



Research article

Feature extraction and process planning of integrated hybrid additive-subtractive system for remanufacturing

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Appendix

Level set functions for the final part:

$$\Phi_{\text{cube1}} = \min(120 - x, y - 30, 110 - y, y - 40, 25 - z, z - 10);$$

$$\Phi_{\text{cube2}} = \min(111 - x, x - 39, 98.5 - y, y - 51.5, 35 - z, z - 25);$$

$$\Phi_{\text{cube3}} = \min(89.5 - x, x - 60.5, 45 - y, y - 40, 21.75 - z, z - 13.25);$$

$$\Phi_{\text{cube4}} = \min(89.5 - x, x - 60.5, 59 - y, y - 60.5, 32 - z, z - 28);$$

$$\Phi_{\text{cyl1}} = \min\{6.25 - (z - 30)^2 - (y - 75)^2, 114.75 - x, x - 104.75\};$$

$$\Phi_{\text{cyl2}} = \min\{25 - (z - 17.5)^2 - (y - 75)^2, 120 - x, x - 105\};$$

$$\Phi_{\text{cyl3}} = \min\{6.25 - (z - 17.5)^2 - (x - 68)^2, 50 - y, y - 45\};$$

$$\Phi_{\text{cyl4}} = \min\{6.25 - (z - 17.5)^2 - (x - 82)^2, 50 - y, y - 45\};$$

$$\Phi_{\text{free}} = \min\{-(x - 55)^3 + (x - 55)^2 * (18 * (y - 55) + 19200) + (x - 55) * (108 * (y - 55)^2 - 46080 * (y - 55) + 216 * (y - 55)^3 + 15360 * (y - 55)^2, x + y - 110, 83 - z, z - 68\}.$$

Level set functions for the used part:

$$\Phi_{\text{cube1}} = \min(125 - x, x - 25, 112.5 - y, y - 37.5, 37.5 - z, z - 12.5);$$

$$\Phi_{\text{cube2}} = \min(115 - x, x - 35, 102.5 - y, y - 47.5, 37.5 - z, z - 32.5);$$

$$\Phi_{\text{cube3}} = \min(70 - x, x - 40, 87.5 - y, y - 52.5, 32.5 - z, z - 27.5);$$

$$\Phi_{\text{cube4}} = \min(110 - x, x - 80, 87.5 - y, y - 52.5, 32.5 - z, z - 27.5).$$



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