CHAPTER 5
IMPLEMENTATION AND RESULTS

5.1. Implementation

```
1  float nadi, suhu;
2  float A, B;
3  float udingin[] = {30, 30, 35};
4  float unormal[] = {34, 36, 38};
5  float upanas[] = {38, 40, 40};
6  float ulambat[] = {50, 50, 60};
7  float usedang[] = {59, 60, 101};
8  float ucepat[] = {101, 120, 120};
9  float sakit = 0;
10 float ks = 0.5;
11 float sehat = 1;
12 float minr[10];
13 float Rule[10];
```

In lines 1 - 13, This section declares pulse and temperature, A and B, and temperature membership (cold, normal, hot) and pulse (slow, medium, fast) to enter the fuzzyfication stage.

```
14 float fudingin()
15 {
16   if (suhu < udingin[1])
17   {
18     return 1;
19   }
20   else if (suhu >= udingin[1] && suhu <= udingin[2])
21   {
22     return (udingin[2] - suhu) / (udingin[2] - udingin[1]);
23   }
24   else if (suhu > udingin[2])
25   {
26     return 0;
27   }
28 }
29
30 float funormal()
31 {
32   if (suhu < unormal[0])
33   {
34     return 0;
35   }
36   else if (suhu >= unormal[0] && suhu <= unormal[1])
37   {
38     return (suhu - unormal[0]) / (unormal[1] - unormal[0]);
39   }
40   else if (suhu >= unormal[1] && suhu < unormal[2])
```

```
41   {
42     return (unormal[2] - suhu) / (unormal[2] - unormal[1]);
43   }
44   else if (suhu > unormal[2])
45   {
46     return 0;
47   }
48 }
49
50 float fupanas()
51 {
52   if (suhu < upanas[0])
53   {
54     return 0;
55   }
56   else if (suhu >= upanas[0] && suhu <= upanas[1])
57   {
58     return (suhu - upanas[0]) / (upanas[1] - upanas[0]);
59   }
60   else if (suhu > upanas[1])
61   {
62     return 1;
63   }
64 }
```

On lines 14 – 64 , pada bagian fuzzyfikasi ini dilakukan membership untuk keanggotaan fuzzy suhu yaitu dingin, normal, dan panas.

```
65 float fulambat()
66 {
67   if (nadi < ulambat[1])
68   {
69     return 1;
70   }
71   else if (nadi >= ulambat[1] && nadi <= ulambat[2])
72   {
73     return (ulambat[2] - nadi) / (ulambat[2] - ulambat[1]);
74   }
75   else if (nadi > ulambat[2])
76   {
77     return 0;
78   }
79 }
80
81 float fusedang()
82 {
83   if (nadi < usedang[0])
84   {
85     return 0;
86   }
87   else if (nadi >= usedang[0] && nadi <= usedang[1])
88   {
89     return (nadi - usedang[0]) / (usedang[1] - usedang[0]);
90   }
```

```
91   else if (nadi >= usedang[1] && nadi <= usedang[2])
92   {
93     return (usedang[2] - nadi) / (usedang[2] - usedang[1]);
94   }
95   else if (nadi > usedang[2])
96   {
97     return 0;
98   }
99 }
100
101      float fucepat()
102      {
103        if (nadi <= ucepat[0])
104        {
105          return 0;
106        }
107        else if (nadi > ucepat[0] && nadi < ucepat[1])
108        {
109          return (nadi - ucepat[0]) / (ucepat[1] - ucepat[0]);
110        }
111        else if (nadi >= ucepat[1])
112        {
113          return 1;
114        }
115      }
```

In the next line, on lines 65 – 115, membership fuzzyfication is carried out for fuzzy pulse membership, namely slow, medium, and fast.float Min(float a, float b)

```
116      {
117        if (a < b)
118        {
119          return a;
120        }
121        else if (b < a)
122        {
123          return b;
124        }
125        else
126        {
127          return a;
128        }
129      }
```

In lines 116 - 129, the minimum value is taken from the results of the comparison of the fuzzyfication value between temperature and pulse. The author uses a zero-order Sugeno fuzzy algorithm where the minimum value is taken to determine the rule.

```
130 void rule()
131 {
132   // if suhu dingin and nadi lambat then kurang sehat
133   minr[1] = Min(fudingin(), fulambat());
134   Rule[1] = ks;
135   // if suhu dingin and nadi sedang then kurang sehat
136   minr[2] = Min(fudingin(), fusedang());
137   Rule[2] = ks;
138   // if suhu dingin and nadi cepat then sakit
139   minr[3] = Min(fudingin(), fucepat());
140   Rule[3] = sakit;
141   // if suhu normal and nadi lambat then kurang sehat
142   minr[4] = Min(funormal(), fulambat());
143   Rule[4] = ks;
144   // if suhu normal and nadi sedang then sehat
145   minr[5] = Min(funormal(), fusedang());
146   Rule[5] = sehat;
147   // if suhu normal and nadi cepat then kurang sehat
148   minr[6] = Min(funormal(), fucepat());
149   Rule[6] = ks;
150   // if suhu panas and nadi lambat then kurangg sehat
151   minr[7] = Min(fupanas(), fulambat());
152   Rule[7] = ks;
153   // if suhu panas and nadi sedang then kurang sehat
154   minr[8] = Min(fupanas(), fusedang());
155   Rule[8] = ks;
156   // if suhu panas and nadi cepat then kurang sehat
157   minr[9] = Min(fupanas(), fucepat());
158   Rule[9] = ks;
159 }
```

In lines 130 - 159 determine the rule from the conditions obtained from fuzzyfication and taking the minimum value. There are 9 possibilities that occur in 2 parameters of temperature and pulse.

```
160      float defuzzyfikasi()
161      {
162        rule();
163        A = 0;
164        B = 0;
165
166        for (int i = 1; i <= 9; i++)
167        {
168          // printf("Rule ke %d = %f\n", i, Rule[i]);
169          // printf("Min ke %d = %f\n", i, minr[i]);
170          A += Rule[i] * minr[i];
171          B += minr[i];
172        }
173        // printf("Hasil A : %f\n", A);
174        // printf("Hasil B : %f\n", B);
175        return A / B;
176      }
```

In lines 160 - 176 the defuzzification stage is carried out where the fuzzy values are converted back into real numbers. Calculation according to the zero order Sugeno fuzzy algorithm formula where the output is a firm constant.

5.2. Results

System testing is the process of trying or executing hardware and software to test whether the system is running as expected. The test was carried out on 10 different respondents with adult age parameters. Then an evaluation process is carried out if the system does not match what the researcher expects. The test carried out is to compare the MLX90614 sensor and pulse sensor with a thermogun and heart rate to determine the accuracy of the sensor in determining decisions in determining conditions through a fuzzy algorithm.

Table 5.1: Pulse sensor and heartbeat measurement results

Testing	Heartbeat (BPM)	Pulse Sensor (BPM)	Difference (BPM)
Respondent #1	83	86	-3
	83	86	-3
	84	86	-2
	85	87	-2
	86	87	-1
AVERAGE	84.2	86.4	-2.2
Respondent #2	84	83	-1
	82	85	-3
	81	83	-2
	82	82	-1
	88	85	-3
AVERAGE	83.4	83.6	-2
Respondent #3	76	77	-1
	75	77	-2
	74	71	-3
	75	77	-2
	75	77	-2
AVERAGE	75	75.8	-2
Respondent #4	72	73	-1
	74	73	-1
	75	70	-5
	74	73	-1
	73	75	-2

AVERAGE	73.6	72.8	-2
Respondent #5	75	72	-3
	75	72	-3
	78	77	-1
	77	75	-2
	78	77	-1
AVERAGE	76.6	74.6	-2
Respondent #6	79	79	0
	80	79	-1
	79	78	-1
	78	79	-1
	77	79	-2
AVERAGE	78.6	78.8	-1
Respondent #7	96	97	-1
	97	98	-1
	97	98	-1
	96	98	-2
	98	97	1
AVERAGE	96.8	97.6	-0.8
Respondent #8	89	90	-1
	88	89	-1
	88	89	-1
	88	90	-2
	87	88	-1
AVERAGE	88	89.2	-1.2
Respondent #9	76	78	-2
	77	79	-2
	77	78	-1
	78	77	1
	76	78	-2
AVERAGE	76.8	78	-1.2
Respondent #10	75	77	-2
	79	79	0
	78	77	1

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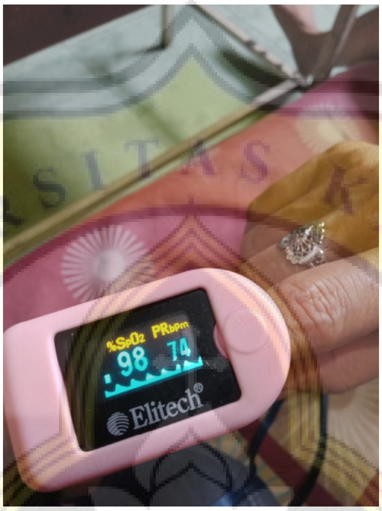
	79	77	2
	76	78	-2
AVERAGE	77.4	77.6	-0.2

From table 5.1 it is obtained that the difference in data between the pulse sensor and the heartbeat is obtained. The possibility that occurs is the condition of each respondent who performs the test is different.



Picture 5.1: Testing with heartbeat

Picture 5.1 is one of the documentation of pulse rate testing activities with heartbeat. Testing the pulse of one of the respondents with heartbeat meter shows 74 bpm.

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Table 5.2: Temperature sensor (MLX90614) and thermogun measurement results

Testing	Thermogun (ºC)	MLX90614 (ºC)	Difference (ºC)
Respondent #1	36.4	36.7	-0.3
	36.5	36.8	-0.3
	36.5	36.8	-0.3
	36.5	36.2	-0.3
	36.5	36.8	-0.3
AVERAGE	36.4	36.6	-0.3
Respondent #2	36.7	36.6	-1
	36.6	36.6	0
	36.6	36.7	-1
	36.7	36.7	0
	36.7	36.8	-1
AVERAGE	36.6	36.6	-0.6
Respondent #3	36.6	36.5	-1
	36.5	36.4	-1
	36.5	36.6	-1
	36.4	36.2	-2
	36.5	36.7	-2
AVERAGE	36.5	36.4	-1.4
Respondent #4	36.5	36.7	-0.2
	36.5	36.6	-0.1
	36.6	36.8	-0.2
	36.5	36.6	-0.1
	36.7	36.4	-0.3
AVERAGE	36.5	36.5	-0.18
Respondent #5	37.1	37.2	-0.1
	36.9	37.1	-0.2
	37.1	37.2	-0.1
	37.0	36.8	-0.2
	37.1	37.2	-0.1
AVERAGE	37.04	37.1	-0.14
Respondent #6	36.4	36.7	-0.3
	36.6	36.5	0.1

	36.7	36.6	0.1
	36.4	36.8	-0.4
	36.5	36.7	-0.2
AVERAGE	36.52	36.66	-0.14
Respondent #7	36.8	36.9	-0.1
	36.7	36.7	0
	36.4	36.6	-0.2
	36.9	37	-0.1
	36.7	36.8	-0.1
AVERAGE	36.7	36.8	-0.1
Respondent #8	36.7	36.5	0.2
	36.6	36.8	-0.2
	36.4	36.6	-0.2
	36.8	36.7	0.1
	36.7	36.6	0.1
AVERAGE	36.64	36.64	0
Respondent #9	36.4	36.6	-0.2
	36.5	36.7	-0.2
	36.7	36.6	0.1
	36.7	36.8	-0.1
	36.5	36.4	0.1
AVERAGE	36.56	36.62	-0.06
Respondent #10	36.7	36.8	-0.1
	36.8	36.6	0.2
	36.8	36.7	0.1
	36.6	36.8	-0.2
	36.7	36.9	-0.2
AVERAGE	36.72	36.76	-0.04

From table 5.2 a comparison of the temperature taking data with the thermogun and the MLX90614 sensor is obtained. The MLX90614 sensor has been calibrated with a thermogun so that the difference in the results from the test is not too far from the thermogun. Body temperature testing is carried out outdoors in a sitting position.

Picture 5.2: Testing with thermogun

Picture 5.2 shows one of the documentation of temperature testing with a thermogun. Testing one of the respondents with a thermogun showed 36.6 ºC.

Table 5.3: Health Monitoring System Test Results

Testing	MLX90614 (ºC)	Pulse Sensor (BPM)	Defuzzy	Output / Condition
Respondent #1	36.7	86	1	Sehat
	36.8	86	1	Sehat
	36.8	86	1	Sehat
	36.2	87	1	Sehat
	36.8	87	1	Sehat
AVERAGE	36.6	86.4	1	Sehat
Respondent #2	36.6	83	1	Sehat
	36.6	85	1	Sehat
	36.7	83	1	Sehat

	36.7	82	1	Sehat
	36.8	85	1	Sehat
AVERAGE	36.6	83.6	1	Sehat
Respondent #3	36.5	77	1	Sehat
	36.4	77	1	Sehat
	36.6	71	1	Sehat
	36.2	77	1	Sehat
	36.7	77	1	Sehat
AVERAGE	36.4	75.8	1	Sehat
Respondent #4	36.7	73	1	Sehat
	36.6	73	1	Sehat
	36.8	70	1	Sehat
	36.6	73	1	Sehat
	36.4	75	1	Sehat
AVERAGE	36.6	72.8	1	Sehat
Respondent #5	37.1	72	1	Sehat
	36.9	72	1	Sehat
	37.1	77	1	Sehat
	37.0	75	1	Sehat
	37.1	77	1	Sehat
AVERAGE	37.04	74.6	1	Sehat
Respondent #6	36.7	79	1	Sehat
	36.5	79	1	Sehat
	36.6	78	1	Sehat
	36.8	79	1	Sehat
	36.7	79	1	Sehat
AVERAGE	36.66	78.8	1	Sehat
Respondent #7	36.9	97	1	Sehat
	36.7	98	1	Sehat
	36.6	98	1	Sehat
	37	98	1	Sehat
	36.8	97	1	Sehat
AVERAGE	36.8	97.6	1	Sehat
Respondent #8	36.5	90	1	Sehat

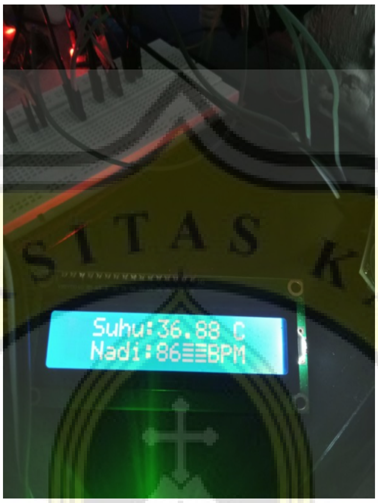
	36.8	89	1	Sehat
	36.6	89	1	Sehat
	36.7	90	1	Sehat
	36.6	88	1	Sehat
AVERAGE	36.64	89.2	1	Sehat
Respondent #9	36.6	78	1	Sehat
	36.7	79	1	Sehat
	36.6	78	1	Sehat
	36.8	77	1	Sehat
	36.4	78	1	Sehat
AVERAGE	36.62	78	1	Sehat
Respondent #10	36.8	77	1	Sehat
	36.6	79	1	Sehat
	36.7	77	1	Sehat
	36.8	77	1	Sehat
	36.9	78	1	Sehat
AVERAGE	36.76	77.6	1	Sehat

Table 5.4: Algorithm Data Simulation

Simulation	MLX90614 (ºC)	Pulse Sensor (BPM)	Defuzzy	Output / Condition
Simulation #1	33.3	110	0	Sakit
Simulation #2	38.9	56	0,5	Kurang Sehat
Simulation #3	34.5	100	0,5	Kurang Sehat
Simulation #4	34.2	70	0,5	Kurang Sehat
Simulation #5	36.8	105	0,5	Kurang Sehat
Simulation #6	37.6	59	0,5	Kurang Sehat
Simulation #7	38.6	69	0.5	Kurang Sehat
Simulation #8	34.1	108	0	Sakit
Simulation #9	35.4	104	0	Sakit
Simulation #10	36.1	53	0.5	Kurang Sehat

As shown in table 5.3 temperature and pulse data were obtained from 5 different respondents. The temperature and pulse values are in accordance with the sensor calibration, and the fuzzy Sugeno algorithm runs according to the specified rules in the form of Sehat, Kurang Sehat, Sakit.

Table 5.4 is a simulation of data for comparison of algorithms that produce sick and unhealthy conditions.



Picture 5.3: Testing Health Monitoring System

Picture 5.3 shows the testing of a monitoring tool or system. LCD displays the output in the form of temperature and pulse of the respondent.

Picture 5.4: Output result

Picture 5.4 shows the results of the decision from Picture 5.3. The LCD displays the output or decision of the respondent's temperature and pulse.