

CONTENT

| | | |
|-----|--|-------|
| 1 | INTRODUCTION..... | 1 |
| 1.1 | MOTIVATION..... | 1 |
| 1.2 | OBJECTIVE..... | 1 |
| 2 | LITERATURE REVIEW..... | 2-22 |
| 2.1 | HAND GRASP AND BIOMECHANICS OF HAND..... | 2-8 |
| 2.2 | COGNITION AND EMBODIED COGNITION..... | 8-9 |
| 2.3 | THE iCub PROJECT..... | 10-17 |
| 2.4 | MANIPULATOR KINEMATICS..... | 17-20 |
| 2.5 | BIOSIGNALS, EXTRACTION AND CLASSIFICATION..... | 21-22 |
| 3 | ARCHITECTURE OF THE SYSTEM..... | 23-25 |
| 3.1 | SERVER-CLIENT ARCHITECTURE..... | 23-24 |
| 3.2 | SERVER-HIGH LEVEL CLASSIFIER..... | 24 |
| 3.3 | CLIENT-iCub SIMULATOR WITH KINEMATIC SOLVER..... | 25 |
| 4 | IMPLEMENTATION..... | 26-32 |
| 4.1 | DH PARAMETERS FOR THE iCub HAND..... | 26-28 |
| 4.2 | KINEMATIC SOLVER..... | 28-31 |
| 4.3 | DEPLOYING THE SIMULATOR..... | 32 |
| 5 | CONCLUSIONS AND FUTURE SCOPE..... | 33 |
| 5.1 | CONCLUSIONS..... | 33 |
| 5.2 | FUTURE SCOPE..... | 33 |
| | APPENDIX A SNAPSHOTS..... | 34-39 |
| | APPENDIX B CODE..... | 40-50 |
| | REFERENCES..... | 51 |

LIST OF FIGURES

| | |
|---|----|
| 2.1 DIFFERENT GRASP TYPES..... | 2 |
| 2.2 BONES OF THE WRIST..... | 3 |
| 2.3 THE HAND, BONES AND JOINTS. DORSAL VIEW..... | 4 |
| 2.4 FLEXION EXTENSION OF THE WRIST..... | 6 |
| 2.5 RADIAL/ULNAR DEVIATION..... | 6 |
| 2.6 ABDUCTION/ADDUCTION (AB/AD), FLEXION/EXTENSION (F/E) FOR ONE FINGER...7 | |
| 2.7 ABDUCTION/ADDUCTION, FLEXION/EXTENSION FOR THE THUMB..... | 8 |
| 2.8 ICUB ROBOT..... | 11 |
| 2.9 A SNAPSHOT OF THE ICUB SIMULATOR..... | 13 |
| 2.10 THE ROOT FRAME OF REFERENCE..... | 14 |
| 2.11 ORIENTATION OF ALL MOTORS IN THE ICUB WRT ROOT FRAME OF REFERENCE..15 | |
| 2.12 TCP IN RELATION TO BASE..... | 18 |
| 2.13 AXIS AND LINK IN DH NOTATION..... | 19 |
| 2.14 ACQUISITION OF EMG SIGNALS..... | 21 |
| 3.1 ARCHITECTURE OF THE SYSTEM..... | 23 |
| 3.2 HIGH LEVEL CLASSIFIER..... | 24 |
| 3.3 CLIENT SIDE..... | 25 |
| 4.1 HAND REFERENCE FRAME..... | 26 |
| 4.2 A THREE LINK MANIPULATOR WITH COUPLED LINKS (L_2 AND L_3)..... | 28 |
| 4.3 SIMULATOR WAITING FOR COMMAND FROM A SERVER..... | 32 |

LIST OF TABLES

| | |
|---|----|
| 2.1 METACARPAL BONES..... | 3 |
| 2.2 METACARPAL BONES AND PHALANGES..... | 5 |
| 2.3 RANGE OF MOTION FOR THE WRIST..... | 6 |
| 2.4 RANGE OF MOVEMENTS FOR THE JOINTS OF THE THUMB..... | 7 |
| 2.5 RANGE OF MOVEMENTS FOR THE JOINTS OF THE FINGERS..... | 7 |
| 2.6 ARM JOINTS OF THE ICUB..... | 16 |
| 2.7 MOTOR-JOINTS RELATION..... | 17 |
| 4.1 Q VALUES FOR POWER GRASP..... | 30 |
| 4.2 Q VALUES FOR PINCH GRASP..... | 30 |
| 4.3 Q VALUES FOR PALM-UP GRASP..... | 30 |
| 4.4 Q VALUES FOR HOOK GRASP..... | 31 |
| 4.5 Q VALUES FOR OBLIQUE GRASP..... | 31 |
| 4.6 Q VALUES FOR PRECISION GRASP..... | 31 |