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Integrated Modelling and Control of Linear Actuator Based Automatic Pedal Pressing Mechanism for Low-Speed Driving in a Road Traffic Delay

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Abstract
Sitting in traffic congestion for hours in a posture that requires recurrent actions of manually pressing the pedal and braking excessively can result in fatigue, especially on the driver's leg and back. This fatigue can have long-term implications and adversely affect the driver's health. Thus, this paper aims to model and develop a control system that utilizes a linear actuator to replace the leg activities involved in pressing and releasing the brake pedal. This approach, combined with the implementation of a PID controller, offers a novel solution to control the vehicle speed by integration with the linear actuator that focus on low-speed driving condition. The design process begins with creating a 3D model using SolidWorks to visualize the movement of the linear actuator and Pedal subsystem. This model is then connected to Matlab-Simulink, where a PID controller is implemented and integrated into the electrical circuit to control the actuator's movement. Integration with the vehicle dynamic model enables a comprehensive analysis of the system's behavior on the vehicle dynamics. This research compares the trial and error method with the Matlab tuner for implementing the PID controller. The performance of the system will be evaluated based on the steady state error, overshoot, rise time, and settling time. The results demonstrate that the Matlab tuner outperforms trial and error method by achieving a faster response and significantly reducing steady state error during robustness testing. With the integration of the linear actuator, the system is capable of tracking the desired speed and has the potential to replace the leg activities involved in pressing and releasing the brake pedal. For future work, validating the proposed mechanism with a physical prototype of the linear actuator and pedal using hardware-in-the-loop techniques poses a challenge, as hardware constraints may vary with different environments.

Author Keywords
Automatic Braking; Linear Actuator; Low Speed Control; Pedal Pressing; PID Controller; Road Traffic Delay

References

- Jagannath, M., Balasubramanian, V.
Assessment of early onset of driver fatigue using multimodal fatigue measures in a static simulator
(2014) *Appl. Ergon*, 45 (4), pp. 1140-1147.
- Hostens, I., Ramon, H.
Assessment of muscle fatigue in low level monotonous task performance during car driving
(2005) *Journal of Electromyography and Kinesiology*, 15 (3), pp. 266-274.
- Oyewole, S. A.
Enhancing ergonomic safety effectiveness of repetitive job activities: rediction of muscle fatigue in dominant and nondominant arms of industrial workers
(2014) *Hum Factors Ergon Manuf*, 24 (6), pp. 585-600.
- Bahri, S.
The Association between Risk Factors and Low Back ain among Commercial Vehicle rivers in eninsular Malaysia: A reliminary Result
(2007) *Industrial Health*, 45 (2), pp. 268-278.
- Yusoff, I., Ng, B. K., Azizan, S. A.
Towards sustainable transport policy framework: A rail-based transit system in

Klang Valley, Malaysia
(2021) *PloS one*, 16 (3), p. e0248519.

- Ting, P. H., Hwang, J. R., Doong, J. L., Jeng, M. C.
river fatigue and highway driving: A simulator study
(2008) *Physiol. Behav*, 94 (3), pp. 448-453.

- Carneiro, J. F., Pinto, J. B., Almeida, F. G. D.
Accurate motion control of a pneumatic linear peristaltic actuator
(2020) *Actuators*, 9 (3).

- Driver, T., Shen, X.
ressure estimation-based robust force control of pneumatic actuators
(2013) *International Journal of Fluid Power*, 14 (1), pp. 37-45.

- Lucidarme, P., Delanoue, N., Mercier, F., Aoustin, Y., Chevallereau, C.
reliminary survey of backdrivable linear actuators for humanoid robots
(2018) *ROMANSY 22 – Robot Design, Dynamics and Control*, 584, pp. 304-313.
Wenger

- Noguchi, T., Kawamura, A.
Sensorless position control of novel electromagnetic linear actuator for tactile display
(2017) *2017 20th International Conference on Electrical Machines and Systems (ICEMS)*, pp. 1-5.

- Rouzbeh, B., Bone, G. M.
Optimal force allocation and position control of hybrid pneumatic-electric linear actuators
(2020) *Actuators*, 9 (3), p. 86.

- **Advanced controlling of the prototype of SMA linear actuator**
(2011) *Solid State Phenomena*, 177, pp. 93-101.
ominik

- Wrat, G., Bhola, M., Ranjan, P., Mishra, S. K., as, J.
Energy saving and Fuzzy-PID position control of electro-hydraulic system by leakage compensation through proportional flow control valve
(2020) *ISA Trans*, 101, pp. 269-280.

- Lai, W. Y., Onn, N., Tang, C. H. H., Hussein, M.
osition Control of Hydraulic Actuators Using Fuzzy ulse Width Modulation (WM)
(2015) *Applied Mechanics and Materials*, 735, pp. 294-298.

- Zhao, Z.-Y., Tomizuka, M., saka, S.
Fuzzy gain scheduling of controllers
(1993) *IEEE Trans Syst Man Cybern*, 23 (5), pp. 1392-1398.

- Sio, K. C., Lee, C. K.
Stability of fuzzy controllers
(1998) *IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans*, 28 (4), pp. 490-495.

- Tzafestas, S., apanikolopoulos, N.
ncremental fuzzy expert control
(1990) *IEEE Transactions on Industrial Electronics*, 37 (5), pp. 365-371.

- Das, S., Bandyopadyay, B., Paul, A. K., Trivedi
osition control of pneumatic actuator using sliding mode control in conjunction with Robust Exact ifferentiator

(2013) *2013 International Conference on Control, Automation, Robotics and Embedded Systems (CARE)*, pp. 1-6.

- Sariyildiz, E., Wang, H., Yu, H.
  A sliding mode controller design for the robust position control problem of series elastic actuators
  (2017) *2017 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 3055-3061.

- Yu, L., Huang, J., Luo, W., Chang, S., Sun, H., Tian, H.
  Sliding-Mode Control for PMLSM Position Control—A Review
  (2023) *Actuators*, 12 (1), p. 31.

- Hernandez-Alvarado, R., Rodriguez-Abreo, O., Garcia-Guendulain, J. M., Hernandez-iaz, T.
  Self-Tuning Control Using an Online-Trained Neural Network to osition a Linear Actuator
  (2022) *Micromachines*, 13 (5), p. 696.

- Zhao, J., Zhong, J., Fan, J.
  osition control of a pneumatic muscle actuator using RBF neural network tuned controller
  (2015) *Math. Probl. Eng*, 2015.

- Choi, G. S., Lee, H. K., Choi, G. H.
  A study on tracking position control of pneumatic actuators using neural network
  (1998) *IECON '98. P oceedings of the 24th Annual Conference of the IEEE Industrial Electronics Society (Cat. No.98CH36200)*, pp. 1749-1753.

- Borase, R. P., Maghade, D. K., Sondkar, S. Y., awar, S. N.
  A review of control, tuning methods and applications
  (2021) *International Journal of Dynamics and Control*, 9, pp. 818-827.

- Karim, M. I., Hashim, A. A. A., Ghani, N. M. A.
  Control of ouble Link Flexible Robotic Manipulator System
  (2022) *Journal Europeen des Systemes Automatises*, 55 (6), pp. 759-763.

- Khalifa, M., Amhedb, A. H., Al Sharqawi, M.
  Real time C motor position control using controller in LabV EW
  (2021) *Journal of Robotics and Control (JRC)*, 2 (5), pp. 342-348.

- Kumar, V., Patra, A.
  Application of Ziegler-Nichols Method for Tuning of PID Controller
  (2017) *International Journal of Electrical and Electronics Engineers*, 8 (2), pp. 559-570.

- atel, V. V.
  Ziegler-Nichols Tuning Method: Understanding the PID Controller
  (2020) *Resonance*, 25, pp. 1385-1397.

- Elbayomy, K. M., Jiao, Z., Zhang, H.
  controller optimization by GA and its performances on the electro-hydraulic servo control system
  (2008) *Chinese Journal of Aeronautics*, 21 (4), pp. 378-384.

- Aly, A. A.
  arameters Optimization Using Genetic Algorithm Technique for Electrohydraulic Servo Control System
  (2011) *ntelligent Control and Automation*, pp. 69-76.
  02 02

- Sadri, A. M., Wright, J. R., Wynne, R. J.
Modelling and optimal placement of piezoelectric actuators in isotropic plates using genetic algorithms
(1999) *Smart Materials and Structures*, 8 (4), p. 490.

- Solihin, M. I., Tack, L. F., Kean, M. L.
Tuning of Controller Using article Swarm Optimization (SO)
(2011) *Int. J. Adv. Sci. Eng. Inf. Technol*, 1 (4), pp. 458-461.

- Jia, L., Zhao, X.
An mproved article Swarm Optimization (SO) Optimized ntegral Separation and its Application on Central osition Control System
(2019) *IEEE Sensors Journal*, 19 (16), pp. 7064-7071.

- Sunar, N. H., Rahmat, M. F., Ismail, Z. H., Faudzi, A. M., Salim, S. N. S., Samsudin, S.
Application of optimization technique for PID controller tuning in position tracking of pneumatic actuator system
(2013) *2013 IEEE 9th International Colloquium on Signal Processing and its Applications*, pp. 33-38.

- Zulfatman, Rahmat, M. F.
Application of Self-Tuning Fuzzy Pid Controller on Industrial Hydraulic Actuator Using System dentification Approach
(2009) *International Journal on Smart Sensing and Intelligent Systems*, 2 (2), pp. 246-261.

- Yu, G.-R., You, C.-S., Hong, R.-J.
Self-Tuning Fuzzy Control of a Piezoelectric Actuator System
(2006) *2006 IEEE International Conference on Systems, Man and Cybernetics*, pp. 1108-1113.

- Saputra, A.
Ma'arif, H. Maghfiroh, Chotikunnan, and S. N. Rahmadhia, " esign and Application of PLC-based Speed Control for DC Motor Using PID with Identification System and MATLAB Tuner
(2023) *International Journal of Robotics and Control Systems*, 3 (2), pp. 233-244.

- Åström, K. J., Hägglund, T.
The future of control
(2001) *Control Eng Pract*, 9 (11), pp. 1163-1175.

- Keel, L. H.
Analytical esign of Controllers [Bookshelf]
(2021) *IEEE Control Systems Magazine*, 41 (1), pp. 80-81.

- Wicaksono, G. R., Puriyanto, R. D.
rogrammable Logic Controller (LC) Based aint Viscosity Control System
(2021) *Buletin Ilmiah Sarjana Teknik Elektro*, 3 (1), pp. 1-9.

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