Technical parameter evaluation indices

Delphi Round 1: Expert Ratings

Expert 1

1.1 Degree of freedom: 5

1.2 Mass: 4

1.3 Conventional power consumption: 3

1.4 Peak power consumption: 4

1.5 Real load: 4

1.6 IP level: 5

1.7 Maximum speed of each joint: 5

1.8 Range of each joint motion: 5

1.9 Maximum torque of each joint: 4

1.10 Absolute positioning accuracy: 2

1.11 Repetitive positioning accuracy: 3

1.12 Arm span of robot: 5

1.13 Bed area: 3

1.14 Maximum end-effector linear velocity: 2

Expert 2

1.1 Degree of freedom: 4

1.2 Mass: 4

1.3 Conventional power consumption: 4

1.4 Peak power consumption: 4

1.5 Real load: 4

1.6 IP level: 4

1.7 Maximum speed of each joint: 4

1.8 Range of each joint motion: 5

1.9 Maximum torque of each joint: 5

1.10 Absolute positioning accuracy: 4

1.11 Repetitive positioning accuracy: 4

1.12 Arm span of robot: 5

1.13 Bed area: 3

1.14 Maximum end-effector linear velocity: 3

Expert 3

1.1 Degree of freedom: 5

1.2 Mass: 4

1.3 Conventional power consumption: 4

1.4 Peak power consumption: 4

1.5 Real load: 4

1.6 IP level: 5

1.7 Maximum speed of each joint: 4

1.8 Range of each joint motion: 4

1.9 Maximum torque of each joint: 5

1.10 Absolute positioning accuracy: 1

1.11 Repetitive positioning accuracy: 3

1.12 Arm span of robot: 5

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 2

Expert 4

1.1 Degree of freedom: 5

1.2 Mass: 5

1.3 Conventional power consumption: 4

1.4 Peak power consumption: 3

1.5 Real load: 4

1.6 IP level: 5

1.7 Maximum speed of each joint: 4

1.8 Range of each joint motion: 5

1.9 Maximum torque of each joint: 5

1.10 Absolute positioning accuracy: 3

1.11 Repetitive positioning accuracy: 4

1.12 Arm span of robot: 4

1.13 Bed area: 3

1.14 Maximum end-effector linear velocity: 3

Expert 5

1.1 Degree of freedom: 4

1.2 Mass: 5

1.3 Conventional power consumption: 4

1.4 Peak power consumption: 5

1.5 Real load: 4

1.6 IP level: 4

1.7 Maximum speed of each joint: 5

1.8 Range of each joint motion: 5

1.9 Maximum torque of each joint: 4

1.10 Absolute positioning accuracy: 2

1.11 Repetitive positioning accuracy: 3

1.12 Arm span of robot: 5

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 2

Expert 6

1.1 Degree of freedom: 5

1.2 Mass: 5

1.3 Conventional power consumption: 4

1.4 Peak power consumption: 5

1.5 Real load: 5

1.6 IP level: 5

1.7 Maximum speed of each joint: 5

1.8 Range of each joint motion: 5

1.9 Maximum torque of each joint: 3

1.10 Absolute positioning accuracy: 3

1.11 Repetitive positioning accuracy: 4

1.12 Arm span of robot: 5

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 4

Expert 7

1.1 Degree of freedom: 4

1.2 Mass: 5

1.3 Conventional power consumption: 4

1.4 Peak power consumption: 4

1.5 Real load: 4

1.6 IP level: 3

1.7 Maximum speed of each joint: 5

1.8 Range of each joint motion: 5

1.9 Maximum torque of each joint: 5

1.10 Absolute positioning accuracy: 3

1.11 Repetitive positioning accuracy: 4

1.12 Arm span of robot: 5

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 3

Expert 8

1.1 Degree of freedom: 5

1.2 Mass: 4

1.3 Conventional power consumption: 4

1.4 Peak power consumption: 4

1.5 Real load: 4

1.6 IP level: 5

1.7 Maximum speed of each joint: 5

1.8 Range of each joint motion: 5

1.9 Maximum torque of each joint: 5

1.10 Absolute positioning accuracy: 2

1.11 Repetitive positioning accuracy: 4

1.12 Arm span of robot: 5

1.13 Bed area: 3

1.14 Maximum end-effector linear velocity: 2

Expert 9

1.1 Degree of freedom: 5

1.2 Mass: 5

1.3 Conventional power consumption: 4

1.4 Peak power consumption: 4

1.5 Real load: 3

1.6 IP level: 4

1.7 Maximum speed of each joint: 5

1.8 Range of each joint motion: 4

1.9 Maximum torque of each joint: 4

1.10 Absolute positioning accuracy: 2

1.11 Repetitive positioning accuracy: 3

1.12 Arm span of robot: 5

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 2

Expert 10

1.1 Degree of freedom: 4

1.2 Mass: 5

1.3 Conventional power consumption: 4

1.4 Peak power consumption: 5

1.5 Real load: 4

1.6 IP level: 5

1.7 Maximum speed of each joint: 4

1.8 Range of each joint motion: 5

1.9 Maximum torque of each joint: 5

1.10 Absolute positioning accuracy: 2

1.11 Repetitive positioning accuracy: 4

1.12 Arm span of robot: 5

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 4

Round 1 Summary and CVR Calculation

1.1 Degree of freedom: 10 agree (CVR = 1.0)

1.2 Mass: 10 agree (CVR = 1.0)

1.3 Conventional power consumption: 9 agree (CVR = 0.8)

1.4 Peak power consumption: 9 agree (CVR = 0.8)

1.5 Real load: 9 agree (CVR = 0.8)

1.6 IP level: 9 agree (CVR = 0.8)

1.7 Maximum speed of each joint: 10 agree (CVR = 1.0)

1.8 Range of each joint motion: 10 agree (CVR = 1.0)

1.9 Maximum torque of each joint: 9 agree (CVR = 0.8)

1.10 Absolute positioning accuracy: 1 agree (CVR = -0.8)

1.11 Repetitive positioning accuracy: 6 agree (CVR = 0.2)

1.12 Arm span of robot: 10 agree (CVR = 1.0)

1.13 Bed area: 6 agree (CVR = 0.2)

1.14 Maximum end-effector linear velocity: 2 agree (CVR = -0.6)

Feedback Report after Delphi Round 1:

Thank you to all the experts for participating in the first round of evaluation. Below is the consistency analysis for each indicator:

For most indices, the experts' ratings were highly consistent, showing a high level of consensus. However, for the following four indices: "absolute positioning accuracy (CVR = -0.8)", "repetitive positioning accuracy (CVR = 0.2)", "bed area (CVR = 0.2)", and "maximum end-effector linear velocity (CVR = -0.6)", the consensus was low.

Please re-evaluate these indices in the second round. Take note of your ratings from the first round and consider whether you need to adjust your ratings.

Delphi Round 2: Expert Ratings (after feedback report)

Expert 1

1.10 Absolute positioning accuracy: 3

1.11 Repetitive positioning accuracy: 4

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 3

Expert 2

1.10 Absolute positioning accuracy: 1

1.11 Repetitive positioning accuracy: 5

1.13 Bed area: 5

1.14 Maximum end-effector linear velocity: 3

Expert 3

1.10 Absolute positioning accuracy: 2

1.11 Repetitive positioning accuracy: 4

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 2

Expert 4

1.10 Absolute positioning accuracy: 3

1.11 Repetitive positioning accuracy: 5

1.13 Bed area: 5

1.14 Maximum end-effector linear velocity: 3

Expert 5

1.10 Absolute positioning accuracy: 2

1.11 Repetitive positioning accuracy: 4

1.13 Bed area: 5

1.14 Maximum end-effector linear velocity: 2

Expert 6

1.10 Absolute positioning accuracy: 3

1.11 Repetitive positioning accuracy: 5

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 3

Expert 7

1.10 Absolute positioning accuracy: 1

1.11 Repetitive positioning accuracy: 4

1.13 Bed area: 4

1.14 Maximum end-effector linear velocity: 3

Expert 8

1.10 Absolute positioning accuracy: 3

1.11 Repetitive positioning accuracy: 4

1.13 Bed area: 5

1.14 Maximum end-effector linear velocity: 1

Expert 9

1.10 Absolute positioning accuracy: 2

1.11 Repetitive positioning accuracy: 4

1.13 Bed area: 5

1.14 Maximum end-effector linear velocity: 2

Expert 10

1.10 Absolute positioning accuracy: 2

1.11 Repetitive positioning accuracy: 4

1.13 Bed area: 5

1.14 Maximum end-effector linear velocity: 4

Round 2 Summary and CVR Calculation

1.10 Absolute positioning accuracy: 0 agree (CVR = -1.0)

1.11 Repetitive positioning accuracy: 10 agree (CVR = 1.0)

1.13 Bed area: 10 agree (CVR = 1.0)

1.14 Maximum end-effector linear velocity: 1 agree (CVR = -0.2)

Feedback Report after Round 2:

Thank you to all the experts for participating in the second round of evaluation. Below is the consistency analysis for each index.

For most indices, the experts' ratings continued to show high consistency. For the indices "absolute positioning accuracy (CVR = -1.0)" and "maximum end-effector linear velocity (CVR = -0.2)", the consistency of ratings has improved but remains generally low. Since these two indices still do not meet the expected level of consistency and importance, it is recommended to consider removing these indices in the third round of discussion.

Delphi Round 3: Expert Ratings (after further discussion)

Expert 1

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Expert 2

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Expert 3

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Expert 4

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Expert 5

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Expert 6

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Expert 7

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Expert 8

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Expert 9

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Expert 10

1.10 Absolute positioning accuracy: Remove

1.14 Maximum end-effector linear velocity: Remove

Round 3 Summary

In the third round, all experts unanimously agreed to remove the indices "absolute positioning accuracy" and "maximum end-effector linear velocity," thereby reaching a consensus.

Final Feedback Report:

Thank you to all the experts for your participation and feedback. Below is the final consensus.

For most indices, the experts reached a consensus. Additionally, after three rounds of discussion and feedback, the experts unanimously agreed that the indices "absolute positioning accuracy" and "maximum end-effector linear velocity" should be removed due to their low scores and insufficient consensus.

The indices retained are as follows:

Degree of freedom

Mass

Conventional power consumption

Peak power consumption

Real load

IP level

Maximum speed of each joint

Range of each joint motion

Maximum torque of each joint

Repetitive positioning accuracy

Arm span of robot

Bed area

Kinematic and dynamic performance evaluation indices

Delphi Round 1: Expert Ratings

Expert 1

2.1 x_{11} : 5

2.2 x_{12} : 3

2.3 x_{13} : 4

2.4 x_{14} : 2

2.5 x_{15} : 5

2.6 x_{16} : 4

2.7 x_{21} : 4

2.8 x_{22} : 3

2.9 x_{23} : 5

2.10 x_{24} : 3

2.11 x_{31} : 5

2.12 x_{32} : 4

2.13 x_{33} : 2

2.14 x_{41} : 5

2.15 x_{42} : 4

2.16 x_{43} : 5

2.17 x_{44} : 4

2.18 x_{45} : 5

2.19 x_{46} : 4

Expert 2

2.1 x_{11} : 4

2.2 x_{12} : 3

2.3 x_{13} : 4

2.4 x_{14} : 3

2.5 x_{15} : 5

2.6 x_{16} : 4

2.7 x_{21} : 4

2.8 x_{22} : 3

2.9 x_{23} : 5

2.10 x_{24} : 3

2.11 x_{31} : 5

2.12 x_{32} : 4

2.13 x_{33} : 2

2.14 x_{41} : 4

2.15 x_{42} : 4

2.16 x_{43} : 5

2.17 x_{44} : 4

2.18 x_{45} : 5

2.19 x_{46} : 4

Expert 3

2.1 x_{11} : 5

2.2 x_{12} : 2

2.3 x_{13} : 4

2.4 x_{14} : 2

2.5 x_{15} : 4

2.6 x_{16} : 5

2.7 x_{21} : 4

2.8 x_{22} : 2

2.9 x_{23} : 5

2.10 x_{24} : 2

2.11 x_{31} : 5

2.12 x_{32} : 4

2.13 x_{33} : 2

2.14 x_{41} : 4

2.15 x_{42} : 5

2.16 x_{43} : 5

2.17 x_{44} : 4

2.18 x_{45} : 4

2.19 x_{46} : 5

Expert 4

2.1 x_{11} : 4

2.2 x_{12} : 3

2.3 x_{13} : 4

2.4 x_{14} : 2

2.5 x_{15} : 5

2.6 x_{16} : 4

2.7 x_{21} : 5

2.8 x_{22} : 3

2.9 x_{23} : 5

2.10 x_{24} : 3

2.11 x_{31} : 4

2.12 x_{32} : 4

2.13 x_{33} : 2

2.14 x_{41} : 5

2.15 x_{42} : 5

2.16 x_{43} : 4

2.17 x_{44} : 5

2.18 x_{45} : 5

2.19 x_{46} : 4

Expert 5

2.1 x_{11} : 5

2.2 x_{12} : 3

2.3 x_{13} : 4

2.4 x_{14} : 2

2.5 x_{15} : 5

2.6 x_{16} : 4

2.7 x_{21} : 4

2.8 x_{22} : 3

2.9 x_{23} : 5

2.10 x_{24} : 2

2.11 x_{31} : 5

2.12 x_{32} : 4

2.13 x_{33} : 3

2.14 x_{41} : 5

2.15 x_{42} : 5

2.16 x_{43} : 4

2.17 x_{44} : 5

2.18 x_{45} : 5

2.19 x_{46} : 5

Expert 6

2.1 x_{11} : 5

2.2 x_{12} : 2

2.3 x_{13} : 5

2.4 x_{14} : 3

2.5 x_{15} : 4

2.6 x_{16} : 5

2.7 x_{21} : 5

2.8 x_{22} : 2

2.9 x_{23} : 5

2.10 x_{24} : 2

2.11 x_{31} : 5

2.12 x_{32} : 4

2.13 x_{33} : 2

2.14 x_{41} : 5

2.15 x_{42} : 4

2.16 x_{43} : 5

2.17 x_{44} : 5

2.18 x_{45} : 4

2.19 x_{46} : 5

Expert 7

2.1 x_{11} : 4

2.2 x_{12} : 3

2.3 x_{13} : 5

2.4 x_{14} : 3

2.5 x_{15} : 4

2.6 x_{16} : 4

2.7 x_{21} : 4

2.8 x_{22} : 3

2.9 x_{23} : 5

2.10 x_{24} : 3

2.11 x_{31} : 4

2.12 x_{32} : 4

2.13 x_{33} : 3

2.14 x_{41} : 5

2.15 x_{42} : 5

2.16 x_{43} : 5

2.17 x_{44} : 4

2.18 x_{45} : 5

2.19 x_{46} : 5

Expert 8

2.1 x_{11} : 5

2.2 x_{12} : 2

2.3 x_{13} : 5

2.4 x_{14} : 3

2.5 x_{15} : 4

2.6 x_{16} : 5

2.7 x_{21} : 4

2.8 x_{22} : 2

2.9 x_{23} : 5

2.10 x_{24} : 2

2.11 x_{31} : 5

2.12 x_{32} : 4

2.13 x_{33} : 2

2.14 x_{41} : 4

2.15 x_{42} : 5

2.16 x_{43} : 4

2.17 x_{44} : 5

2.18 x_{45} : 4

2.19 x_{46} : 4

Expert 9

2.1 x_{11} : 4

2.2 x_{12} : 2

2.3 x_{13} : 5

2.4 x_{14} : 3

2.5 x_{15} : 5

2.6 x_{16} : 4

2.7 x_{21} : 4

2.8 x_{22} : 3

2.9 x_{23} : 5

2.10 x_{24} : 2

2.11 x_{31} : 5

2.12 x_{32} : 4

2.13 x_{33} : 2

2.14 x_{41} : 5

2.15 x_{42} : 4

2.16 x_{43} : 5

2.17 x_{44} : 4

2.18 x_{45} : 5

2.19 x_{46} : 4

Expert 10

2.1 x_{11} : 5

2.2 x_{12} : 2

2.3 x_{13} : 5

2.4 x_{14} : 3

2.5 x_{15} : 4

2.6 x_{16} : 5

2.7 x_{21} : 4

2.8 x_{22} : 3

2.9 x_{23} : 5

2.10 x_{24} : 3

2.11 x_{31} : 5

2.12 x_{32} : 4

2.13 x_{33} : 2

2.14 x_{41} : 5

2.15 x_{42} : 4

2.16 x_{43} : 5

2.17 x_{44} : 5

2.18 x_{45} : 5

2.19 x_{46} : 5

Round 1 Summary and CVR Calculation

2.1 x_{11}: 10 agree (CVR = 1.0)

2.2 x_{12}: 2 agree (CVR = -0.6)

2.3 x_{13}: 10 agree (CVR = 1.0)

2.4 x_{14}: 0 agree (CVR = -1.0)

2.5 x_{15}: 10 agree (CVR = 1.0)

2.6 x_{16}: 10 agree (CVR = 1.0)

2.7 x_{21}: 8 agree (CVR = 0.6)

2.8 x_{22}: 3 agree (CVR = -0.4)

2.9 x_{23}: 10 agree (CVR = 1.0)

2.10 x_{24}: 2 agree (CVR = -0.6)

2.11 x_{31}: 10 agree (CVR = 1.0)

2.12 x_{32}: 10 agree (CVR = 1.0)

2.13 x_{33}: 0 agree (CVR = -1.0)

2.14 x_{41}: 10 agree (CVR = 1.0)

2.15 x_{42}: 10 agree (CVR = 1.0)

2.16 x_{43}: 10 agree (CVR = 1.0)

2.17 x_{44}: 10 agree (CVR = 1.0)

2.18 x_{45}: 10 agree (CVR = 1.0)

2.19 x_{46}: 10 agree (CVR = 1.0)

Feedback Report after Delphi Round 1

Thank you to all the experts for participating in the first round of evaluation. Below is the consistency analysis for each indicator:

Indices with consensus: x_{11} (CVR = 1.0), x_{13} (CVR = 1.0), x_{15} (CVR = 1.0), x_{16} (CVR = 1.0), x_{21} (CVR = 0.6), x_{23} (CVR = 1.0), x_{31} (CVR = 1.0), x_{32} (CVR = 1.0), x_{41} (CVR = 1.0), x_{42} (CVR = 1.0), x_{43} (CVR = 1.0), x_{44} (CVR = 1.0), x_{45} (CVR = 1.0), x_{46} (CVR = 1.0).

Indices without consensus: x_{12} (CVR = -0.6), x_{14} (CVR = -1.0), x_{22} (CVR = -0.4), x_{24} (CVR = -0.6), x_{33} (CVR = -1.0).

Please re-evaluate these indices in the second round. Take note of your ratings from the first round and consider whether you need to adjust your ratings.

Delphi Round 2: Expert Ratings (after feedback report)

Expert 1

2.2 x_{12}: 4

2.4 x_{14}: 2

2.8 x_{22}: 4

2.10 x_{24}: 4

2.13 x_{33}: 4

Expert 2

2.2 x_{12}: 4

2.4 x_{14}: 1

2.8 x_{22}: 4

2.10 x_{24}: 4

2.13 x_{33}: 4

Expert 3

2.2 $x_{12}:3$

2.4 $x_{14}:2$

2.8 $x_{22}:4$

2.10 $x_{24}:4$

2.13 $x_{33}:3$

Expert 4

2.2 $x_{12}:4$

2.4 $x_{14}:1$

2.8 $x_{22}:4$

2.10 $x_{24}:4$

2.13 $x_{33}:4$

Expert 5

2.2 $x_{12}:4$

2.4 $x_{14}:3$

2.8 $x_{22}:4$

2.10 $x_{24}:4$

2.13 $x_{33}:4$

Expert 6

2.2 $x_{12}:4$

2.4 $x_{14}:2$

2.8 $x_{22}:4$

2.10 $x_{24}:3$

2.13 $x_{33}:4$

Expert 7

2.2 $x_{12}:4$

2.4 $x_{14}:2$

2.8 $x_{22}:4$

2.10 $x_{24}:4$

2.13 $x_{33}:4$

Expert 8

2.2 $x_{12}:4$

2.4 $x_{14}:2$

2.8 $x_{22}:4$

2.10 $x_{24}:3$

2.13 $x_{33}:3$

Expert 9

2.2 x_{12} : 4

2.4 x_{14} : 1

2.8 x_{22} : 4

2.10 x_{24} : 4

2.13 x_{33} : 4

Expert 10

2.2 x_{12} : 4

2.4 x_{14} : 2

2.8 x_{22} : 4

2.10 x_{24} : 4

2.13 x_{33} : 4

Round 2 Summary and CVR Calculation

2.2 x_{12} : 9 agree (CVR = 0.8)

2.4 x_{14} : 0 agree (CVR = -1.0)

2.8 x_{22} : 9 agree (CVR = 0.8)

2.10 x_{24} : 8 agree (CVR = 0.6)

2.13 x_{33} : 8 agree (CVR = 0.6)

Feedback Report after Delphi Round 2

Thank you to all the experts for participating in the second round of evaluation. Below is the consistency analysis for each indicator.

Indices with consensus: x_{12} (CVR = 0.8), x_{22} (CVR = 0.8), x_{24} (CVR = 0.6), x_{33} (CVR = 0.6).

Indicator without consensus: x_{14} (CVR = -1.0).

Since consensus of x_{14} was not reached and its CVR < 0.62, it is recommended to consider removing this indicator in the third round.

Delphi Round 3: Expert Ratings (After further discussion)

Expert 1

2.4 x_{14} : Remove

Expert 2

2.4 x_{14} : Remove

Expert 3

2.4 x_{14} : Remove

Expert 4

2.4 x_{14} : Remove

Expert 5

2.4 x_{14} : Remove

Expert 6

2.4 x_{14} : Remove

Expert 7

2.4 x_{14} : Remove

Expert 8

2.4 x_{14} : Remove

Expert 9

2.4 x_{14} : Remove

Expert 10

2.4 x_{14} : Remove

Round 3 Summary

In the third round, all experts unanimously agreed to remove the index x_{14} , reaching a consensus.

Final Feedback Report

Thank you to all the experts for your participation and feedback. Below is the final consensus.

For most indices, the experts reached a consensus. After three rounds of discussion and feedback, the experts unanimously agreed to remove this indicator due to its low rating and insufficient consensus.

The retained indices are as follows:

2.1 x_{11}

2.2 x_{12}

2.3 x_{13}

2.5 x_{15}

2.6 x_{16}

2.7 x_{21}

2.8 x_{22}

2.9 x_{23}

2.10 x_{24}

2.11 x_{31}

2.12 x_{32}

2.13 x_{33}

2.14 x_{41}

2.15 x_{42}

2.16 x_{43}

2.17 x_{44}

2.18 x_{45}

2.19 x_{46}