Response to Reviewer 2 Comments

For research article: applsci-3447801

This is an updated new response to Reviewer 1. Namely, taking into account the comments of the last review, the lines in the manuscript were changed. The authors apologize for resending the answer.

1. Summary

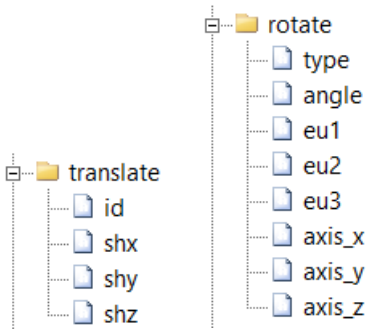
Thank you very much for taking the time to review this manuscript. Please find the detailed responses below and the corresponding revisions and corrections written in red color in the re-submitted manuscript. Reviewer's suggestions are provided readable and improved text.

2. Questions for General Evaluation	**Reviewer's Evaluation**	**Response and Revisions**
Does the introduction provide sufficient background and include all relevant references?	Must be improved	*Please see Responses 1, 2, and 3.*
Is the research design appropriate?	Can be improved	*Please see the Answer below.*
Are the methods adequately described?	Yes	*Thank you for the comment.*
Are the results clearly presented?	Yes	*Thank you for the comment.*
Are the conclusions supported by the results?	Yes	*Thank you for the comment.*

Answer

Thank you for your suggestion. In order to show applicability of the XML input language to different mechanism the Figure 7 was added below Figure 6. It contains definition of translation and rotation elements, which are used in Figure 6b to define the next body frame. Next, on lines 286 – 291 description of <drive /> element is added. Thus, all cases of the practical values are covered.

"[



Type	Kind	Rotation angles
x, y, z	elementary	angle
zxz, zyz	proper Euler	eu1, eu2, eu3
zyx, xyz	Tait-Bryan	eu1, eu2, eu3
axis	finite rotations	angle axis_x,axis_y,axis_z

(a) **(b)**

Figure 7. (**a**) Translate element; (**b**) Rotate element with the corresponding attributes (on the right)

The <drive /> element represent link diver, which can be real or virtual. In any case it is defined by *type* attribute, which can be one of the following diver types: prismatic_x, prismatic_y, prismatic_z, revolute_x, revolute_y, revolute_z, and spherical. First six types correspond to single degree of freedom joints, and the last is three degree of freedom rotation about an axis through center of the joint.

]"

In order to enhance understanding of Bond Graph modeling an introductory subsection was added (3.1. Introduction to Bond Graphs, pp.12-16, lines 397 - 552, Figures 13-17, Table 1; see in Response 4. for details).

"[Due to the length of the updated text, it is not copied here]"

3. Point-by-point response to Comments and Suggestions for Authors

Comments 1:

In lines 38, 39, and 40, it is necessary to cite some works.

Response 1:

Thank you for pointing this out. We agree with this comment. Therefore, we have expanded the existing Introduction with an additional research review from line 58 (in previous version it is line 39), page 2 to line 100, page 3, and we have added one sentence from line 116 to line 118, page 3. The texts are given below.

- line 58, page 2 to line 101, page 3

"[The popularity of XML-based languages has increased over the past years due to the possibility of exchanging data between heterogeneous systems, and numerous studies discuss them: XML-based Robot Description Language for describing robot structures was presented in [16], RoboML based on XLM for robot programming in [17]; AVSML (Agent and Virtual Space Markup Language) an XML-based markup language for integrating web information into virtual 3D space in [18].

In the work of [19], an application for the robot palletizing process is developed in the ABB native language RAPID with an interface written in XML has ability to work together with the software for offline robot programming RobotStudio.

An XML is used as the basis for a new language to specify video game - Video Game Description Language (XVGDL) in [20].

One of the most common robot description formats - Unified Robot Description Format (URDF) was introduced in 2009 [21,22], with the development of an open source set of software libraries and tools for building of robot applications, named the Robot Operation System (ROS). URDF is based on XML technology, and was applied to describe the kinematic structures of robots, their dynamics and geometry [22,23]. The self-calibration procedure of a low-cost 5-axis 3D printer, where the calibration data was used to generate a kinematic model in URDF format, was proposed in [24]. Procedures for automatic generation of URDF files from Solid Works are the subject of research in [25,26]: for the visualization of a modular robot manipulator in [25] and a micro-assembly robot in [26].

Similarly to URDF, the XML-based Simulation Description Format (SDF) has emerged, expanding the possibilities of developing a robotic environment [23]. Because both URDF and SDF are XML-based, they follow the rules of XML syntax, making them both human-readable and machine-parsable. SDF was used to describe Building Infor-mation Modelling objects and integrated with the finite element method (FEM) and ROS to assess structural stability in [27].

An overview of robot description formats and methodologies for visualizing robots and their environment is presented in [28].

Visualization of systems and devices, i.e., their virtual 3D models and digital twins (DT), are recognized as a potential solution for the improvement of these processes and systems and therefore attract extreme attention from the academic community and industry. An XML is one of the most commonly used technologies to develop the digital twin. In the paper [29], due to the analysis of the sheet metal punching process, different configurations of sheet metal punching machines were developed with a complete virtual 3D scene in the form of XML files. On the example of a digital twin of the overhead crane, in [30] it is presented a system framework for its integration into an Extended Reality (XR). The application of digital twins as possible answers on challenges in production systems is the subject of research in [31,32]. In [31], an overview of the possibility of Digital Twins to support Human-Robot Collaboration in production systems is presented as well as a comparison of key commercial software regarding the possibility of fulfilling the requirements for DT development. The review of research in [32] pointed out numerous gaps in the application of DT in production systems as well as indicated directions for future research.*]"*

- line 116 to line 118, page 3

*"[*A comparative study of Gazebo and Unity 3D in the development of a virtual model of the collaborative robot UR3 and its application for assembly work in production is presented in [53].*]"*

Comments 2:

The search for state-of-the-art works addressing the topic of robot modeling using XML needs to be expanded. A quick search found the following work: J. Smith and A. Johnson, "A 3D XML-based modeling approach for robotic systems," IEEE Transactions on Robotics, vol. 25, no. 3, 2023, which is not included in the state-of-the-art section.

Response 2:

We agree. According to reviewer's suggestion we have extended the existing research overview (from line 58, page 1) with the state-of-the-art works addressing the topic of robot modeling using XML. As we pointed out in Response 1, we have added the research overview from line 58, page 2 to line 100. This additional research overview explains the context, motivations for the creation and use of XML (eXtensible Markup Language), the development of other XML-based Robot Description Languages with special reference to URDF (Unified Robot Description Format) and SDF (Simulation Description Format).

Unfortunately, we did not find the work suggested by the reviewer (J. Smith and A. Johnson, "A 3D XML-based modeling approach for robotic systems," IEEE Transactions on Robotics, vol. 25, no. 3, 2023) in IEEE web portal (https://ieeexplore.ieee.org/Xplore/home.jsp) and any bibliographic database of scholarly articles (Web od Science or others), but we added the list of references with 18 new literary sources.

Added text in Introduction is listed in Response 1, and below is a list of added references:

1. *"[*Ji Hwan Park; Tae Houn Song; Soon Mook Jung; Jae Wook Jeon XML Based Robot Description Language. In Proceedings of the 2007 International Conference on Control, Automation and Systems; IEEE: Seoul, South Korea, 2007; pp. 2477–2482.
2. Makatchev, M.; Tso, S.K. Human-Robot Interface Using Agents Communicating in an XML-Based Markup Language. In Proceedings of the Proceedings 9th IEEE International Workshop on Robot and Human Interactive Communication. IEEE RO-MAN 2000 (Cat. No.00TH8499); IEEE: Osaka, Japan, 2000; pp. 270–275.
3. Kitamura, Y.; Shibata, Y.; Tokuda, K.; Kobayashi, K.; Nagata, N. XML-Based Markup Language for Web Information Integration in 3D Virtual Space. In Proceedings of the 2007 IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology - Workshops; IEEE: Silicon Valley, CA, USA, November 2007; pp. 226–229.
4. Moura, F.M.; Silva, M.F. Application for Automatic Programming of Palletizing Robots. In Proceedings of the 2018 IEEE International Conference on Autonomous Robot Systems and Competitions (ICARSC); IEEE: Torres Vedras, April 2018; pp. 48–53.
5. Quinones, J.R.; Fernandez-Leiva, A.J. XML-Based Video Game Description Language. *IEEE Access* **2020**, *8*, 4679–4692, doi:10.1109/ACCESS.2019.2962969.
6. URDF - Unified Robot Description Format, project website, 2024, https://wiki.ros.org/urdf (Accessed: 2025-02-11)
7. Tola, D.; Corke, P. Understanding URDF: A Dataset and Analysis. *IEEE Robot. Autom. Lett.* **2024**, *9*, 4479–4486, doi:10.1109/LRA.2024.3381482.
8. Qiu, N.; Song, C.; Wan, F. Describing Robots from Design to Learning: Towards an Interactive Lifecycle Representation of Robots. In Proceedings of the 2024 International Conference on Advanced Robotics and Mechatronics (ICARM); IEEE: Tokyo, Japan, July 8 2024; pp. 1081–1086.
9. Ahlers, D.; Schmolzi, T.; Junca, G.; Zhang, J.; Wasserfall, F. Calibration and Compensation of 5-Axis 3D-Printers for Printed Electronics. *Additive Manufacturing Letters* **2025**, *12*, 100265, doi:10.1016/j.addlet.2024.100265.
10. Feder, M.; Giusti, A.; Vidoni, R. An Approach for Automatic Generation of the URDF File of Modular Robots from Modules Designed Using SolidWorks. *Procedia Computer Science* **2022**, *200*, 858–864, doi:10.1016/j.procs.2022.01.283.
11. Terei, N.; Wiemann, R.; Raatz, A. ROS-Based Control of an Industrial Micro-Assembly Robot. *Procedia CIRP* **2024**, *130*, 909–914, doi:10.1016/j.procir.2024.10.184.
12. Xu, Q.; Zhu, A.; Xu, G.; Shao, Z.; Zhang, J.; Zhang, H. FEM-Based Real-Time Task Planning for Robotic Construction Simulation. *Automation in Construction* **2025**, *170*, 105935, doi:10.1016/j.autcon.2024.105935.
13. Ivanou, M.; Mikhel, S.; Savin, S. Robot Description Formats and Approaches: Review. In Proceedings of the 2021 International Conference "Nonlinearity, Information and Robotics"

(NIR); IEEE: Innopolis, Russian Federation, August 26 2021; pp. 1–5.
14. Moreno, A.; Velez, G.; Ardanza, A.; Barandiaran, I.; De Infante, Á.R.; Chopitea, R. Virtualisation Process of a Sheet Metal Punching Machine within the Industry 4.0 Vision. *Int J Interact Des Manuf* **2017**, *11*, 365–373, doi:10.1007/s12008-016-0319-2.
15. Yang, C.; Tu, X.; Autiosalo, J.; Ala-Laurinaho, R.; Mattila, J.; Salminen, P.; Tammi, K. Extended Reality Application Framework for a Digital-Twin-Based Smart Crane. *Applied Sciences* **2022**, *12*, 6030, doi:10.3390/app12126030.
16. Baratta, A.; Cimino, A.; Longo, F.; Nicoletti, L. Digital Twin for Human-Robot Collaboration Enhancement in Manufacturing Systems: Literature Review and Direction for Future Developments. *Computers & Industrial Engineering* **2024**, *187*, 109764, doi:10.1016/j.cie.2023.109764.
17. Böttjer, T.; Tola, D.; Kakavandi, F.; Wewer, C.R.; Ramanujan, D.; Gomes, C.; Larsen, P.G.; Iosifidis, A. A Review of Unit Level Digital Twin Applications in the Manufacturing Industry. *CIRP Journal of Manufacturing Science and Technology* **2023**, 45, 162–189, doi:10.1016/j.cirpj.2023.06.011.
18. Wijaya, G.D.; Caesarendra, W.; Petra, M.I.; Królczyk, G.; Glowacz, A. Comparative Study of Gazebo and Unity 3D in Performing a Virtual Pick and Place of Universal Robot UR3 for Assembly Process in Manufacturing. *Simulation Modelling Practice and Theory* **2024**, *132*, 102895, doi:10.1016/j.simpat.2024.102895.*]"*

According to Reviewer 3's suggestions, we supplemented the Introduction with a shorter overview of simulators that are applied in other areas (not in robotics). On this occasion, we supplemented the list of references with 14 more scientific papers, 12 of which are in journals in Q1 (Scimago) and one is in Q2 (Scimago).

Comments 3:
The state-of-the-art section needs improvement as there are few journal articles referenced.

Response 3:
We agree. Accordingly, the Introduction of the paper has been significantly improved. A detailed overview of the research in the mentioned area with the achieved results was made. In doing so, the existing list of references was supplemented with 18 new literary sources, of which nine (9) are journal articles, eight (8) papers published in conference proceedings and one web portal. Eight (out of a total of 9) cited journal papers were published in the last 5 years, which reflects the actuality of the topic from which the paper was written. Seven (7) journals from which articles were cited are Q1 (Scimago), and two are Q2 (Scimago). The six conferences from which papers were cited are IEEE. All the above data confirm the relevance of the cited references that were added to the existing list, so that the paper now has 74 cited references (we also added a book). Added text in Introduction with explanation of improvement is presented in Response 1, and a list of added references is given in Response 2.

Comments 4: The presentation of Figures 26 and 27 needs to be improved as they extend beyond the document margins.

Response 4:

We agree. According to other reviewer's comments, the figures are improved and modified. We made sure that they did not exceed the margins of the document.

Comments 5: For Figure 27, it is recommended to take the photos from the same reference point to better illustrate the robot's movement over time.

Response 5:

We agree. Accordingly, we have replaced the existing photos with new photos taken from the same reference point.

4. Response to Comments on the Quality of English Language

Point 1:

(x) The English is fine and does not require any improvement.

Response 1:

OK.

5. Additional clarifications

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