On-chip reference and track and hold

1.5V p-p differential analog input range

5.0V and 3.3V supply operation

3.3V CMOS/TTL output

DE multiplexed output each at 105 MSPS

3.33 C945

a. Packaging Type	TO-92
b. Transistor Type	NPN
c. Collective Current	150mA
d. Max Transistor Frequency	200MHz

3.34 433MHz RF Receiver Module Features

The Transmitter offers only one-way communication through 433.92MHz frequency at 1Kb data rate

It operates at a range of 3-12V which is also the power operating volts of most of the microcontrollers and boards.

It is one of the very low-cost power effective modules for commercial, hobbyist, and developers.

433MHz Transmitter is one of the cheapest RF transmitters and it has a lot of applications and can be used interface with almost every microcontroller

3.35 Specifications of 433MHz RF Transmitter Module

Max range with the antenna in normal Conditions: 100 Meters

RX Receiver Frequency	433 MHz
RX Typical Sensitivity	105 Dbm
RX Supply Current	3.5 mA
RX IF Frequency	1MHz
RX Operating Voltage	5V
TX Frequency Range	433.92 MHz
TX Supply Voltage	3V ~ 6V
TX Output Power	4 ~ 12 Dbm

3.36 Specifications of 433MHz RF Receiver Module

Max range with the antenna in normal Conditions: 100 Meters

RX Typical Sensitivity	105 Dbm
RX Supply Current	3.5 mA
RX IF Frequency	1MHz
RX Operating Voltage	**5V**

3.37 MAX232

a. Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
b. Operates From a Single 5-V Power Supply With 1.0-μF Charge-Pump Capacitors
c. Operates up to 120 kbit/s
d. Two Drivers and Two Receivers
e. ±30-V Input Levels
f. Low Supply Current: 8 mA Typical
g. 0.1-μF Charge-Pump Capacitors is Available With the MAX202 Device

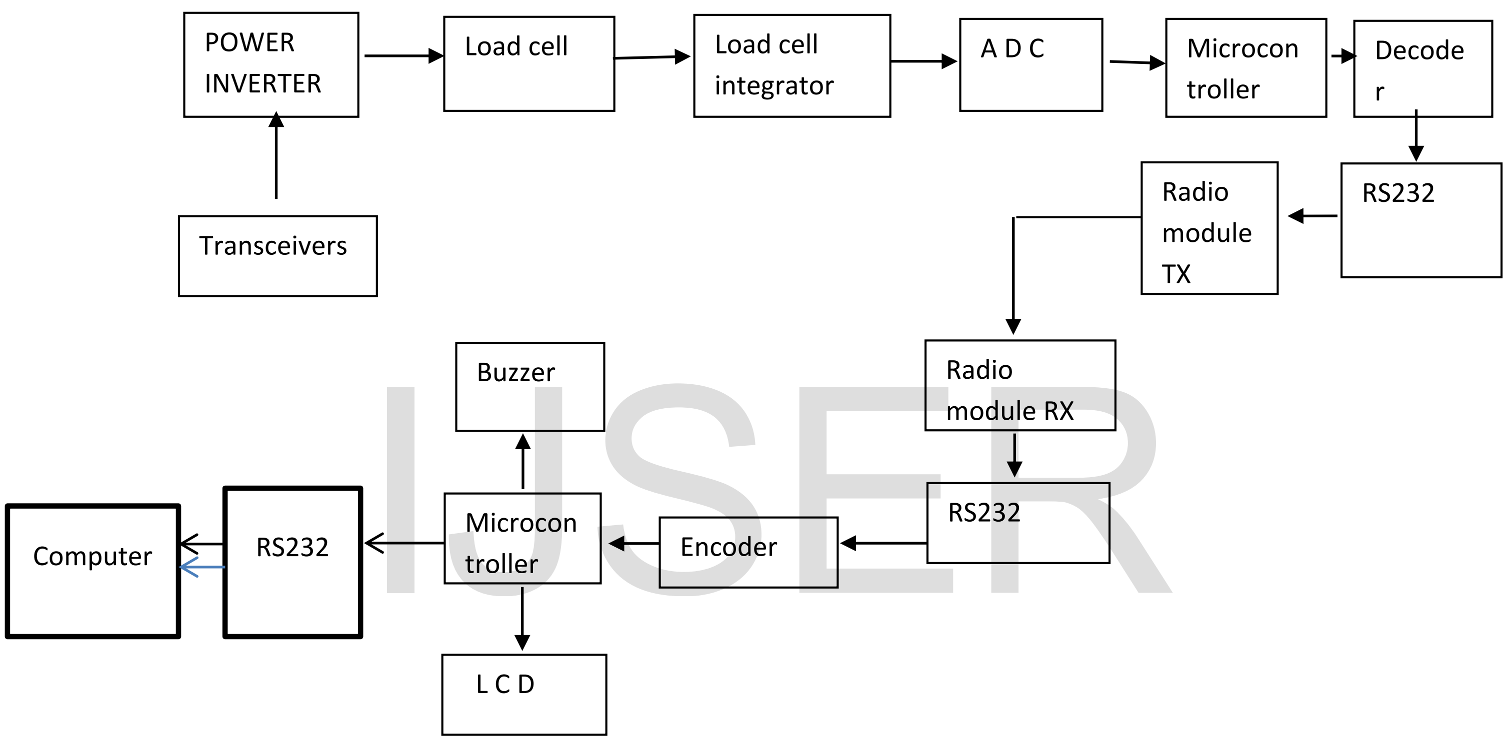

Fig 3.1 Block Diagram for multifaceted intravenous therapy monitor

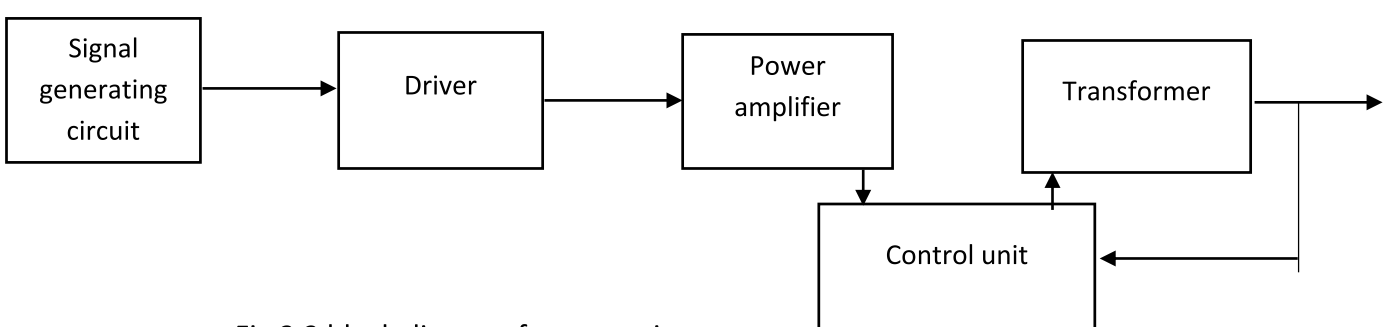

Fig 3.2 block diagram for power inverter

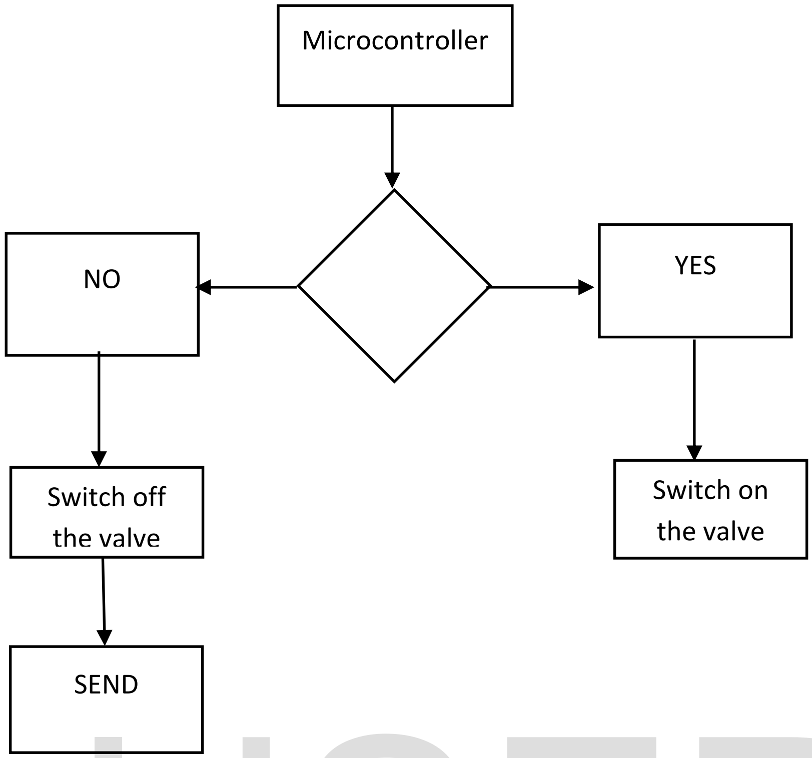

Fig 3.3 Flow chart for drip bag monitor

4.0 Test and Result

4.1 Parameter measured from the load cell

The output impedance of the load cell was measured at 1000Ω

Excitation voltage of the load cell was measured at 5V

Rated voltage of the load cell was measured at 1.15V

4.2 Load cell Voltage sensitivity in response to weight at the load sensor

Cell voltage sensitivity output 0.5mV = load weight of 460g

Cell voltage sensitivity output 0.60mV = load weight 383.3g

Cell voltage sensitivity output 0.75mV = load weight 306.6g

Cell voltage sensitivity output 1.2mV = load weight 230g

Cell voltage sensitivity 1.3mV = load weight 176.9g

Cell voltage sensitivity 1.7mV = load weight 135.3g

Cell voltage sensitivity 2.1mV = load weight 109.5g

Cell voltage sensitivity 3.1mV = load weight 74.2g

4.3 Full operation of the analogue to digital converter which was displayed at the LCD

The ADC converts the analogue signal to digital

1O bit resolution A.D.C was used in the design

$$\frac{Resolution\ of\ the\ ADC}{System\ Voltage} = \frac{ADC\ Reading}{Analouge\ Voltage\ Measured}$$ equ 4.30

$$\frac{1023}{X} = \frac{460}{2.6}$$

The system voltage is the reference voltage

$$\boldsymbol{reference\ voltage} = \frac{1023 \times 2.6V}{460} = 5.7V$$ equ 4.31

Thus it takes 5.7V of the reference voltage to convert 2.6V to an equivalent of 460 digital voltages.

$$\frac{Resolution\ of\ the\ ADC}{System\ Voltage} = \frac{ADC\ Reading}{Analouge\ Voltage\ Measured}$$

$$\frac{1023}{X} = \frac{383.3}{2.2}$$ equ 4.32

The system voltage is the reference voltage

$$\boldsymbol{reference\ voltage} = \frac{1023 \times 2.2V}{383.3} = 5.87V$$ equ 4.3 3

Thus it takes 5.87V of the reference voltage to convert 2.2V to an equivalent of 383.3 digital voltages

$$\frac{Resolution\ of\ the\ ADC}{System\ Voltage} = \frac{ADC\ Reading}{Analouge\ Voltage\ Measured}$$ equ 4.34

$$\frac{1023}{X} = \frac{306}{1.76}$$ equ 4.35

The system voltage is the reference voltage

$$\boldsymbol{reference\ voltage} = \frac{1023 \times 1.76V}{306} = 5.883V$$ equ 4.36

Thus it takes 5.883V of the reference voltage to convert 1.76V to an equivalent of 306 digital voltages

$$\frac{Resolution\ of\ the\ ADC}{System\ Voltage} = \frac{ADC\ Reading}{Analouge\ Voltage\ Measured}$$

$$\frac{1023}{X} = \frac{230}{1.32} \qquad \text{equ 4.37}$$

The system voltage is the reference voltage of ADC

$$\boldsymbol{reference\ voltage} = \frac{1023 \times 1.32V}{230} = 5.871\text{V} \qquad \text{equ 4.38}$$

Thus it takes 5.871V of the reference voltage to convert 1.32V to an equivalent of 230 digital voltages

$$\frac{Resolution\ of\ the\ ADC}{System\ Voltage} = \frac{ADC\ Reading}{Analouge\ Voltage\ Measured}$$

$$\frac{1023}{X} = \frac{176.9}{1.01} \qquad \text{equ 4.39}$$

The system voltage is the reference voltage

$$\text{reference voltage} = \frac{1023 \times 1.01V}{176.9} = 5.84\text{V}$$

Thus it takes 5.84V of the reference voltage to convert 1.01V to an equivalent of 176.9 digital voltages

Thus the reference voltage for the ADC is approximately 5.8V

All the digital values were displayed on the liquid crystal display

Under test the maximum distance cover during transmission process - 100 meter

4.4 Operational test result from the full design (multifaceted intravenous therapy monitoring system)

a. When the drip liquid reduces to an expected value (20ml) it sends a distress call and data as message to a reception indicating which ward needs an attention which was displayed in the computer as virtual image
b. Distance between the transmission of data and reception data is 100m^2 radius

c. The visual operation of the system was projected to as virtual images using computer interface technique.
d. Time response frame in between the computer virtual imaging operation and the physical medical object in operation is 0.5 seconds

s/n	Sensitivity (mV)	Load (g)
1	0.5	460
2	0.6	383
3	0.75	306
4	1.2	230
5	1.3	176
6	1.7	135
7	2.1	103
8	3.1	74

Table 4.41

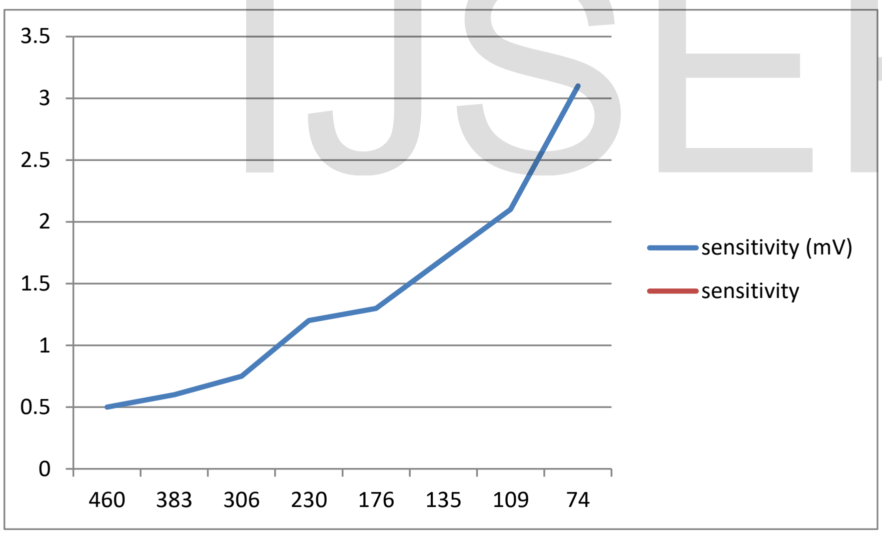

Fig 4.42 Sensitivity of the load cell plot vs. load weight

4.5 Discussion

In the design the higher the load on the load cell, the lower the voltage sensitivity of the cell and the lower the load on the load cell, the higher the voltage sensitivity of the load cell, we found out that it does not correspond with our design plan because we want the sensitivity to increase as the load increases on the load cell, thus we decided to adopt a negative feedback operational amplifier in the design, this design adoption help us to achieved our aim in making sure that when the sensitive voltage increases at the load cell it is decreasing at the output of the operational amplifier and when the sensitive voltage is reducing at the load cell it is increasing at the output of the operational amplifier, this design makes it possible when the load is been increased at the input the voltage increase in response, which is equivalent of the tension of the load.

In the analogue to digital voltage design, different reference voltage was adopted to actualize the positive result of different digital voltage output to analogue voltage equivalent.

5.0 Conclusion

We have been able to use load cell sensor to monitor the volumetric change in the drip bag of the system. We have been able to solve the problem of administration of drip by health workers to large number of patient at the same time by using smart system that can monitor and regulate the process of the volumetric change of fluid in the drip bag when administered to patient, with less or no human intervention.

Plate 5.1 Multifaceted intravenous therapy monitoring system

Acknowledgement

I give my gratitude to God for the success of the project , I acknowledge prof Idris Bugaje the E.S for NBTE for his great contribution to the project, I also acknowledge Dr Aliyu the director for the Office of Advance Polytechnic Kaduna for his noble support , finally I acknowledge my wife for her unconditional support to the development of the project.

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