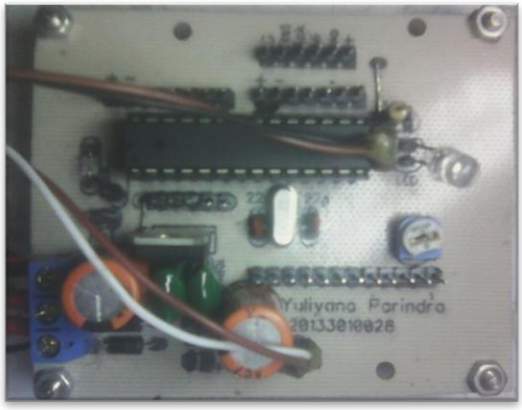
LAMPIRAN

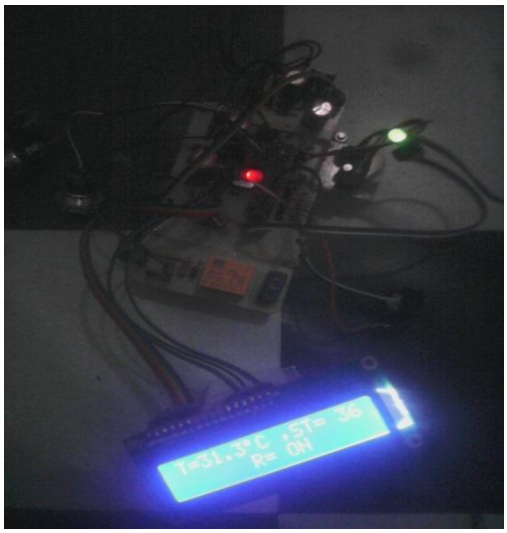
A. Pembuatan *Minimun system* dan Penanaman Program

1. Rangkaian Minimum System yang telah dilarutkan, di bor dan dipasang komponen



2. Rangkaian *Driver relay* dan sensor suhu yang telah dilarutkan dan di bor

3. Pemasangan *minimum system*, *diver relay*, sensor suhu dan pengecekan program menggunakan cv avr



B. Pembuatan *Heater*

1. Pembuatan *Heater* menggunakan bahan *Stainless* dan *heater* penghangat nasi

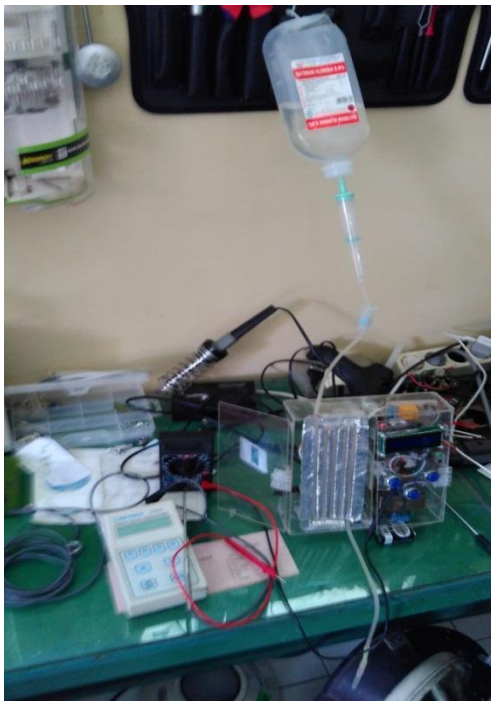
C. Proses Pembuatan *Chasing Box* Prototipe *Bood Warmer*

1. Pembuatan *chasing box* menggunakan bahan *axrilix*

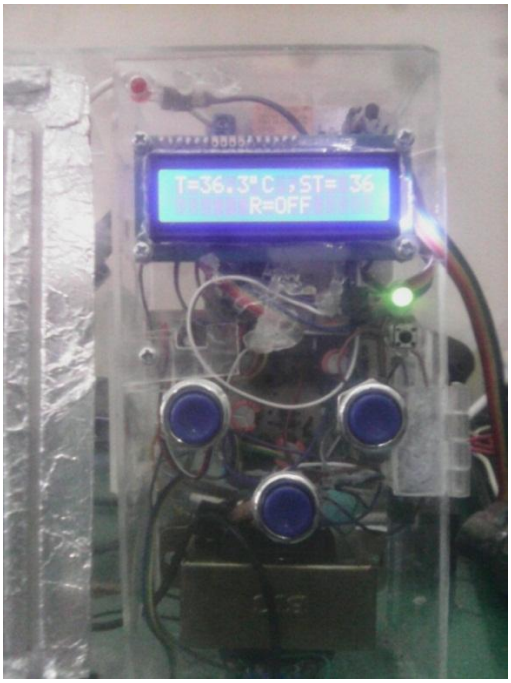
2. Pemasangan semua komponen

D. Foto Hasil Pengukuran Alat di RS Wirosaban

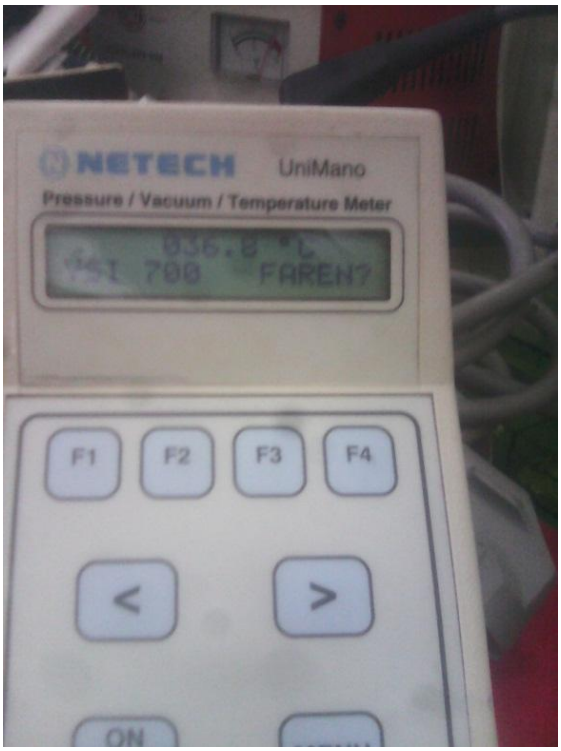
1. Pemasangan dan Persiapan Alat



2. Pengukuran di setting suhu 36ºC

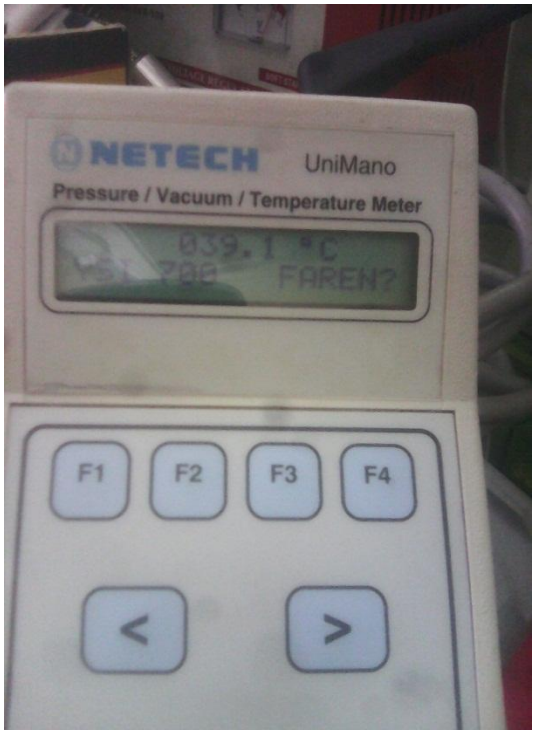


3. Pengukuran di setting suhu 37 ºC



4. Pengukuran di setting suhu 38 ºC

5. Pengukuran di setting suhu 39 ºC



E. PERHITUNGAN

1. Rata-rata

   a. Rata-rata suhu 36ºC

      1. Suhu Thermometer

$$\frac{\begin{array}{c}36.4 + 36.0 + 36.6 + 36.1 + 36.7 + 36.7 + 36.5 + 35.9 \\ +36.0 + 36.7 + 36.5 + 36.7 + 36.5 + 36.0 + 36.5 + 36.5 \\ +36.7 + 36.7 + 36.7 + 36.5\end{array}}{20}$$

$$= 36.445\ ^{o}C$$

      2. Suhu Modul

$$\frac{\begin{array}{c}36.3 + 36.3 + 36.3 + 35.8 + 36.3 + 35.8 + 35.8 + 35.8 \\ +35.8 + 36.3 + 36.3 + 36.3 + 35.8 + 35.8 + 36.3 + 35.8 \\ +36.3 + 35.8 + 35.8 + 36.3\end{array}}{20}$$

$$=36.05\ ^{o}C$$

   b. Rata-rata suhu 37 ºC

      1. Suhu Thermometer

$$\frac{\begin{array}{c}37.1 + 37.5 + 37.5 + 37.4 + 37.6 + 37.6 + 37.6 + 37.5 \\ +37.5 + 37.5 + 37.6 + 37.6 + 37.4 + 37.4 + 37.5 + 37.5 \\ +37.6 + 37.5 + 37.6 + 37.6\end{array}}{20}$$

$$= 37.505\ ^{o}C$$

      2. Suhu Modul

$$\frac{\begin{array}{c}36.8 + 37.3 + 37.3 + 36.8 + 36.8 + 37.3 + 36.8 + 37.3 \\ +36.8 + 37.3 + 37.3 + 37.3 + 36.8 + 36.8 + 37.3 + 36.8 \\ +37.3 + 36.8 + 36.8 + 37.3\end{array}}{20}$$

$$= 37.05\ ^{o}C$$

c. Rata-rata suhu 38ºC

1. Suhu Thermometer

$$\frac{\begin{array}{c}37.7 + 38.5 + 38.4 + 38.6 + 38.0 + 38.3 + 38.3 + 38.2 \\ +38.1 + 38.3 + 38.6 + 38.4 + 38.3 + 38.2 + 38.0 + 38.5 \\ +38.2 + 38.6 + 38.1 + 38.3\end{array}}{20}$$

= 38.28 ºC

2. Suhu Modul

$$\frac{\begin{array}{c}37.7 + 38.3 + 37.8 + 37.8 + 38.3 + 38.3 + 38.3 + 37.8 \\ +37.8 + 37.8 + 38.3 + 37.8 + 38.3 + 37.8 + 37.8 + 38.3 \\ +37.8 + 37.3 + 37,8 + 38.3\end{array}}{20}$$

$= 37.97895ºC$

d. Rata-rata suhu 39ºC

1. Suhu Thermometer

$$\frac{\begin{array}{c}39.2 + 39.2 + 39.4 + 39.3 + 38.4 + 39.5 + 39.3 + 39.0 \\ +39.3 + 38.8 + 39.1 + 39.2 + 39.3 + 39.3 + 39.2 + 39.2 \\ +39.1 + 39.3 + 39.1 + 39.3\end{array}}{20}$$

= 39.2 ºC

2. Suhu Modul

$$\frac{\begin{array}{c}38.8 + 39.7 + 38.8 + 39.2 + 38.8 + 38.3 + 39.2 + 38.8 \\ +39.2 + 38.8 + 39.2 + 38.8 + 39.2 + 39.2 + 38.8 + 39.2 \\ +38.8 + 39.2 + 39.2 + 39.2\end{array}}{20}$$

= 39.02 ºC

2. Simpangan

   a. Suhu 36 ºC

      36 - 36.445 = -0.445 ºC

   b. Suhu 37 ºC

      37 - 37.505 = -0.505 ºC

   c. Suhu 38 ºC

      38.28 - 38.28 = -0.28 ºC

   d. Suhu 39 ºC

      39 - 39.2 = -0.2 ºC

3. *Error*

   a. 36 ºC

      $$Error\% = \frac{36.445-36.05}{36.445} \text{ x } 100\% = 1.083825\%$$

   b. 37 ºC

      $$Error\% = \frac{37.505-37.05}{37.505} \text{ x } 100\% = 1.213172\%$$

   c. 38 ºC

      $$Error\% = \frac{38.28-37.979}{38.28} \text{ x } 100\% = 0.786449\%$$

   d. 39 ºC

      $$Error\% = \frac{39.2-39.02}{39.2} \text{ x } 100\% = 0.46\%$$

4. *SD*

a. 36 ºC

$$\sqrt{\frac{\begin{array}{c}(36.445-36{,}4)^2+(36.445-36)^2+(36.445-36.6)^2\\+(36.445-36{,}1)^2+(36.445-36.7)^2+(36.445-36.7)^2\\+(36.445-36.5)^2+(36.445-35.9)^2+(36.445-36)^2\\+(36.445-36.7)^2+(36.445-36.5)^2+(36.445-36.7)^2\\+(36.445-36.5)^2+(36.445-36)^2+(36.445-36.5)^2\\+(36.445-36.5)^2+(36.445-36.7)^2+(36.445-36.7)^2\\+(36.445-36.7)^2+(36.445-36.5)^2\end{array}}{(20-1)}}$$

$= 0.281864096$ ºC

b. 37ºC

$$\sqrt{\frac{\begin{array}{c}(37.505-37.1)^2+(37.505-37.5)^2+(37.505-37.5)^2\\+(37.505-37.4)^2+(37.505-37.6)^2+(37.505-37.6)^2\\+(37.505-37.6)^2+(37.505-37.5)^2+(37.505-37.5)^2\\+(37.505-37.5)^2+(37.505-37.6)^2+(37.505-37.6)^2\\+(37.505-37.4)^2+(37.505-37.4)^2+(37.505-37.5)^2\\+(37.505-37.5)^2+(37.505-37.6)^2+(37.505-37.5)^2\\+(37.505-37.6)^2+(37.505-37.6)^2\end{array}}{(20-1)}}$$

= 0.119097483ºC

c. 38ºC

$$\sqrt{\frac{\begin{array}{c}(38.28-37.7)^2+(38.28-38.5)^2+(38.28-38.4)^2\\+(38.28-38.6)^2+(38.28-38)^2+(38.28-38.3)^2\\+(38.28-38.3)^2+(38.28-38.2)^2+(38.28-38.1)^2\\+(38.28-38.3)^2+(38.28-38.6)^2+(38.28-38.4)^2\\++(38.28-38.3)^2+(38.28-38.2)^2+(38.28-38)^2\\+(38.28-38.5)^2+(38.28-38.2)^2+(38.28-38.6)^2\\+(38.28-38.1)^2+(38.28-38.3)^2\end{array}}{(20-1)}}$$

= 0.230788123 ºC

d. 39ºC

$$\sqrt{\frac{\begin{array}{c}(39.2-39.2)^2+(39.2-39.2)^2+(39.2-39.4)^2\\+(39.2-39.3)^2+(39.2-38.4)^2+(39.2-39.5)^2\\+(39.2-39.3)^2+(39.2-39)^2+(39.2-39.3)^2\\+(39.2-38.8)^2+(39.2-39.1)^2+(39.2-39.2)^2\\+(39.2-39.3)^2+(39.2-39.3)^2+(39.2-39.2)^2\\+(39.2-39.2)^2+(39.2-39.1)^2+(39.2-39.3)^2\\+(39.2-39.1)^2+(39.2-39.3)^2\end{array}}{(20-1)}}$$

= 0.164750894 ºC

5. *UA*

a. 36 ºC

$$= \frac{0.281864}{\sqrt{20}} = 0.06302671\ ^{o}C$$

b. 37ºC

$$= \frac{0.119097}{\sqrt{20}} = 0.0266309\ ^{o}C$$

c. 38ºC

$$= \frac{0.230788}{\sqrt{20}} = 0.05160577\ ^{o}C$$

d. 39ºC

$$= \frac{0.164751}{\sqrt{20}} = 0.03683944^{o}C$$

F. Program

```
/*****************************************************
*******
This program was produced by the
CodeWizardAVR V2.05.3 Standard
Automatic Program Generator
© Copyright 1998-2011 Pavel Haiduc, HP InfoTech
s.r.l.
http://www.hpinfotech.com

Project :
Version :
Date    : 5/29/2016
Author  : tyery08
Company : embeeminded.blogspot.com
Comments:
Chip type               : ATmega8
Program type            : Application
AVR Core Clock frequency: 12.000000 MHz
Memory model            : Small
External RAM size       : 0
Data Stack size         : 256
*****************************************************
******/
float suhu_celcius;
int setpoint;
char str[16];
unsigned int adc;
char temp[10];
```

```
#include <mega8.h>
#include <delay.h>
#include <stdio.h>
#include <stdlib.h>

// Alphanumeric LCD functions
#include <alcd.h>

#define ADC_VREF_TYPE 0x40

// Read the AD conversion result
unsigned int read_adc(unsigned char adc_input)
{
ADMUX=adc_input | (ADC_VREF_TYPE & 0xff);
// Delay needed for the stabilization of the
ADC input voltage
delay_us(10);
// Start the AD conversion
ADCSRA|=0x40;
// Wait for the AD conversion to complete
while ((ADCSRA & 0x10)==0);
ADCSRA|=0x10;
return ADCW;
}

// Declare your global variables here

void main(void)
{
```

```
 setpoint=36;
// Declare your local variables here

// Input/Output Ports initialization
// Port B initialization
//   Func7=In   Func6=In   Func5=In   Func4=In
Func3=Out Func2=Out Func1=Out Func0=Out
// State7=T State6=T State5=T State4=T State3=0
State2=1 State1=1 State0=1
PORTB=0x07;
DDRB=0x0F;

// Port C initialization
// Func6=In Func5=In Func4=In Func3=In Func2=In
Func1=In Func0=In
// State6=T State5=T State4=T State3=T State2=T
State1=T State0=T
PORTC=0x00;
DDRC=0x00;

// Port D initialization
//  Func7=Out  Func6=Out  Func5=Out  Func4=Out
Func3=In Func2=In Func1=In Func0=Out
// State7=1 State6=1 State5=1 State4=1 State3=T
State2=T State1=T State0=0
PORTD=0x0F;
DDRD=0x01;

// Timer/Counter 0 initialization
```

```
// Clock source: System Clock
// Clock value: Timer 0 Stopped
TCCR0=0x00;
TCNT0=0x00;

// Timer/Counter 1 initialization
// Clock source: System Clock
// Clock value: Timer1 Stopped
// Mode: Normal top=0xFFFF
// OC1A output: Discon.
// OC1B output: Discon.
// Noise Canceler: Off
// Input Capture on Falling Edge
// Timer1 Overflow Interrupt: Off
// Input Capture Interrupt: Off
// Compare A Match Interrupt: Off
// Compare B Match Interrupt: Off
TCCR1A=0x00;
TCCR1B=0x00;
TCNT1H=0x00;
TCNT1L=0x00;
ICR1H=0x00;
ICR1L=0x00;
OCR1AH=0x00;
OCR1AL=0x00;
OCR1BH=0x00;
OCR1BL=0x00;

// Timer/Counter 2 initialization
```

```
// Clock source: System Clock
// Clock value: Timer2 Stopped
// Mode: Normal top=0xFF
// OC2 output: Disconnected
ASSR=0x00;
TCCR2=0x00;
TCNT2=0x00;
OCR2=0x00;

// External Interrupt(s) initialization
// INT0: Off
// INT1: Off
MCUCR=0x00;

//       Timer(s)/Counter(s)       Interrupt(s)
initialization
TIMSK=0x00;

// USART initialization
// USART disabled
UCSRB=0x00;

// Analog Comparator initialization
// Analog Comparator: Off
//   Analog   Comparator   Input   Capture   by
Timer/Counter 1: Off
ACSR=0x80;
SFIOR=0x00;
```

```
// ADC initialization
// ADC Clock frequency: 750.000 kHz
// ADC Voltage Reference: AVCC pin
ADMUX=ADC_VREF_TYPE & 0xff;
ADCSRA=0x84;

// SPI initialization
// SPI disabled
SPCR=0x00;

// TWI initialization
// TWI disabled
TWCR=0x00;

// Alphanumeric LCD initialization
// Connections are specified in the
//                          Project|Configure|C
Compiler|Libraries|Alphanumeric LCD menu:
// RS - PORTB Bit 0
// RD - PORTD Bit 7
// EN - PORTD Bit 6
// D4 - PORTD Bit 5
// D5 - PORTD Bit 4
// D6 - PORTB Bit 1
// D7 - PORTB Bit 2
// Characters/line: 16
lcd_init(16);
lcd_gotoxy(2,0);
lcd_putsf("B           ");
```

```
delay_ms(100);
lcd_gotoxy(2,0);
lcd_putsf("BL          ");
delay_ms(100);
lcd_gotoxy(2,0);
lcd_putsf("BL0         ");
delay_ms(100);
lcd_gotoxy(2,0);
lcd_putsf("BLOO        ");
delay_ms(100);
lcd_gotoxy(2,0);
lcd_putsf("BLOOD       ");
delay_ms(100);
lcd_gotoxy(2,0);
lcd_putsf("BLOOD W     ");
delay_ms(100);
lcd_gotoxy(2,0);
lcd_putsf("BLOOD WA    ");
delay_ms(100);
lcd_gotoxy(2,0);
lcd_putsf("BLOOD WAR   ");
delay_ms(100);
lcd_gotoxy(2,0);
lcd_putsf("BLOOD WARM  ");
delay_ms(100);
lcd_gotoxy(2,0);
lcd_putsf("BLOOD WARME ");
delay_ms(100);
lcd_gotoxy(2,0);
```

```
lcd_putsf("BLOOD WARMER ");
lcd_gotoxy(0,0);
lcd_putsf("->BLOOD WARMER<-");

while(PIND.1==1)                  //enter
  {
  //-----------------------------------
    if(PIND.2==0&&setpoint<39)    //up
     {
      setpoint++;
      sprintf(str,"%i",setpoint);
      lcd_gotoxy(12,1);
      lcd_puts(str);
      delay_ms(200);
     }
    else if(PIND.3==0&&setpoint>36) //down
     {
      setpoint--;
      sprintf(str,"%i",setpoint);
      lcd_gotoxy(12,1);
      lcd_puts(str);
      delay_ms(200);
     }
     PORTD.0=0;
     lcd_gotoxy(0,1);
     lcd_putsf("->Set Point=36<-");
     sprintf(str,"%i",setpoint);
     lcd_gotoxy(12,1);
     lcd_puts(str);
```

```
     delay_ms(200);

   }
 lcd_clear();
 lcd_gotoxy(0,0);
 lcd_putsf("T=   ");
 lcd_gotoxy(9,0);
 lcd_putsf(",ST=  ");
 lcd_gotoxy(14,0);
 lcd_puts(str);
 lcd_gotoxy(4,1);
 lcd_putsf(" R=    ");

while (1)
      {
       adc=read_adc(0);
       suhu_celcius   =   ((float)adc*500/1023-
2.3);//rumus untuk mengubah desimal kedalam
derajat celcius
       ftoa(suhu_celcius,1,temp);//float     to
array, mengubah tipe data float ke tipe data
array yg akan ditampilkan di LCD
       lcd_gotoxy(0,0);
       lcd_putsf("T=   ");
       lcd_gotoxy(2,0);
       lcd_puts(temp);
       lcd_gotoxy(6,0);
       lcd_putchar(0xdf);//menampilkan karakter
derajat
```

```
        lcd_gotoxy(7,0);
        lcd_putsf("C");
        delay_ms(500);

//=================================
        if(suhu_celcius>setpoint )
         {
          PORTD.0=0;
          lcd_gotoxy(4,1);
          lcd_putsf("  R=     ");
          lcd_gotoxy(8,1);
          lcd_putsf("OFF");
          delay_ms(1000);
         }
          else
        if(suhu_celcius<setpoint)
         {
          PORTD.0=1;
          lcd_gotoxy(4,1);
          lcd_putsf("  R=    ");
          lcd_gotoxy(8,1);
          lcd_putsf(" ON");
         }
    //=========================================
        if(suhu_celcius>42)     //buzer on
         {
          PORTB.3=1;
          delay_ms(1000);
          PORTB.3=0;
```

```
          delay_ms(1000);
         }else
        if(suhu_celcius<40)
         {
          PORTB.3=0;
         }
       }
}
```

G. Rangkaian Keseluruhan Alat Prototipe Blood Warmer