|  |  |  |
| --- | --- | --- |
| Figure 1.1 | Project overview for American sign language……………………………. | 11 |
| Figure 2.1 | A Data Glove design with Sensor………………………………………… | 15 |
| Figure 2.2 | A Glove device with Sensor………………………………………………... | 16 |
| Figure 3.1 | American Sign language Manual Alphabet……………………………….. | 17 |
| Figure 3.2 | American Sign language numbers…………………………………………. | 18 |
| Figure 3.3 | Data set images…………………………………………………………….  . | 20 |
| Figure 4.1 | Hand posture detection steps………………………………………………. | 26 |
| Figure 4.2 | HSV Colour Space………………………………………………………… | 29 |
| Figure 4.3 | Images of detecting hand postures…………………………………………. | 30 |
| Figure 5.1 | Diagram of image processing pipeline……………………………………. | 34 |
| Figure 5.2 | The figure shows different levels of generalization of the model………………… | 41 |
| Figure 5.3 | Relationship between the model complexity and its ultimate accuracy is the relationship between training and testing error……………………………. | 43 |
| Figure 6.1 | Diagram of artificial neuron………………………………………………. | 47 |
| Figure 6.2 | Activation Functions ………………………………………………………. | 50 |
| Figure 6.3 | Fully connected Feed Forward Neural Network…………………………… | 52 |
| Figure 6.4 | Structure of Convolutional Neural Network………………………………. | 56 |
| Figure 6.5 | A zero padded 4x4 matrix………………………………………………….. | 58 |
| Figure 6.6 | Principle of Max-pooling…………………………………………………. | 60 |
| Figure 6.7 | Dropout: (a)Standard fully connected network. (b) Network with some neurons deactivated. (c) Activation of neuron during training phase. (d) Activation of neuron during testing phase………………………………… | 64 |
| Figure 7.1 | CNN network architecture for Alphabets…………………………………. | 70 |
| Figure 7.2 | Epochs vs. validation accuracy for digits…………………………………. | 74 |
| Figure 7.3 | Epochs v's validation accuracy for alphabets ……………………………… | 75 |
| Figure 7.4 | Confusion matrix for 0 to 9 digits………………………………………… | 75 |
| Figure 7.5 | Confusion matrix for A to Z digits ……………………………………….. | 76 |

|  |  |  |
| --- | --- | --- |
| Figure 1.1 | Project overview for American sign language……………………………. | 11 |
| Figure 2.1 | A Data Glove design with Sensor………………………………………… | 15 |
| Figure 2.2 | A Glove device with Sensor………………………………………………... | 16 |
| Figure 3.1 | American Sign language Manual Alphabet……………………………….. | 17 |
| Figure 3.2 | American Sign language numbers…………………………………………. | 18 |
| Figure 3.3 | Data set images……………………………………………………………. | 20 |
| Figure 4.1 | Hand posture detection steps………………………………………………. | 26 |
| Figure 4.2 | HSV Colour Space………………………………………………………… | 29 |
| Figure 4.3 | Images of detecting hand postures…………………………………………. | 30 |
| Figure 5.1 | Diagram of image processing pipeline……………………………………. | 34 |
| Figure 5.2 | The figure shows different levels of generalization of the model…………… | 41 |
| Figure 5.3 | Relationship between the model complexity and its ultimate accuracy is the relationship between training and testing error……………………………. | 43 |
| Figure 6.1 | Diagram of artificial neuron………………………………………………. | 47 |
| Figure 6.2 | Activation Functions ………………………………………………………. | 50 |
| Figure 6.3 | Fully connected Feed Forward Neural Network…………………………… | 52 |
| Figure 6.4 | Structure of Convolutional Neural Network………………………………. | 56 |
| Figure 6.5 | A zero padded 4x4 matrix………………………………………………….. | 58 |
| Figure 6.6 | Principle of Max-pooling…………………………………………………. | 60 |
| Figure 6.7 | Dropout: (a)Standard fully connected network. (b) Network with some neurons deactivated. (c) Activation of neuron during training phase. (d) Activation of neuron during testing phase………………………………… | 64 |
| Figure 7.1 | CNN network architecture for Alphabets…………………………………. | 70 |
| Figure 7.2 | Epochs vs. validation accuracy for digits…………………………………. | 74 |
| Figure 7.3 | Epochs v's validation accuracy for alphabets ……………………………… | 75 |
| Figure 7.4 | Confusion matrix for 0 to 9 digits………………………………………… | 75 |
| Figure 7.5 | Confusion matrix for A to Z digits ……………………………………….. | 76 |

|  |  |  |
| --- | --- | --- |
| Table 1.1 | Sign Language in the Americas…………………………………………….. | 8 |
| Table 2.1 | Statics about Sign Language as a Mother Tongue………………………….. | 19 |
| Table 2.2 | Statics about Knowledge of Sign Languages………………………………… | 19 |
| Table 3.1 | Dataset Description and Image property……………………………………... | 21 |
| Table 7.1 | Hardware configuration……………………………………………………... | 68 |
| Table 7.2 | Software configuration………………………………………………………. | 68 |

|  |  |  |
| --- | --- | --- |
| Table 1.1 | Sign Language in the Americas………………………………………………………………………… | 8 |
| Table 2.1 | Statics about Sign Language as a Mother Tongue…………………………………………… | 19 |
| Table 2.2 | Statics about Knowledge of Sign Languages…………………………………………………… | 19 |
| Table 3.1 | Dataset Description and Image property……………………………………....................... | 21 |
| Table 7.1 | Hardware configuration……………………………………………………................................ | 68 |
| Table 7.2 | Software configuration……………………………………………………………………………………. | 68 |