

## TABLE OF CONTENTS

|  |             |
|--|-------------|
| <b>APPROVAL PAGE</b> .....                         | <b>ii</b>   |
| <b>STATEMENT</b> .....                             | <b>iii</b>  |
| <b>FOREWORD</b> .....                              | <b>v</b>    |
| <b>TABLE OF CONTENTS</b> .....                     | <b>vii</b>  |
| <b>LIST OF TABLES</b> .....                        | <b>x</b>    |
| <b>LIST OF FIGURES</b> .....                       | <b>xi</b>   |
| <b>ABSTRACT</b> .....                              | <b>xiii</b> |
| <b>INTISARI</b> .....                              | <b>xiv</b>  |
| <b>CHAPTER I INTRODUCTION</b> .....                | <b>1</b>    |
| <b>1.1 Background</b> .....                        | <b>1</b>    |
| <b>1.2 Research Problem</b> .....                  | <b>2</b>    |
| <b>1.3 Research Scopes</b> .....                   | <b>3</b>    |
| <b>1.4 Research Objectives</b> .....               | <b>3</b>    |
| <b>1.5 Benefits</b> .....                          | <b>3</b>    |
| <b>1.6 Research Methodology</b> .....              | <b>4</b>    |
| <b>1.7 Thesis Organization</b> .....               | <b>5</b>    |
| <b>CHAPTER II LITERATURE REVIEW</b> .....          | <b>6</b>    |
| <b>CHAPTER III BASIC THEORY</b> .....              | <b>8</b>    |
| <b>3.1 Machine Translation</b> .....               | <b>8</b>    |
| <b>3.1.1 Rule-based Machine Translation</b> .....  | <b>8</b>    |
| <b>3.1.2 Statistical Machine Translation</b> ..... | <b>8</b>    |
| <b>3.1.3 Neural Machine Translation</b> .....      | <b>9</b>    |
| <b>3.2 Artificial Neural Network</b> .....         | <b>9</b>    |
| <b>3.3 Recurrent Neural Network</b> .....          | <b>10</b>   |

|   |  |           |
|---|--|-----------|
| 3.4   | ADAM .....                               | 10        |
| 3.5   | Attention Mechanism .....                | 10        |
| 3.6   | Encoder-Decoder Based NMT .....          | 12        |
| 3.7   | Multi-Encoder NMT .....                  | 13        |
| 3.8   | Multi-Source NMT with Missing Data ..... | 15        |
| 3.9   | BLEU .....                               | 16        |
| <b>CHAPTER IV ANALYSIS AND DESIGN .....</b>   |  | <b>19</b> |
| 4.1   | General Analysis .....                   | 19        |
| 4.2   | Data Acquisition .....                   | 20        |
| 4.3   | Data Generation .....                    | 20        |
| 4.4   | Language Relatedness .....               | 21        |
| 4.5   | Experiment .....                         | 22        |
| 4.5.1   | Multi-source NMT .....                   | 22        |
| 4.5.2   | NMT Settings .....                       | 25        |
| 4.6   | Evaluation .....                         | 25        |
| <b>CHAPTER V IMPLEMENTATION .....</b>         |  | <b>26</b> |
| 5.1   | Specification .....                      | 26        |
| 5.2   | Data Acquisition Implementation .....    | 26        |
| 5.3   | Data Generation Implementation .....     | 27        |
| 5.4   | Language Relatedness .....               | 28        |
| 5.5   | Experiment Implementation .....          | 30        |
| 5.6   | Evaluation Implementation .....          | 45        |
| <b>CHAPTER VI RESULT AND DISCUSSION .....</b> |  | <b>47</b> |
| 6.1   | Data Acquisition Result .....            | 47        |
| 6.2   | Data Generation Result .....             | 48        |
| 6.3   | Language Relatedness .....               | 51        |

|   |                                 |           |
|---|---------------------------------|-----------|
| <b>6.4</b>  | <b>Experiment Results .....</b> | <b>53</b> |
| 6.4.1   | Two-to-one NMT Settings .....   | 53        |
| 6.4.2   | Three-to-one NMT Setting .....  | 55        |
| <b>6.5</b>  | <b>Evaluation .....</b>         | <b>58</b> |
| <b>CHAPTER VI CONCLUSION AND FUTURE WORKS .....</b> |                                 | <b>67</b> |
| 7.1   | Conclusion .....                | 67        |
| 7.2   | Future Works .....              | 68        |
| <b>REFERENCES .....</b>                             |                                 | <b>69</b> |
| <b>APPENDICES .....</b>                             |                                 | <b>73</b> |