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IMPLEMENTATION OF UNBALANCED MASS IN A HORIZONTAL DRUM WASHING MACHINE USING DISTURBANCE OBSERVER

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ABSTRACT

The water utilization in front stacking clothes washers is such a great amount of not exactly a conventional washing machine. Also these machines are to a great degree vitality productive all alone; they cut dry times significantly since they turn out much speedier than a customary top stacking machine. The execution of the front stacking clothes washer is restricted by the uneven burden in the washing drum and in this manner an exact estimation of the mass of the unequal burden is vital. This paper proposes a way to deal with assessment the lopsided mass utilizing an unsettling influence eyewitness. Utilizing the proposed model the mass of the lopsided burden is resolved from the unsettling influence in the drum speed because of the unequal mass.

Key words: Unbalance Load; Disturbance Observer.

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1. INTRODUCTION

Consumer Demand For Front Burden Washers Has Been Radically Expanding Because of The Extra Limits, Vitality Effectiveness, and Enhanced Garments Mind These Machines Offer. The Vitality Effectiveness and The General Execution of The Machine Is Restricted By The Unequal Burden Which Is Because of The Dissemination of The Clothing Inside The Drum When The Precise Pace of The Drum Is Above 200 Rpm For Turning. Because of Lopsided Burden The Machine Makes Undesirable Vibrations Which Once In A While Lead To Breakdown Of The Machine. Research on the estimation of lopsided burden has been did following 2001 and different routines for estimation of unbalance burdens has been proposed.

Uneven burden estimation utilizing different sensors and using sensor combination has been exhibited in [1].a 3 d model of an even pivot versatile clothes washer and adjustment techniques are displayed in [2].some have utilized additional hardware to diminish vibrations [3].an way to deal with assess the position and mass of the unequal burden utilizing fluffy rationale and fake neural systems has been proposed in [4]. A recreation model of the even pivot clothes washer has been produced a calculation has been proposed to appraise the precise position of the uneven burden with greatest blunder of 3%in [5] a count technique for dormancy estimation is proposed in [6]. The amount of the clothing is evaluated by the deliberate inertia. also ideal washing time figuring strategy time is proposed for vitality productivity in [6]. In this paper a model of an all inclusive engine with dc supply and the model of the washing drum with lopsided burden is proposed. Likewise a rate controller and an unsettling influence onlooker is inferred and executed in Matlab/Simulink. A disturbance onlooker is intended for zero unbalance mass and it goes about as reference evaluating the condition of the framework. [7] The distinction between the first and evaluated state will give the data about the mass of the unbalance load demonstrated with the Matlab alongside the drum model. [8]

2. THE PROPOSED WASHING MACHINE MODEL

The piece of the clothes washer which is of interest basically comprises of client interface, a controller, a converter and an electric engine joined with the washing drum by a belt as appeared in fig .1.the clothes washer is supplied with a solitary –phase 230v ac source yet since the widespread engine is utilized as dc, a converter is utilized .[9-10] the converter is represented by the controller which computes the fitting voltage from the evaluated speed and the reference pace is set by the client interface.

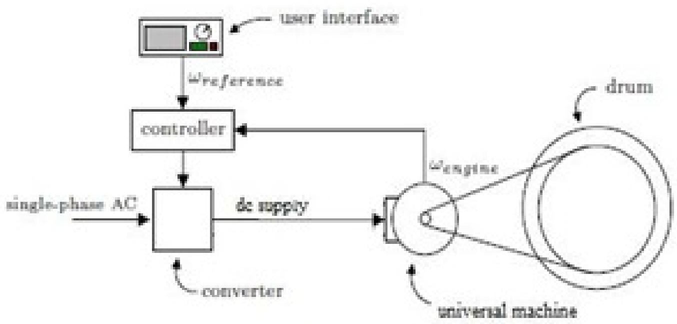

Figure 1 Typical washing machine with user interface and controller

The heap torque on the engine shaft is not just subject to the idleness of the drum additionally on the mass and area of the clothing inside the drum .The uneven dissemination of the clothing inside the drum results in the unequal burden which causes the torque on the all inclusive engine yield shaft to differ the rakish area of the drum. This reasons an unsettling influence in the velocity and it is relative to the mass of the lopsided burden. [10-11]

3. ENGINE MODEL AND DRUM MODEL

From the proportional circuit of the engine we can compose the dynamic comparison as,

$$V=(R_{se}+R_a)\, i_a+(L_{se}+L_a)\, \frac{di_a}{dt}+e_b \quad (1)$$

$$e_b=K_b\, \omega \quad (2)$$

$$T_d-T_l=J\, \frac{d\omega}{dt}+B\omega \quad (3)$$

$$T_d=K_t i_a \quad (4)$$

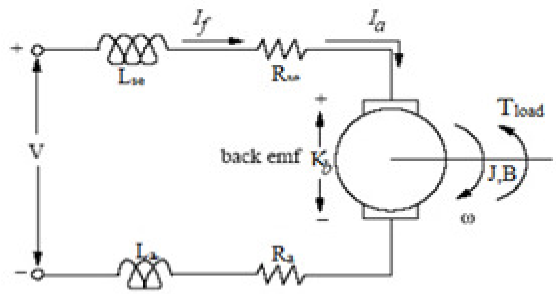

Figure 2 Equivalent circuit of Universal motor used as DC

From the drum model we can write the force and the torque equations as,

$$\omega = \omega_1 \quad (5)$$

$$F_k = \delta(r_1\theta_1 - r_2\theta_2) + b(r_1\omega_1 - r_2\omega_2) \quad (6)$$

$$T_k = F_k r_k \quad (7)$$

Where, k=1, 2;

$$T_{load} = T_1 + T_{J1} + T_{B1} \quad (8)$$

$$T_{load} = F_1 r_1 + J_1 \frac{d\omega_1}{dt} + B_1\omega_1 \quad (9)$$

$$T_2 = T_{J1} + T_{B2} + T_{ub} \quad (10)$$

$$F_2 r_2 = J_2 \frac{d\omega_2}{dt} + B_2\omega_2 + \frac{d\omega_2}{dt} m r_m^2 + r_m m g cos(\theta_2) \quad (11)$$

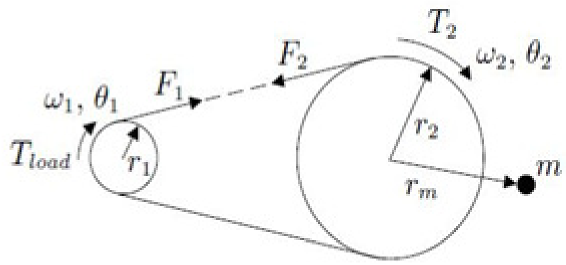

Figure 3 Drum of the washing machine driven by the DC motor – model

$$T_{load} = \delta(r_1^2\theta_1 - r_1 r_2\theta_2) + b(r_1^2\omega_1 - r_1 r_2\omega_2) + J_1 \frac{d\omega_2}{dt} + B_1\omega_1 \quad (12)$$

After rearranging these equations we will finally arrive at the following dynamic state equations.

$$\frac{di_a}{dt} = \frac{V-(R_{se}+R_a)i_a - K_b\omega_1}{L_{se}+L_a} \quad (13)$$

$$\frac{d\omega_1}{dt} = \frac{K_t i_a - \delta(r_1^2\theta_1 - r_1 r_2\theta_2) - b(r_1^2\omega_1 - r_1 r_2\omega_2) - (B_1+B_2)\omega_1}{J+J_1} \quad (14)$$

$$\frac{d\omega_2}{dt} = \frac{\delta(r_1 r_2\theta_1 - r_2^2\theta_2) - b(r_1 r_2\omega_1 - r_2^2\omega_2) - r_m m g cos(\theta_2) - B_2\omega_2}{J_2 + m r_m^2} \quad (15)$$

$$\frac{d\theta_1}{dt} = \omega_1 \quad (16)$$

$$\frac{d\theta_2}{dt} = \omega_2 \quad (17)$$

4. SIMULINK IMPLEMENTATION

The state model in the real time parameters are put in a MATLAB function and the results are being calculated.

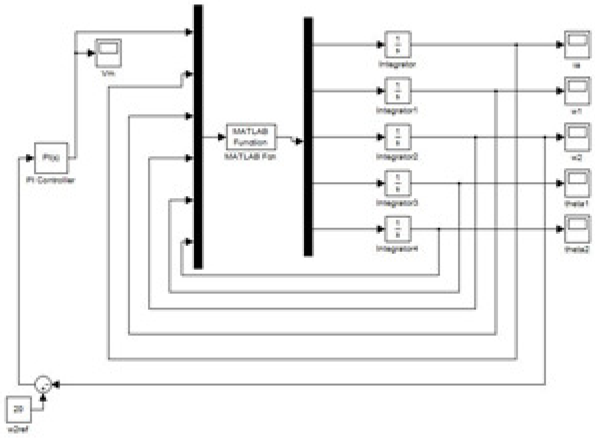

Figure 4 Simulink model of the washing machine system

5. DISTURBANCE OBSERVER

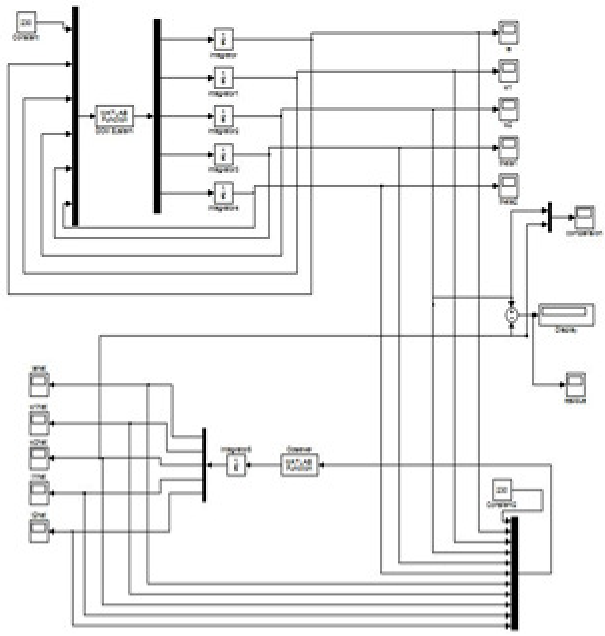

Figure 5 Simulink diagram of washing machine with observer

The top bit demonstrates the DC engine model and the base part demonstrates the eyewitness model. The onlooker is intended for zero unbalance mass i.e., framework with no outside unsettling influence.[14-18] The deposit in the middle of unique and assessed will give the data about the mass of the unbalance load.

The spectator is outlined without the unbalance load.[12-13] On the off chance that unsettling influence presented in the framework implies buildup will be delivered in the yield.[19-20] Different mass qualities w2, w2hat plot and unsettling influence plots are as per the following. Comparison of the system and observer response for m=0

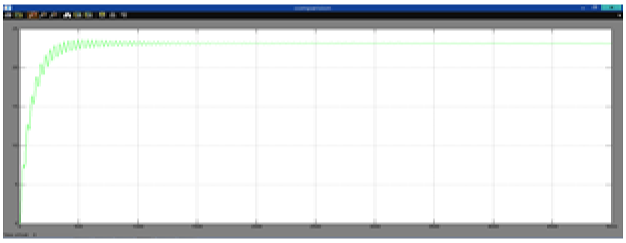

Figure 6 Comparison plot for system output response for m=0

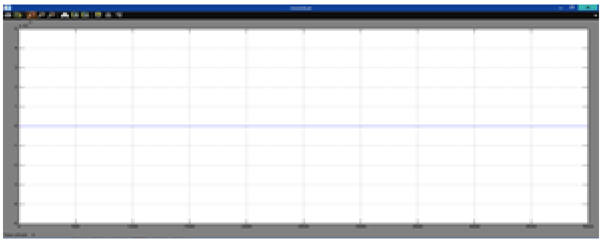

Figure 7 Residue plot for m=0

Comparison of the system and observer response for m=0.4

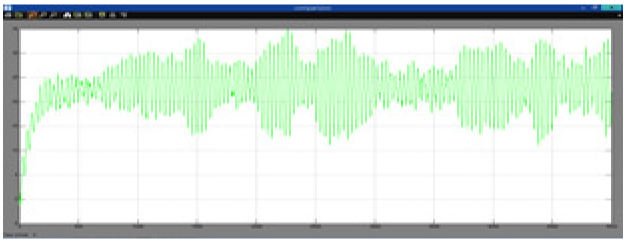

Figure 8 Comparison plot for system output response for m=0.4

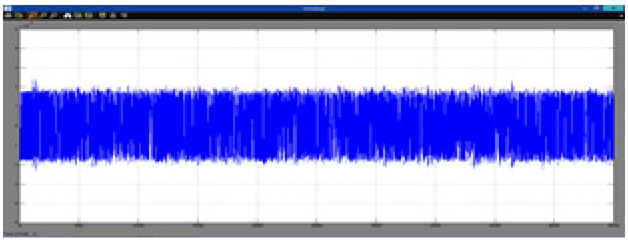

Figure 9 Residue plot for m=0.4

Comparison of the system and observer response for m=0.7

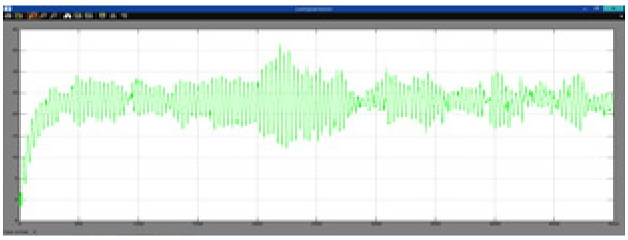

Figure 10 Comparison plot for system output response for m=0

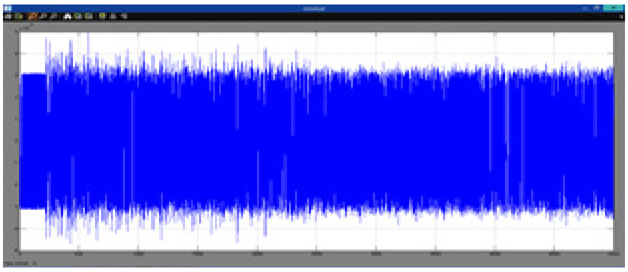

Figure 11 Residue plot for m=0

Comparison of the system and observer response for m=0.7

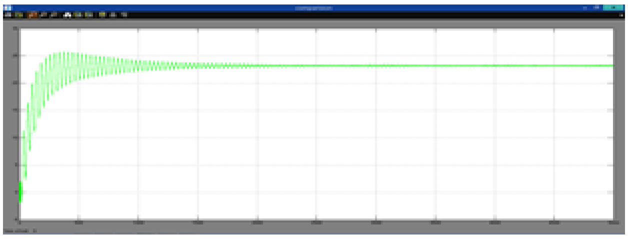

Figure 12 Comparison plot for system output response for m=0.4

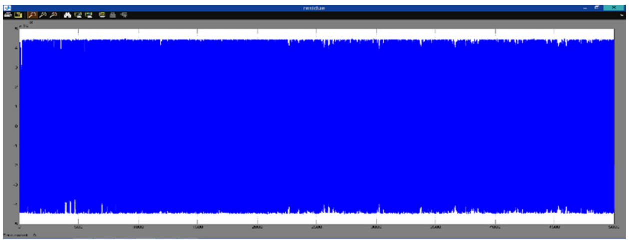

Figure 13 Residue plot for m=0

Table I Disturbance Ripple Values For Various Unbalance Masses

Unbalance mass(m) in kg	**Ripple magnitude(d)**
0	0
0.1	$0.44x10^{-3}$
0.2	$0.88x10^{-3}$
0.3	$1.32x10^{-3}$
0.4	$1.76x10^{-3}$
0.5	$2.20x10^{-3}$
0.6	$2.66x10^{-3}$
0.7	$3.10x10^{-3}$
0.8	$3.54x10^{-3}$
0.9	$3.98x10^{-3}$
1.0	$4.42x10^{-3}$

From the above results, it is clear that 1% increase in the unbalance mass will cause the disturbance ripple to increase by $0.044x10^{-3}$. This is the relationship between the unbalance mass and the disturbance acting on the system. By using this approach, the unbalance mass can be easily found.

6. CONCLUSION

In this paper and approach of estimating the unbalance mass of horizontal drum washing machine from the disturbance in speed using disturbance observer has been proposed. This method leads to a cost effective way of estimating the unbalance mass as it do not require any sensor and sensor fusion devices. Using the same approach the unbalance mass can also be estimated from the disturbance in the armature current. The future work includes the real time experiment of the simulation done.

REFERENCES

[1] Magnus Hedin, Linda Lundström, "Analysis and Modelling of an induction machine with pulsating load torque used for a washing machine application", Master of science thesis, April 2007.

[2] Ahmet Yörükoğlu, Eerdinç Altuğ, "Determining the Mass and Angular position of the Unbalanced load in Horizontal Washing Machines", IEEE/ASME International conference on Advance Intelligent Mechatronics, July 14-17, 2009.

[3] Kumaravel, A., Udhayakumarapandian, D., Consruction of meta classifiers for apple scab infections, International Journal of Pharma and Bio Sciences, v-4, i-4, pp-B1207-B1213, 2013.

[4] Kumaravel, A., Udayakumar, R., Web portal visits patterns predicted by intuitionistic fuzzy approach, Indian Journal of Science and Technology, v-6, i-5, pp-4549-4553, 2013.

[5] Anbuselvi, S., Chellaram, C., Jonesh, S., Jayanthi, L., Edward, J.K.P., Bioactive potential of coral associated gastropod, Trochus tentorium of Gulf of Mannar, Southeastern India, Journal of Medical Sciences, v-9, i-5, pp-240-244, 2009.

[6] Y. Yuan, A. Buendia, R. Martin, and F. Ashrafzadeh, "Unbalanced load estimation algorithm using multiple mechanical measurements for horizontal washing machines," in *Proc. IEEE Sens. Conf.*, 2007, pp. 1033–1306.K. Elissa, "Title of paper if known," unpublished.

[7] Sengottuvel, P., Satishkumar, S., Dinakaran, D., Optimization of multiple characteristics of EDM parameters based on desirability approach and fuzzy modeling, Procedia Engineering, v-64, i-, pp-1069-1078, 2013.

[8] Jayalakshmi, V., Gunasekar, N.O., Implementation of discrete PWM control scheme on Dynamic Voltage Restorer for the mitigation of voltage sag /swell, 2013 International Conference on Energy Efficient Technologies for Sustainability, ICEETS 2013, pp-1036-1040, 2013.

[9] Kaliyamurthie, K.P., Parameswari, D., Udayakumar, R., QOS aware privacy preserving location monitoring in wireless sensor network, Indian Journal of Science and Technology, v-6, i-5, pp-4648-4652, 2013.

[10] Sundararajan, M., Optical instrument for correlative analysis of human ECG and breathing signal, International Journal of Biomedical Engineering and Technology, v-6, i-4, pp-350-362, 2011.

[11] Kaliyamurthie, K.P., Udayakumar, R., Parameswari, D., Mugunthan, S.N., Highly secured online voting system over network, Indian Journal of Science and Technology, v-6, i-SUPPL.6, pp-4831-4836, 2013.

[12] Khanaa, V., Thooyamani, K.P., Saravanan, T., Simulation of an all optical full adder using optical switch, Indian Journal of Science and Technology, v-6, i-SUPPL.6, pp-4733-4736, 2013.

[13] Raj, M.S., Saravanan, T., Srinivasan, V., A modified direct torque control of induction motor using space vector modulation technique, Middle - East Journal of Scientific Research, v-20, i-11, pp-1572-1574, 2014.

[14] Kumaravel, A., Dutta, P., Application of Pca for context selection for collaborative filtering, Middle - East Journal of Scientific Research, v-20, i-1, pp-88-93, 2014.

[15] BrinthaRajakumari, S., Nalini, C., An efficient data mining dataset preparation using aggregation in relational database, Indian Journal of Science and Technology, v-7, i-, pp-44-46, 2014.

[16] Udayakumar, R., Khanaa, V., Saravanan, T., Saritha, G., Retinal image analysis using curvelet transform and multistructure elements morphology by reconstruction, Middle - East Journal of Scientific Research, v-16, i-12, pp-1781-1785, 2013.

[17] Khanaa, V., Thooyamani, K.P., Using triangular shaped stepped impedance resonators design of compact microstrip quad-band, Middle - East Journal of Scientific Research, v-18, i-12, pp-1842-1844, 2013.

[18] Thamotharan, C., Prabhakar, S., Vanangamudi, S., Anbazhagan, R., Anti-lock braking system in two wheelers, Middle - East Journal of Scientific Research, v-20, i-12, pp-2274-2278, 2014.

[19] Khanaa, V., Mohanta, K., Saravanan, T., Comparative study of uwb communications over fiber using direct and external modulations, Indian Journal of Science and Technology, v-6, i-6, pp-4845-4847, 2013.

[20] K L N Sandeepa Sarma, B. Venkateshwarlu and Jacob Thottathil Varghese, Analysis of Stress Distribution on Different Sections Under Different Loading and Machining Conditions, International Journal of Mechanical Engineering and Technology, 8(7), 2017, pp. 897–908, 8(7).

[21] Osman Ashraf Ansari and Dr. P. Sampath Rao, Design and Analysis of Crane Hook for Load Conditions. International Journal of Mechanical Engineering and Technology, 7(5), 2016, pp. 75–79.

[22] Saravanan, T., Srinivasan, V., Udayakumar, R., A approach for visualization of atherosclerosis in coronary artery, Middle - East Journal of Scientific Research, v-18, i-12, pp-1713-1717, 2013.