

A Real-Time Alert for Infus Pump Occlusion Using Bluetooth Communication

Nisa'ul Sholihah, Abd Kholiq, Sumber

Department of Electromedical Engineering Poltekkes Kemenkes, Surabaya
Jl. Pucang Jajar Timur No. 10, Surabaya, 60245, Indonesia
Nisaul05@gmail.com, abdkholiq@gmail.com, sumberrani@gmail.com

Article Info	Abstract
Article History: Received Sep 9, 2019 Revised May 20, 2020 Accepted Jun 11, 2020	The infuse pump is medical equipment that is designed to control and regulate the administration of intravenous fluids in the treatment. This module uses the L298N motor driver as a stepper motor controller. The choice of the infuse pump setting is the volume setting from 100 ml to 500 ml and the speed setting of 30 ml/hour, 60 ml/hour, and 90 ml/hour. The author uses the ATMEGA 328 microcontroller as a droplet controller per minute, volume and speed. Occlusion in this device is in the detector of the droplets that are alerted in the presence of a sound buzzer. This tool is also equipped with monitoring volume, rpm and speed on a wireless-based PC using HC-11 as a transmission from module to PC. This tool is equipped with occlusion. The flow rate data processing in IDA from infusion got the highest error result at the setting of 30 ml/hour which was equal to 5.97%. the highest error for the calculation of droplets in the module is the setting of 30 ml/hour which is equal to 32% and manually at setting 60 which is 23%.
Keywords: Driver Motor Infusion Pump Flowmeter Occlusion Wireless	
Corresponding Author: Sumber Department of Electromedical Engineering Poltekkes Kemenkes, Surabaya Jl. Pucang East Jajar No. 10, Surabaya, 60245, Indonesia Email: sumberrani@gmail.com	This work is an <i>open-access article</i> and licensed under a Creative Commons Attribution ShareAlike 4.0 International (CC BY-SA 4.0).



I. INTRODUCTION

The infusion pump is a medical aid designed to control and regulate the administration of intravenous fluids to patients who are in care. The most important element in the infusion pump is a system for controlling the droplet speed of intravenous fluids using an electronically controlled pumping mechanical system [1] [2]. Based on the reference from the world health center in 2011, it was explained that the Infusion pump is also a tool that is useful for regulating the amount of fluid or drugs that enter the patient's blood circulation directly through the vein. To maintain the patient's condition to be monitored and facilitate the nurse in administering intravenous fluids. Therefore, manual infusion devices are less effective because there is no monitoring of indicator fluids in the nurse's room.

And then, nurses who assist in meeting the needs of intravenous fluids in patients experience difficulties and limitations of nurses who cannot always be next to patients at any time become a problem with using the infuse pump

manually. Because of this, many innovations in the infuse pump tool serve as reminders for nurses about the availability of intravenous fluids and make it easier to control, nurses can arrive on time and the patient's family is not confused looking for the presence of nurses during the patient's fluid replacement process.

In 2014 the research on "Monitoring of Atmega16 Microcontroller Based Infusion" made by Ardiyanto Iqbal Nugroho, from this final project developed a tool that detects flow velocity and fluid volume at infusion. This tool uses an Atmega 16 microcontroller with an LCD display and is equipped with a buzzer indicator, in this tool the buzzer will sound if the droplet speed is slower or faster 4 drops per minute than specified. The LCD displays droplet data per minute. This tool is equipped with monitoring on this tool is the speed of flow rate and volume of fluid [3]. This tool does not use a PC as a monitoring or monitoring device for an infuse pump.

In the same study in 2015, Putra Wira Merdeka conducted a study entitled "Detection of Infusion Fluid Consuming with Monitoring to Computers" having a manual infusion

background was ineffective because it was not equipped with indicator fluid monitors in the nurse's room and monitored the infused fluid and made it easier to call the nurse to provide fluid information to the nurse to immediately take action to replace fluids if the liquid has run out. This tool uses photodiodes and infrared as droplet detection sensors and ATmega 8 AVR as processing data with computer displays [4]. The disadvantages of this tool have not been equipped with the detection of the occlusion of the hose (occlusion).

In the next study in 2016, the research entitled "Liquid Droplet Sensor Simulation in Conventional Infusions" by Wadianto et al. Was motivated by fluid entering the patient's body always varying according to their needs, so nurses must always control patients. To create a system that makes it easier for nurses to control infusion for patients, this tool is designed to be able to monitor the number of droplets and detect fluids when droplets do not flow within a minute. This tool uses Arduino pro mini Atmega 328 data processor to display LCD, this tool also has infrared and optocoupler as droplet detection sensors in this tool[5]. This tool cannot display the PC because the monitor only uses LCD Characters. Then in 2016 conducted a study of "Infuse Set Monitoring Tool in Inpatient Patients Based on Atmega 8535 Microcontroller" By Decy Natalia et al. This tool has several parameters including the number of droplets per minute with a maximum number of drops/minutes detected by 255 drops, a warning if droplets are not detected for 10 seconds and a warning if the Infusion liquid will run out (± 50 ml). This tool uses infrared and photodiode as droplet sensors and processing the device using the Atmega 8535 microcontroller with led indicators and buzzers[6]. This tool has the disadvantage of not using a PC as monitoring infuse pump.

Furthermore, in 2017 Vicky Baysan Putra conducted a study entitled "Centralized Patient Infusion Remaining Monitoring System Based on LAN Networks". The background of this tool is due to the distance between the monitoring room and the patient's room between 5 meters and 20 meters. The distance that is too far in the monitor room with the patient's room is an obstacle to monitoring and monitoring the patient's condition, the main obstacles are the distance and frequency of the monitor. From the background, it was designed to monitor the condition of the infusion fluid centrally through a monitor in a room. This tool uses a level sensor to find out the remaining infusion fluid, the photodiode sensor is used to determine the condition of infusion droplets and the speed of infusion of patients. A photodiode sensor is also used to detect blood flowing on the IV line. This tool cannot control the refill of intravenous fluids[7]. This tool uses the Atmega 328 microcontroller as data processing and displays LCD and PC.

Recent research in 2018 Bayu Ponco R. With the title "Central Infusion Monitoring Tool that Monitor Infusion Volume and Monitor the Number of Drops of Infuse". In this study, a tool that has several functions is produced, namely monitoring infusion drops, volume, flow rate and remaining time at infusion. This tool is equipped with a reminder alarm

that aims if the infusion drops are in a critical condition or passes the set tolerance, the alarm will remind the nurse in charge to take action quickly In this study using the Atmega 328 microcontroller appeared LCD and PC[8]. However, this tool is not equipped with occlusion and lock door detectors.

Based on the identification of the above problems, the author wants to perfect the infuse pump monitoring tool with a sensor-equipped with exclusion and lock doors, in this case, the author intends to make a "Wireless Based Infuse Pump Monitoring (Occlusion)".

II. MATERIALS AND METHODS

A. Experimental Setup

Penelitian ini menggunakan pengaturan kecepatan (flowrate) dengan 30 ml/jam, 60 ml/jam, dan 90 ml/jam. Volume yang digunakan adalah 100, 200, 300, 400, 500. Jarak pengirimannya datanya adalah dari 1-20 meter. Tetesan permenit di dapatkan dari kecepatan setting dikalikan factor tetes dibagi dengan 60 menit. Pengambilan datanya untuk tetes permenit, kecepatan, jarak pengiriman dilakukan 5 kali.

1) Materials and Tool

In this study using 500 ml infusion fluid (PT Widrata Bhati, Indonesia) with infusion sets (OneMed, Jayamas Medical Industri, Indonesia). In the infusion set, a drop sensor is installed to detect droplets on the infusion. The droplet detection circuit uses infrared and photodiode as a sensor, the comparator, and the monostable circuit uses LM741 OP-AMP and IC NE555, using the L298N motor driver module which is used to control or drive a stepper motor. Using the limit switch as a safety lock door. Arduino Uno is used to processing data on droplet sensors, process data to a motor driver to be able to adjust the speed of a stepper motor, and communicate data on a computer (PC) with the HC-11 wireless module. Oscilloscopes with digital storage (Textronic, DPO2012, Taiwan) are used to retrieve test point data in analog circuits. An Infuse Device Analyzer or IDA 4 plus (Fluke, USA) which is used to calibrate Flowrate.

2) Experiment

In this study, after the design was carried out a tool to test the fall sensor by manually counting droplets and comparing it with the appearance of the nodule. In conducting calibration on the Infusion pump, use the flow rate setting (30, 60 and 90 ml/hour). Each set will be observed in IDA, as long as every 10 minutes the results in IDA and settings must be closer to the number of settings or the same. in the Volume selection there are 5 elections namely 100, 200, 300, 400 and 500 ml / hour. each patient usually has his own needs for fluids entering the body.

B. The Diagram Block

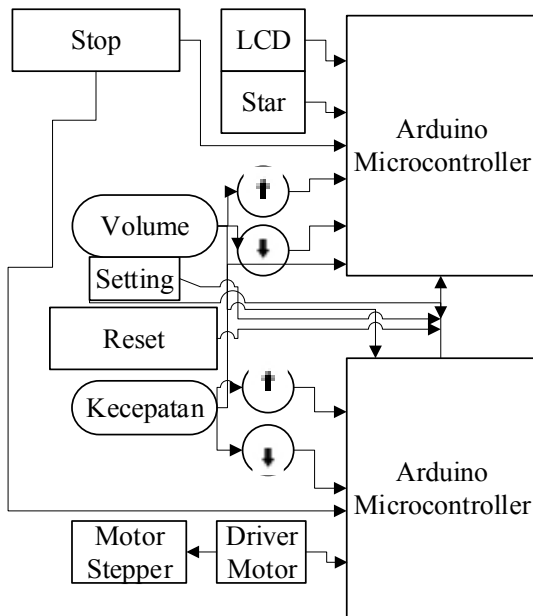
In this study droplets detected by infrared and photodiode sensors are then amplified by a comparator and monostable circuit and then the output is connected to an Arduino UNO digital, from analogs converted in digital then converted in a minute to update and update in units of ml. From Arduino

UNO the digital data is connected to the motor driver and the motor driver will adjust the speed of the stepper motor. To lock the door detected by the limit switch and then connect to an Arduino UNO digital then it will be detected when logic 0 the door opens when logic 1 door is closed. Data on the pump infusion device will also be sent to a computer unit by wireless HC-11.

Here uses 2 Arduino due to the use of 1 Arduino to make the motor system work while on Arduino 1 it is again used to give the appearance. Block diagrams are used to understand the contents or systems that work on the infusion pump. here use wireless HC-11 as data transmission on a PC.

On the infusion diagram block, there is a sender and receiver system. the sender is the system in the module circuit contained in the infusion pump and receiver used in PC reading with the use of HC-11. There are 2 systems namely :

Transmitter



Receiver

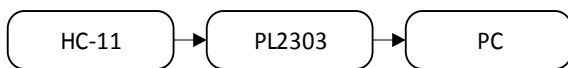


Fig. 1. The diagram block

C. The Flowchart

The Arduino program is built based on the flowchart as shown in Figure. 2. After the Arduino initialization, the program will ask for the volume and speed settings so the program will adjust the motor speed and read droplets per minute.

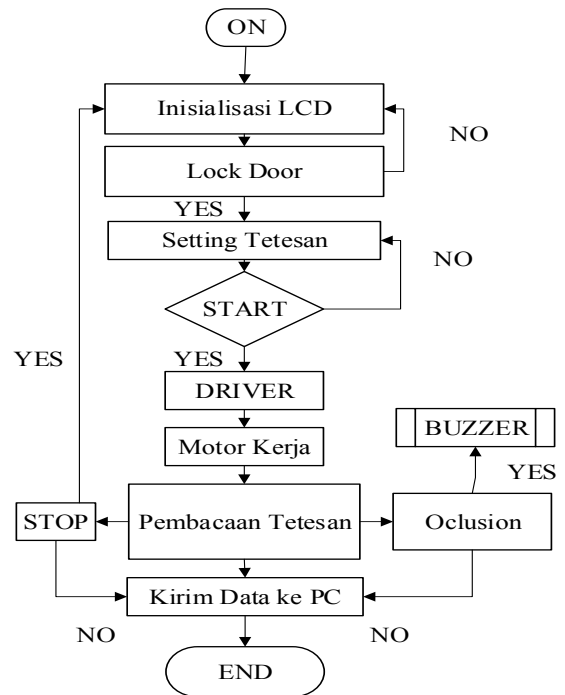


Fig. 2. The Flowchart of the Arduino Program

D. The Analog Circuit

An important part of developing this tool is the analog circuit in Figure. 4 (instrumentation amplifier), This circuit is used to amplify the results of measurements so that they can be read, Arduino. Therefore it will be ready for digital processing using Arduino.

1) Sensor Circuit

In the above circuit, there is a series of droplet sensors. This circuit serves to detect droplets that are driven by a motor, in this series using photodiode and infrared as a sensor to detect droplets

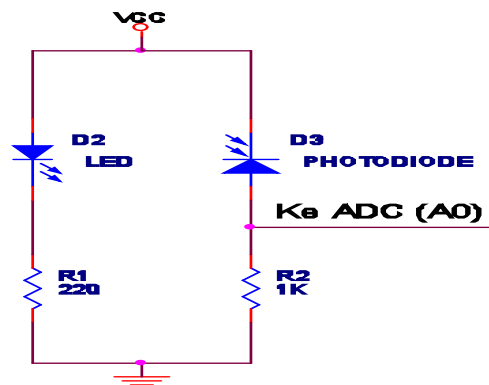


Fig. 3. Sensor Circuit

2) Komparator Monostabil

In this circuit, it functions to compare the incoming voltage at one input with another input voltage (reference voltage). At the non-inverting input voltage comparator, it is connected

with (+) IC lm741, while the reference voltage is connected to (-) IC lm741. If V_{in} is greater than V_{ref} , the output voltage approaches the V_{cc} voltage.

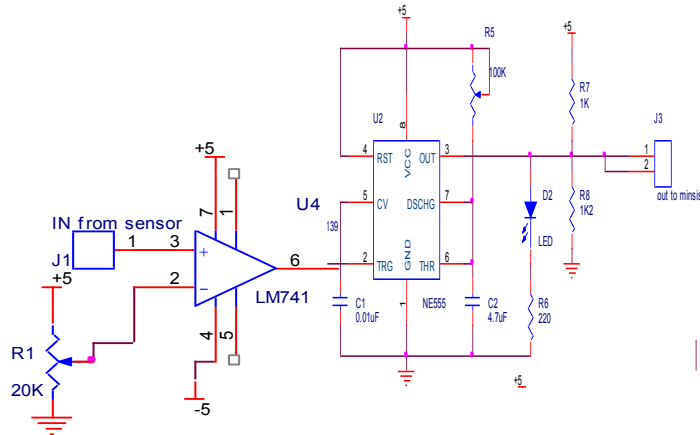


Fig. 4. Comparator

3) *Driver motor*

The stepper motor driver circuit is used to activate the stepper motor, the IC L298D obtains logic inputs (0 1 0 1), (1 0 0 1), (1 0 1 0), (0 1 1 0), which is generated by PIN 8, PIN 9, PIN 10, PIN 11, stepper motor speed is regulated by the delay changes in each L298D IC input logic, the faster the delay changes logic, the faster the stepper motor turns or vice versa. Diode functions as a safety return current on a stepper motor.

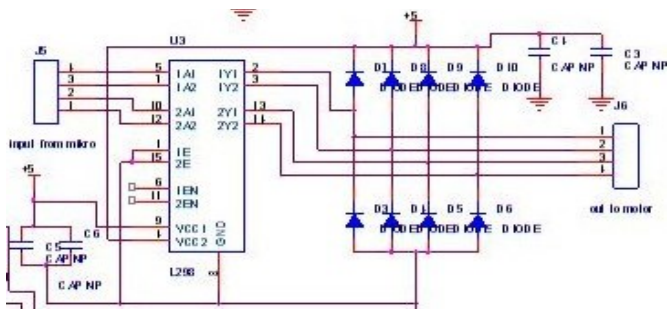


Fig. 5. Driver Motor

4) *Modul Wireless*

This wireless module uses HC-11. This wireless module is used as the sender and receiver of the data from the infusion pump module data displayed on the computer (PC). The display includes volume, minute droplets, open and closed-door detection, and flowrate. It requires two Tx pins to send the pump infusion pump and Rx data modules as recipients of information between the microcontroller and the computer (PC). the connection between wireless and Arduino as shown in Figure.6

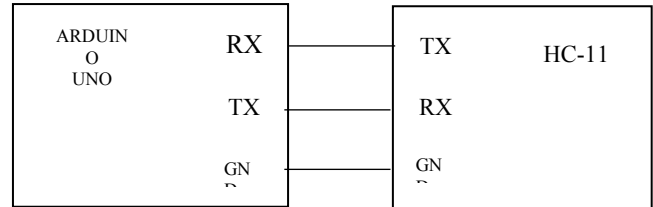


Fig. 6. Driver Motor

III. RESULTS

The use of infrared sensors and photodiodes for reading droplets is taken from the resistance when there are droplets is a measurement of the droplet circuit if there are droplets with an amplitude value of 2, 48 Volt.

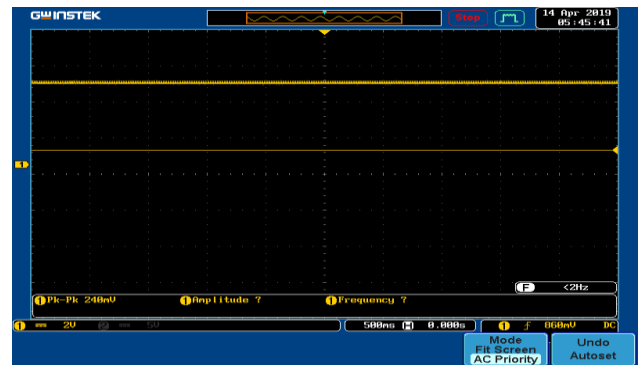


Fig. 7. Output Sensor result no Droplets

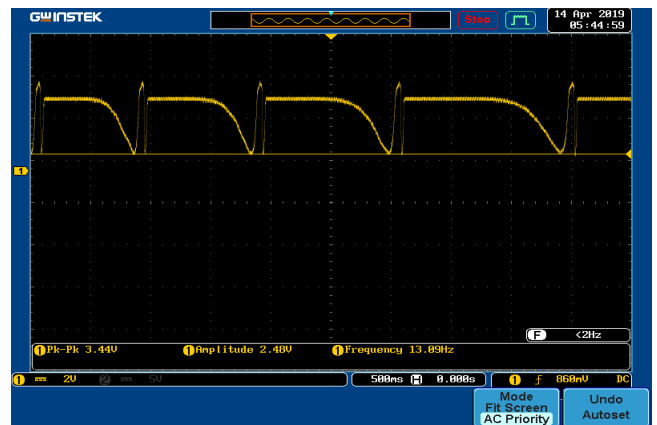


Fig. 8. Sensor circuit output after being the difference

1) *The Listing Program basic initialization program at Arduino*

Initialization serves as the initial address for entering programs on the microcontroller.

The Minimum System uses ArduinoUno with a 0x27 LCD display. The LCD displays the TPM value, droplets, Volume, and Speed. The stepper motor driver has input pins 8, 9, 10, 11

heading to Arduino. TPM results are updated 60 seconds (1 minute) until they are stable from droplet readings.

```
#include <Wire.h>
#include <Stepper.h> // Inisialisasi Motor Stepper
#include <LiquidCrystal_I2C.h> // Inisialisasi library LCD
LiquidCrystal_I2C lcd(0x27,20,4); // set the LCD address to
0x27 for a 16 chars and 2 line display
int IN1=8;
int IN2=9;
int IN3=10;
int IN4=11;
Stepper myStepper(stepsPerRevolution, 8, 9, 10, 11); //
Inisialisasi Pin Motor Stepper pada Arduino
int adc1=0;
int adc2=0;
int adc3=0; // Inisialisasi Pin ADC untuk Stepper
unsigned long cacah;
void interruptSetup() //inisialisasi buat timer
{ TCCR2A = 0x02;
  TCCR2B = 0x06;
  OCR2A = 0X3e;
  TIMSK2 = 0x02;
  sei(); }
ISR(TIMER2_COMPA_vect) //interupsi timer tiap 1 ms
{ cacah++;}
int tetesan = 2;
int tetesanx;
int tbstart = 3;
int tbsetting = 4;
int tbupkec = 5;
int tbdownkec = 6;
int tbupvol = 7;
int tbdownvol = 8;
int tbstop = 10;
int tbstartx = 0;
int tbsettingx = 0;
int tbupkecx = 0;
int tbdownkecx = 0;
int tbupvolx = 0;
int tbdownvolx = 0;
int tbresetx = 0;
int tbstopx = 0;
int buzzer = 11;
// Inisialisasi Penggunaan Pin Arduino untuk Push Button
int tetes,count; // Inisialisasi variable counter per tetes
int tpm; // Inisialisasi variable Tetesan Per Menit
int volume; // Inisialisasi variable Volume
float est_vol, tetes_vol; // Inisialisasi tipe data menjadi desimal
int kecepatan; // Inisialisasi Variable kecepatan
int kabel1 = A0;
int kabel2 = A1;
int kabel3 = A2;
// Inisialisasi Pin ADC Arduino
int sw = 12;
int swx; //Inisialisasi Pin 12 pada sw
```

```
unsigned long waktucacah=0; // //Inisialisasi waktucacah
dengan nilai awal 0
```

2) *Data transmission via HC-11*

The baud-rate setting that we use is equal to 9600. The baud-rate setting is done by writing on the microprogram listing and also setting the configuration on HC-11 via PL2303 which is connected to the PC.

```
Serial.begin(9600);
interruptSetup();
{
  Serial.print("a");
  Serial.print(volume);
  Serial.print("b");
  Serial.print("c");
  Serial.print(tetes_vol,0);
  Serial.print("d");
  Serial.print("e");
  Serial.print(kecepatan);
  Serial.print("f");
  Serial.print("g");
  Serial.print(swx);
  Serial.print("h");
}
```

3) *The Listing Program Occlusion*

The program listing above is an occlusion program used by researchers in completing the thesis made. Making this occlusion program is based on taking logic from drip drops. If droplets get logic 1 will turn on the buzzer as a warning that there is a blockage (no droplets). and if you get logic 0 the buzzer will die that there are droplets (no blockage). The buzzer will sound and turn off automatically when you get the logic.

```
if(tetesanx == 1){
  count = count+1;
  if(count == 350){
    digitalWrite(buzzer, HIGH);
  }
}
if(tetesanx == 0){
  delay(200);
  tetes++;
  tetes_vol++;
  est_vol = tetes_vol/60;
  count=0;
  digitalWrite(buzzer, LOW);
}
```

4) *The Listing Program Motor Stepper*

Programs for stepper motors have input and output. The input uses 3 ADC pins, namely adc1, adc2, and adc 3 which are given 3 logic. For the selection of 30 ml/hour which gets logic 1 (motor works) is pin adc1, for selection 60 ml/hour which gets logic 1 (motor works) is pin adc2, and for selection 90 ml/hour which gets logic 1 (motor works) is the adc3 pin and for the unused one, it gets logic 0.

```
if(kecepatan = 30){
    digitalWrite(kabel1,HIGH);
    digitalWrite(kabel2,LOW);
    digitalWrite(kabel3,LOW);
}
if((kecepatan = 40)
digitalWrite(kabel1,LOW);
digitalWrite(kabel2,HIGH);
digitalWrite(kabel3,LOW);
}
if((kecepatan = 90)
digitalWrite(kabel1,LOW);
digitalWrite(kabel2,LOW);
digitalWrite(kabel3,HIGH);
}
{
adc1 = digitalRead(A0);
adc2 = digitalRead(A1);
adc3 = digitalRead(A2);

if((adc1 == 1)&&(adc2 == 0)&&(adc3 == 0))
{
    myStepper.setSpeed(120);
    for (int i=0; i<60; i++){
        myStepper.step(-stepsPerRevolution);
    }
}

if((adc1 == 0)&&(adc2 == 1)&&(adc3 == 0))
{
    myStepper.setSpeed(240);
    for (int i=0; i<60; i++){
        myStepper.step(-stepsPerRevolution);
    }
}

if((adc1 == 0)&&(adc2 == 0)&&(adc3 == 1)){
    myStepper.setSpeed(370);
    for (int i=0; i<60; i++){
        myStepper.step(-stepsPerRevolution);
    }
}

if((adc1 == 0)&&(adc2 == 0)&&(adc3 == 0)){
}
}
}
```

5) *The Listing Program Readings Delphi*

The Delphi program for reading this volume is displayed when the volume selection 0 (Before setting) is white. If the selection of the 100 ml display will be blue, in the selection of 200 blue displays younger, 300 colors will be younger, up to a maximum of 500 ml.

```
begin
Val(Str,dataVolume,E);
if E = 0 then begin
Volume := dataVolume ;
    lbl2.Caption := inttostr (Volume) ;
    if (volume > 400)and ( volume <= 500 ) then begin
shp1.Brush.Color:=clGradientInactiveCaption;
shape1.Brush.Color:=clGradientActiveCaption;
shape2.Brush.Color:=clHighlight;
shp2.Brush.Color:=clBlue;
shp3.Brush.Color:=clNavy;
end;

    if (volume > 300)and ( volume <= 400 ) then begin
shp1.Brush.Color:=clwhite;
shape1.Brush.Color:=clGradientActiveCaption;
shape2.Brush.Color:=clHighlight;
shp2.Brush.Color:=clBlue;
shp3.Brush.Color:=clNavy;
end;

    if (volume > 200)and ( volume <= 300 ) then begin
shp1.Brush.Color:=clwhite;
shape1.Brush.Color:=clwhite;
shape2.Brush.Color:=clHighlight;
shp2.Brush.Color:=clBlue;
shp3.Brush.Color:=clNavy;
end;

    if (volume > 100)and ( volume <= 200 ) then begin
shp1.Brush.Color:=clwhite;
shape1.Brush.Color:=clwhite;
shape2.Brush.Color:=clwhite;
shp2.Brush.Color:=clBlue;
shp3.Brush.Color:=clNavy;
end;

    if (volume > 0)and ( volume <= 100 ) then begin
shp1.Brush.Color:=clwhite;
shape1.Brush.Color:=clwhite;
shape2.Brush.Color:=clwhite;
shp2.Brush.Color:=clwhite;
shp3.Brush.Color:=clNavy;
end;

    if (volume = 50) then begin
shp1.Brush.Color:=clwhite;
shape1.Brush.Color:=clwhite;
shape2.Brush.Color:=clwhite;
shp2.Brush.Color:=clwhite;
shp3.Brush.Color:=clNavy;
end;

    if (volume = 1) then begin
lbl2.caption := '0';
```

```

lbl3.Caption := '0';
shp1.Brush.Color:=clwhite;
shape1.Brush.Color:=clwhite;
shape2.Brush.Color:=clwhite;
shp2.Brush.Color:=clwhite;
shp3.Brush.Color:=clwhite;
end;
end;
end;
    
```

This Delphi program is for Speed and droplets. On display when getting data from HC-11 shipments it will display according to the display on the Infusion Pump. Listing Program. Data Reading Program

In this Delphi program to reset and close. When pressing Close there will be a text "Apakah Anda Yakin Ingin Memonitoring Infus Dari Awal?" And if you press Reset there is a display "Anda Yakin Ingin Menghentikan Monitoring dan keluar?".

```

procedure TForm1.Button2Click(Sender: TObject);
begin
if messagedlg('Apakah Anda Yakin Ingin Memonitoring Infus Dari Awal?',mtconfirmation,
[mbYes,mbNo],0)=mrYes then
begin
lbl2.Caption:='0';
lbl3.Caption:='0' ;
lbl4.Caption:='0';
shp1.Brush.Color:=clwhite;
shape1.Brush.Color:=clwhite;
shape2.Brush.Color:=clwhite;
shp2.Brush.Color:=clwhite;
shp3.Brush.Color:=clwhite;
end;
end;
procedure TForm1.Button3Click(Sender: TObject);
begin
if messagedlg('Anda Yakin Ingin Menghentikan Monitoring dan keluar?',mtconfirmation,
[mbYes,mbNo],0)=mrYes then
begin
close;
end;
end;
    
```

6) The Error of Flow with IDA

TABLE I. THE ERROR OF MEASUREMENT WITH IDA.

No	Subject	Error (%)
1	30 ml/jam	5.97 %
2	60 ml/jam	1.13%
3	90 ml/jam	2.48 %

The table above is a table of data retrieval error rate flow rate from the infusion pump which is done by measuring using IDA (Infusion Device Analyzer).

7) The Error of TPM

TABLE II. THE ERROR OF MEASUREMENT TPM.

No	Subject	Error (%)	Mode
1	30 ml/jam	32 %	Modul
		20 %	Manual
2	60 ml/jam	26 %	Modul
		23 %	Manual
3	90 ml/jam	26 %	Modul
		22.67 %	Manual

The results of the reading of the droplet error value are influenced by several factors, namely the stepper motor and the sensitivity of the sensor that has been made. The data above is data droplets per minute from the infusion pump made.

IV. DISCUSSION

The ATMEGA328 microcontroller module is coupled with several other electronic components and is combined with the mechanics of the stepper motor and its peristalsis able to work properly running an infusion pump system. The flow rate data processing in IDA from infusion got the highest error result in the setting of 30 ml/hour which was equal to 5.97% and the lowest error was found in the setting of 60 ml/hour which was equal to 1.13%. Infusion TPM found the error for the highest manual error calculation at the setting of 60 ml/hour which is equal to 23%, the lowest error was in the setting of 30 ml/hour which is equal to 20%. At a distance of one to 20 meters, data transmission without obstacles can be sent properly. At a distance of one to 13 send data with obstacles the data is sent well too. When occlusion is detected, that is, if the hose has an obstacle, the buzzer will appear and if there is a drop back the buzzer will die.

V. CONCLUSION

The development of this research can be done by step:

Use additional antennas so that the distance can reach further. Designing sensors to make them more sensitive to avoid a lot of errors in TPM readings (Droplets per minute). Using the sensor for occlusion so that the blockage in the infusion pump detection is more accurate. Increase the accuracy of the tool to avoid a lot of errors.

REFERENCES

[1] N. Thongpance, Y. Pititeeraphab, and M. Ophasphanichayakul, "The design and construction of infusion pump calibrator," *5th 2012 Biomed. Eng. Int. Conf. BMEICON 2012*, vol. 100, pp. 3-5, 2012.

[2] M. Deepalakshmi and R. Jayaparvathy, "Design and implementation of a lowcost Integrated Insulin Infusion system," in *2016 International Conference on Computation of Power, Energy, Information and Communication, ICCPEIC 2016*, 2016, pp. 25-32.

- [3] A. I. Nugroho, "Monitoring Tetesan Infus Berbasis Mikrokontroler Atmega16," 2014.
- [4] E. Y. Putra Wira M, Bambang Guruh Irianto, "Seminar Tugas Akhir Mei 2015," *Deteksi Cairan Infus Habis Dengan Monit. Ke Komput.*, pp. 1–9, 2015.
- [5] W. Wadianto and Z. Fihayah, "Simulasi Sensor Tetesan Cairan, pada Infus Konvensional," *J. Kesehat.*, vol. 7, no. 3, p. 394, 2016.
- [6] D. NATALIANA, N. TARYANA, and E. RIANDITA, "Alat Monitoring Infus Set pada Pasien Rawat Inap Berbasis Mikrokontroler ATmega 8535," *J. Elkomika*, vol. 4, no. 1, pp. 1–15, 2017.
- [7] P. V. Baysan, "Sistem Monitoring Sisa Cairan Infus Pasien Secara Terpusat Berbasis Jaringan LAN," 2017.
- [8] R. H. Sudhan, M. G. Kumar, A. U. Prakash, S. A. R. Devi, and S. P., "Arduino Atmega-328 Microcontroller," *Ijireeice*, vol. 3, no. 4, pp. 27–29, 2015.