

LIST OF FIGURES

Figure 2.1. The D-H convention frame assignment.....	25
Figure 3.1. A schematic diagram of the proposed approach for design and planning of robotic workcell.....	57
Figure 3.2. The classification of the point cloud modeling of workcell objects.....	60
Figure 3.3. Illustrative diagram for the point cloud modeling of non-moving object (a) the side view of an object (b) top view of same object (c) CAD model (d) meshed model (e) point cloud model.....	61
Figure 3.4. (a) Image of the real robot installed in a workcell, (b) snapshot of the AutoCAD file disintegrating robot model and (c) the point cloud model of the robot.....	64
Figure 3.5. Schematic diagram for modeling and transformation of an object in various coordinate frames.....	65
Figure 3.6. Algorithm 1 for generating point cloud model of an object.....	66
Figure 3.7. Algorithm 2 for transforming the point cloud model in coordinate space.....	67
Figure 3.8. Algorithm to generate the optimal location of the variables.....	68
Figure 3.9. Flowchart of the point cloud simulation approach.....	69
Figure 3.10. Different configurations of RVC model (black) and point cloud model (blue) of ABB IRB 6640 robot.....	70
Figure 3.11. Robotic Workcell in M/s Electrosteel Castings Ltd., Dhanbad, India.....	71
Figure 3.12. Depicted diagram of the industrial robotic workcell under study.....	72

Figure 4.1. Top view of the robotic workcell (a) the industry layout (b) the proposed layout.....	82
Figure 4.2. Angular values of the joint configuration of industry and proposed layout for single cycle.....	84
Figure 4.3. Isometric view of the optimal layout of industrial robotic workcell.....	86
Figure 5.1. Proposed multirobot workcell layout design.....	96
Figure 5.2. Depicted diagram of two single robotic workcells operating simultaneously....	97
Figure. 5.3. Point cloud map of the optimal multirobot workcell layout.....	100
Figure 5.4. Point cloud map of the single robot workcell layout.....	101
Figure 5.5. Point cloud map of the optimal multirobot layout in isometric view.....	103
Figure 6.1. Point cloud maps of the industrial workcell having two machines and a robot with tool (a) top view and (b) isometric view.....	111
Figure 6.2. Point cloud maps of robotic manipulator with two machines in a workcell with optimal and original trajectories.....	119
Figure 6.3. Isometric view of the point cloud map of robotic workcell illustrating the fifth order optimal and original trajectory profile.....	121
Figure 6.4 Third order derivative of the interpolated curve in joint space for (a) original fifth degree polynomial, (b) fifth-degree polynomial single via-point optimal and (c) optimal sixth-degree polynomial.....	121
Figure 6.5. Point cloud maps of the sixth-degree single via-point trajectory interpolation with via-point.....	122

Figure 6.6. Point cloud map of the fifth degree B-Spline trajectory profile passing through four via point..... 125

Figure 6.7. Third order derivative of (a) fifth-degree polynomial, (b) optimal fifth degree B-spline interpolated curves in joint space..... 126

Figure 6.8. Point cloud map showing the isometric view of the fifth degree B-spline profile and fifth degree polynomial profile passing through optimal via-points..... 126