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Norsahperi, N.M.H.^a, Ahmad, S.^b, Toha, S.F.^b, Mahmood, I.A.^c

Analysis and practical validation on a multi-linkage scissor platform's drive system for the satellite test facilities (2021) *International Journal of Heavy Vehicle Systems*, 28 (1), pp. 1-14.

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^a Department of Electrical and Electronics Engineering, Faculty of Engineering, Universiti Putra Malaysia, UPM Serdang, Selangor 43400, Malaysia

^b Department of Mechatronics Engineering, Kulliyah of Engineering, International Islamic University Malaysia, Jalan Gombak, Selangor 53100, Malaysia

^c Facilities of Future, GR&T Project Delivery and Technology (PD&T) Division, PETRONAS Research SDN. Bhd. (PRSB), Kawasan Institusi Bangi, Kajang, 43000, Malaysia

Abstract

This paper evaluates a modified structural analysis in measuring the reaction forces on the multi-linkage scissor mechanism driven by a ball-screw system. The proposed structural-virtual work (SV) analysis takes into account all reaction forces on the designed linkages to evaluate the accurate sizing of the actuator and as the consequence, the overall machinery development cost will be significantly reduced. The idea is proven in three ways: analytical analysis, simulation analysis and experimental analysis based on the developed prototype. The simulation study has shown that the estimated torque is successfully reduced by 29% as compared to the conventional approach. The superiority of the proposed analysis is confirmed by 12% error between the simulation and results from the developed prototype. The successful method proposed in this paper can be further used for all multi-linkage systems in the heavy-vehicle industry that require accurate sizing of the actuators. © 2021 Inderscience Enterprises Ltd.

Author Keywords

Drive system; Dynamic analysis; Scissor mechanism; Static analysis; Structural analysis; Virtual work analysis

Index Keywords

Machinery, Tools; Analytical analysis, Ball screw system, Conventional approach, Experimental analysis, Machinery development, Simulation analysis, Simulation and results, Simulation studies; Ball screws

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Biographical notes: N.M.H. Norsahperi received his BE and MSc in Mechatronics Engineering from International Islamic University of Malaysia (IIUM) in 2015 and 2017 respectively. In 2017, he is currently pursuing the PhD in Control and Mechatronic Engineering at University of Technology Malaysia. His PhD is sponsored by Universiti Putra Malaysia and Ministry of Higher Education Malaysia. His research area mainly includes nonlinear control, robotics and artificial intelligence. He is a graduate member of Board of Engineer Malaysia (BEM).

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References

- Bariskan, M., Benenson, G.
(2014) *Desgin and FEM Analysis of Scissor Jack*,
City College of New York

- Chikahiro, Y., Ario, I., Nakazawa, M., Ono, S., Holnicki-Szule, J., Pawlowski, P., Graczykowski, C., Watson, A.
Experimental and numerical study of full-scale scissor type bridge
(2016) *Automation in Construction*, 71, pp. 171-180.
Elsevier, B.V
- Corrado, A., Polini, W., Canale, L., Cavaliere, C.
To design a belt drive scissor lifting table
(2016) *International Journal of Engineering and Technology*, 8 (1), pp. 515-525.
- Dong, R., Pan, C., Hartsell, J.
An investigation on the dynamic stability of scissor lift
(2012) *Open Journal of Safety*, pp. 8-15.
March
- Gao, X., Xu, X., Wang, S., Wang, C.
Simulation analysis and experiment for the articulating booms of the mobile elevating work platforms
(2016) *DEStech Transactions on Engineering and Technology Research*,
- Ghanashyam, K.G., Vasudevamurthy, B.H., Krishnaprasad, A.K.
Design, development and analysis of Z-axis translation for an earth sensor test facility
(2013) *International Journal of Scientific and Research Publication*, 3 (7), pp. 1-6.
- Gonzalez, D.J., Asada, H.H.
Design and analysis of 6-dOF triple scissor extender robots with applications in aircraft assembly
(2017) *IEEE Robotics and Automation Letters*, 2 (3), pp. 1420-1427.
- Hibbeler, R.C.
(2009) *Mechanics for Engineers: Statics*,
12th ed., Pearson Prentice Hall, Prentice Hall, Louisiana
- Hua, X.
(2010) *Hypoid and Spiral Bevel Gear Dynamics with Emphasis on Gear-Shaft-Bearing Structural Analysis*,
University of Cincinnati
- Hua, X., Lim, T.C., Peng, T., Wali, W.E.
Dynamics analysis of spiral bevel geared rotor systems applying finite elements and enhanced lumped parameters
(2012) *International Journal of Automotive Technology*, 13 (1), pp. 97-107.
- Islam, M.T., Yin, C., Jian, S., Rolland, L.
Dynamic analysis of scissor lift mechanism through bond graph modeling
(2014) *IEEE/ASME International Conference on Advanced Intelligent Mechatronics*, pp. 1393-1399.
AIM
- Jangam, P., Jadhav, N., Narkar, R.R.
Analysis of pin in hydraulic scissor lift
(2017) *Imperial Journal of Interdisciplinary Research*, (4), pp. 989-991.

- Kim, K., Teizer, J.
Automatic design and planning of scaffolding systems using building information modeling
(2014) *Advanced Engineering Informatics*, 28 (1), pp. 66-80.
Elsevier Ltd
- Lee-St. John, A., Sidman, J.
Combinatorics and the rigidity of CAD systems
(2013) *CAD Computer Aided Design*, 45 (2), pp. 473-482.
Elsevier Ltd
- Leng, E.W.L., Ismail, M., Subari, M.D.
Setting-up the assembly, integration and test centre in Malaysia
(2009) *RAST 2009 - Proceedings of 4th International Conference on Recent Advances Space Technologies*, pp. 453-458.
IEEE
- Liu, T., Sun, J.
Simulative calculation and optimal design of scissor lifting mechanism
(2009) *2009 Chinese Control and Decision Conference*, pp. 2079-2082.
CCDC. (2009)
- Luo, Y., Zhao, N., Wang, H., Kim, K.J., Shen, Y.
Design, modelling and experimental validation of a scissor mechanisms enabled compliant modular earthworm-like robot
(2017) *2017 IEEE/RSJ International Conference on Intelligent Robots and System (IROS)*, pp. 2421-2426.
- Momin, G.G., Hatti, R., Dalvi, K., Bargi, F., Devare, R.
Design, manufacturing and analysis of hydraulic scissor lift
(2015) *International Journal of Engineering Research and General Science*, 3 (2), pp. 733-740.
- Norsahperi, N.M.H., Ahmad, S., Fuad, A.F.M., Mahmood, I.A., Toha, S.F., Akmeliawati, R., Darsivan, F.J.
Modelling and control of base plate loading subsystem for the motorized adjustable vertical platform
(2017) *International Conference on Mechanical, Automotive and Aerospace Engineering (2016) Gombak: IOP Conference Series: Materials Science and Engineering*, p. 012049.
- Parr, A.
(2013) *Hydraulics and Pneumatics: A Technician's and Engineer's Guide*,
Oxford: Elsevier Ltd
- Shi, H., Li, P.Y.
Coordination control of a 3 DOF distributed human assistive load lifting system with force amplification
(2016) *IEEE 2016 12TH World Congress on Intelligent Control and Automation (WCICA)*, pp. 1359-1365.
- Spackman, H.
(1989) *Mathematical Analysis of Scissor Lifts*, p. 67.

- Spackman, H.
Mathematical analysis of actuator forces in a scissor lift
(1994), NAVAL COMMAND CONTROL AND OCEAN SURVEILLANCE CENTER RDT AND E DIV SAN DIEGO CA (NRAD-TD-2643)
- Stanley, M.O.
(2012) *Scissor Lift Design for Use in the Automotive Industry*, Niger Delta University, August
- Xu, W., Xu, Y., Zheng, X.
Adaptive twisting sliding mode control for overhead-cranes
(2015) *IEEE International Conference on Cyber Technology in Automation Control and Intelligent System (CYBER)*, pp. 1379-1384.
- Xu, X., Luo, T., Luo, J., Hua, X., Langari, R.
Dynamical load sharing behaviors of heavy load planetary gear system with multi-floating components
(2018) *International Journal of Modeling, Simulation, and Scientific Computing*, p. 1850005.
09 01
- Yi, S., Yuancai, L., Binghua, X.
Mechanical analysis of symmetrical driving the-movement of the lifting platform
(2012) *2nd International Conference on Electronics, Mechanical Engineering and Information Technology*, pp. 428-432.
- Zhang, W.
A study on the static stability of scissor lift
(2015) *The Open Mechanical Engineering Journal*, 9, pp. 954-960.

Correspondence Address

Norsahperi N.M.H.; Department of Electrical and Electronics Engineering, Malaysia; email: nmhaziq@yahoo.com

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