CHAPTER 5
EXPERIMENTAL STUDY

This chapter puts forth the realization of the system in the form of illustrative examples and the screens depicting the outputs generated.

5.1 IMPLEMENTATION

The JAVA framework with the main classes and the corresponding functionality, used for developing the system are given as follows:

- WindowHandler Class: To handle the window operations like closing of window, minimizing, maximizing etc.
- Annotator Class: To display annotator feedback screen, to collect the data and to store the values in database (MS-Access).
- Bar-Chart Class: to display the emotion indication bars and emotion charts.
- Data Class: to process the variables used in the complete system.
- Mat_lab Class: to process the data generated by FIS of MATLAB.
- Comparison Class: to compare the output of the emotion recognition system with the
- Temp Class: includes the main() method which connects all the other classes.
- User_interface Class: generates the UI screens, processes the I/O variables and computes the emotional weight and polarity values.
- Display_Value: to display the final output.
The system developed in JAVA is exercised on synthetic events as given in Appendix-B. Some of the sample events are listed below:

## SAMPLE EVENTS

<table>
<thead>
<tr>
<th>Emotion</th>
<th>HAPPINESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Polarity</td>
<td>The students were overcome with joy when they defeated the faculty in the cricket match.</td>
</tr>
<tr>
<td>Negative Polarity</td>
<td>She was not pleased with her performance in the interview.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emotion</th>
<th>DESPAIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Polarity</td>
<td>He became depressed after the stock market hit an all time low.</td>
</tr>
<tr>
<td>Negative Polarity</td>
<td>There was no trace of sadness on the faces of the relatives after his death.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emotion</th>
<th>ANGER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Polarity</td>
<td>The Principal was quite furious with the students for their misbehavior.</td>
</tr>
<tr>
<td>Negative Polarity</td>
<td>She did not let her temper levels rise in the meeting.</td>
</tr>
<tr>
<td>Emotion</td>
<td>FEAR</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td><strong>Positive Polarity</strong></td>
<td>People in the city got very scared after listening to the weather forecast.</td>
</tr>
<tr>
<td><strong>Negative Polarity</strong></td>
<td>The children swam the dark waters without any fear.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emotion</th>
<th>SURPRISE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive Polarity</strong></td>
<td>The owner was perplexed at the display of affection by his pet dog.</td>
</tr>
<tr>
<td><strong>Negative Polarity</strong></td>
<td>The results were in the normal range and did not lead to any surprise element.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emotion</th>
<th>DISGUST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive Polarity</strong></td>
<td>The sight of the surgery was quite repulsive for the new intern.</td>
</tr>
<tr>
<td><strong>Negative Polarity</strong></td>
<td>A dedicated nurse never expresses disgust, irrespective of the situation.</td>
</tr>
</tbody>
</table>
**Neutral:**

1. As part of its continuing effort to strengthen the bond with people in the Valley, Army has published a coffee-table book on shrines of Kashmir.

2. The AP State Road Transport Corporation is introducing ‘Metro Express’ buses to the Airport from Dwaraka Bus Station (RTC Complex).

**Multiple Emotions:**

1. The student was outraged by the teachers comment and sported a contrite expression on her face.

2. The family members were not very scared of the impending scenario but grew sick of it.

**Illustration 1:**

Consider the sample event with a single emotion: “The Professor was very happy that one of her students had topped the University examination”.

N = 6 // Recognition Task Algorithm

No.of tokens = 15

Emotional keyword = happy // Recognition Task Algorithm

Emotion Modifier = very; Grade = 2 // K-Window1 Algorithm

Scaling Factor(SF) = 5; NOC = 1; Term Frequency (tf) = 1

Inverse Term Frequency (itf) = log(N/NOC) = log(6/1) = 0.7781
Emotional Value (EV) = \( tf \times itf \times SF = 1 \times 0.7781 \times 5 = 3.8905 \)

Weight = grade \( \times \) EV = 2 \( \times \) 3.8905 = 7.781 // Recognition Task Algo.

Polarity = 1 // K-Window2 Algo.

Emotion = Happiness

Intensity value of emotion generated by NFS = 7.4

i.e., Intensity = Medium

**Illustration 2:**

Consider the sample event with an exemplified emotion: “The child was so very surprised to see her father that she stood dumbfounded”.

\( N = 6 \)

No. of tokens = 14

Emotional keyword1 = surprised, Emotional keyword2 = dumbfounded

Emotion Modifier1 = so, Emotional Modifier2 = very

Grade = 3; Scaling Factor (SF) = 5; NOC = 1;

Term Frequency (tf) = 2

Inverse Term Frequency (itf) = \( \log (6/1) = 0.7781 \)

Emotional Value (EV) = \( tf \times itf \times SF = 2 \times 0.7781 \times 5 = 7.781 \)

Weight = grade \( \times \) EV = 3 \( \times \) 7.781 = 23.343

Normalized value for Weight = 20

Emotion = SURPRISE

Polarity = 1

Intensity value of emotion generated by NFS = 16.8
Illustration 3:

Consider the sample event with a negative emotion: “There was no trace of repulsion on the face of the doctor at the sight of the burnt body”. 
N = 6
No.of tokens = 19
Emotional keyword = repulsion
Negation word = no; Polarity = -1
Grade = 1; Scaling Factor(SF) = 5 ; NOC = 1;
Term Frequency (tf) = 1
Inverse Term Frequency (itf) = log (6/1) = 0.7781
Emotional Value(EV) = tf * itf * SF = 1 * 0.7781 * 5 = 3.8905
Weight = grade * EV = 1 * 3.8905 = 3.8905
Emotion = DISGUST
Intensity value of emotion generated by NFS = 4
i.e., Intensity = Low

Illustration 4:

Consider the sample event with multiple emotions: “The student was outraged by the teachers comment and sported a contrite expression on her face”.

i.e., Intensity = High
N = 6
No.of tokens = 16

Emotional keyword1 = outraged, Emotional keyword2 = contrite
Grade = 1; Scaling Factor(SF) = 5; NOC = 2;
Term Frequency (tf) = 1

Inverse Term Frequency (itf) = \log \left(\frac{6}{2}\right) = 0.477121

Emotional Value(EV) = tf * itf * SF = 1 * 0.477121 * 5 = 2.4

Weight = grade * EV = 1 * 2.4 = 2.4

Emotion1 = ANGER, Emotion2 = DESPAIR

Intensity value of emotion generated by NFS = 3.2
i.e., Intensity = Low (for both the emotions)

( NOTE : In case of multiple emotions the intensity is shared by the multiple emotions)

MATLAB, a software package for high-performance numerical computation and visualization has been used to generate the Fuzzy Inference System. It includes a number of built-in functions for technical computation and also provides an interactive environment. It provides several ‘Toolboxes’ which are collections of functions written for special applications like Image Processing, Statistics, Neural Networks, Fuzzy Logic etc. The Fuzzy Logic toolbox is used to develop the inference system of the emotional state calculator.
5.2 RESULTS

The screens generated using MATLAB are given below:

The Fuzzy Inference System (MAMDANI model) generated in MATLAB with “weight” and “polarity” as input variables and “emotion” as output variable.
The membership function (trapezoid function) for the input linguistic variable “weight” with three linguistic states (Low, Medium, High) generated in the Fuzzy Inference System, takes the values in the range of 0 to 1.

Screen 2: Membership Function for “WEIGHT”
The membership function (trapezoid function) for the input linguistic variable “polarity” with two linguistic states (Negative, Positive) generated in the Fuzzy Inference System, takes the values in the range of 0 to 1.

Screen 3: Membership function for “POLARITY”
The membership function (trapezoid function) for the output linguistic variable “emotion” with six linguistic states (Negative Low, Negative Medium, Negative Low, Positive Low, Positive Medium, Positive High) generated in the Fuzzy Inference System, has values in the range of 0..1.

Screen 4: Membership Function for “EMOTION”
The six inference rules used by the inference engine of the Fuzzy Inference System to deduce the resultant emotion based on the values of weight and polarity are as follows:

Screen 5: Inference Rules
The Rule Viewer of FIS for the input values of weight = 3.89 and polarity=0.9 generates the output value for emotion as 4 as given below:

Screen 6: Inference Rule Viewer for LOW intensity and POS polarity
The Surface Viewer for the input values of weight = 3.89, polarity = 0.9 and output value emotion = 4 as depicted in screen 7.

Screen 7: Surface Viewer
The Rule Viewer of FIS for the input values of weight=3.89 and polarity = -0.9 generates the output value for emotion as -4 as in Screen 8.

Screen 8: Inference Rule Viewer for LOW intensity and NEG polarity
The Surface Viewer for the input values of weight = 3.89, polarity = 0.9 and output value emotion = 4 is denoted by the following screen.

Screen 9: Surface Viewer
The Rule Viewer of Fuzzy Inference System for the input values of weight=7.78 and polarity=0.99 generates the output value as 7.4.

Screen 10: Inference Rule Viewer for MEDIUM intensity and POS polarity
The Rule Viewer of Fuzzy Inference System for the input values of weight=15.6 and polarity=0.9 generates the output value as 16.

Screen 11: Inference Rule Viewer for HIGH intensity and POS polarity
The Surface Viewer for the input values of weight = 15.6 and polarity = 0.9 and output value of emotion = 16

Screen 12: Surface Viewer
The screens generated through JAVA code are as follows:

**Screen 1.1:** The input screen for the event “The students were rejoicing after defeating the faculty in the cricket match”.

![Image 1]

**Screen 1.2:** The computed emotional value and weight of the emotional keyword in the above event.

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Category</th>
<th>Emotional value</th>
<th>Weight</th>
<th>polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>rejoicing</td>
<td>0</td>
<td>3.6007635319182164</td>
<td>3.6007635319182164</td>
<td>pos</td>
</tr>
</tbody>
</table>

![Image 2]
Screen 1.3: The output generated for the above event indicates that the emotion is HAPPINESS with LOW intensity and POSITIVE polarity.

Screen 1.4: The screen for accepting the input from the human annotator.

Input Event: The students were rejoicing after defeating the faculty in the cricket match

What's the emotion that you observe?

Emotion: HAPPINESS

Level: FAIRLY

Type: POSITIVE
Screen 1.5: The output screen displaying the expected output (of annotator) and the observed output (of the NFS system).

<table>
<thead>
<tr>
<th>Expected output (from Annotator)</th>
<th>Observed output (from Calculations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotion: happiness</td>
<td>Keyword: rejoicing</td>
</tr>
<tr>
<td>Level: low</td>
<td>Emotion: Happiness</td>
</tr>
<tr>
<td>Polarity: pos</td>
<td>Level: low</td>
</tr>
<tr>
<td></td>
<td>Polarity: Positive</td>
</tr>
</tbody>
</table>
Screen 2.1: The input screen for the event “There was no trace of repulsion on the face of the doctor at the site of the burnt body of the patient”.

Screen 2.2: The screen generated for the above event indicates that the emotion is DISGUST with LOW intensity and NEGATIVE polarity.
Screen 3.1: The input screen for the event “The speaker was not angered by the question but afraid to answer it”.

Screen 3.2: The output screen generated for the above event indicates that the emotions are ANGER with LOW intensity and NEGATIVE polarity; FEAR with LOW intensity and POSITIVE polarity.
Screen 4.1: The input screen for the event “The AP State Road Transport Corporation is introducing Metro Express buses to the Airport from RTC Complex”.

Screen 4.2: The output screens generated for the above event indicates that the emotion is NEUTRAL.
**Screen 4.3**: The output screen displaying the comparison of expected output with that of observed output. In both cases emotion is NEUTRAL.

<table>
<thead>
<tr>
<th>Expected output (from Annotator)</th>
<th>Observed output (from Calculations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotion: neutral</td>
<td>Keyword: emotion is neutral</td>
</tr>
<tr>
<td>Level: neutral</td>
<td>Emotion: neutral</td>
</tr>
<tr>
<td>Polarity: neutral</td>
<td>Level: neutral</td>
</tr>
<tr>
<td></td>
<td>Polarity: neutral</td>
</tr>
</tbody>
</table>
Screen 5.1: The input screen for the event “The child was so very surprised to see her father that she stood dumbfounded”.

Screen 5.2: The output screen generated indicates the emotion for the above event is SURPRISE with MEDIUM intensity and POSITIVE polarity.
Events with Multiple Emotions

**Example 1:** Gymnast was *surprised* with the scores and *very happy* that he won the competition.

Weight of Happiness = 7.7, Polarity = 1  
Weight of Surprise = 3.85, Polarity = 1  
Weight of Disgust = Fear = Anger = Despair = 0

This is an event with more than one emotion, that of happiness and surprise. The emotional weights for both are computed and a pie-chart is generated with the relative intensities. The presence of remaining four emotions is 0%.
Example 2: The student was *outraged* by the teachers comment and sported a *contrite* expression on her face.

Weight of Anger = 2.4, Polarity = 1
Weight of Despair = 2.4 , Polarity = 1
Weight of Disgust = Fear = Happiness = Surprise = 0

This is an event with more than one emotion, that of anger and despair. The emotional weights for both are computed and a pie-chart is generated with the relative intensities. The presence of remaining four emotions is 0%.
**Example 3:** The family members were *not very scared* of the impending scenario but grew *sick* of it.

Weight of Disgust = 2.4, Polarity = 1  
Weight of Fear = 4.8, Polarity = -1  
Weight of Despair = Anger = Happiness = Surprise = 0

This is an event with more than one emotion, that of disgust and fear. The emotional weights for both are computed and a pie-chart is generated with the relative intensities. The presence of the other four emotions is 0%. 