Optical mouse sensor used to predict mechanical damages in the rotation parts of an electrical motor

Diogo Aranha, Deisenara Marques, Alexandrino Vaz, Roberto Braga, Daniel Pereira
Engeneering Dep., CEDIA, Federal University of Lavras
mailto:robertobraga@deg.ufla.br

This work proved the feasibility of an adapted computer mouse with an external laser to predict mechanical damages in electrical motors. The results presented the reliability of the method to separate the electrical motor with damaged bearings from the motor with healthy bearings.

1 Introduction

The optical computer mouse has been used in several applications beyond its traditional use in computers [1], using the Digital Signal Processor (DSP), to process and to generate the signal related to the mouse movement [2]. The alternative applications of the mouses are linked to the cursor position, related to the movement of particles [3] and objects, to roughness analysis [4], to monitor the deformation [5], and linked to the monitoring of oscillations and vibrations [6, 7]. In turn, the adoption fo the mouse out of the surface can only be conducted when the built-in light is disabled and an external laser beam is replaced [1, 8]. The optical mouse associated with a laser light source thus presented feasible application as an instrument to monitor biological and non-biological phenomena through the movement observation [8].
The electrical motors play a relevant position in the industry, and their unexpected damage need to be avoided, since the costs of a break are high, which include security conditions. Thus, there are many efforts to predict the conditions of the motor bearings, that are one of the many possible causes of faults [9, 10, 11, 12, 13]. This work aimed to present the adoption of an adapted optical mouse as an instrument to identify the damage in the bearings of electrical motors as an instrument to contactlessly.

2 Methods

An optical mouse with a CMOS of 800 DPI, with an USB connection, and with the internal LED disabled was adapted with an external laser set (solid state of 635 nm and 5mW) built-in.

The mouse was placed as presented in Fig. 1 with a distance of 70 mm apart from the surface of the electrical motor.

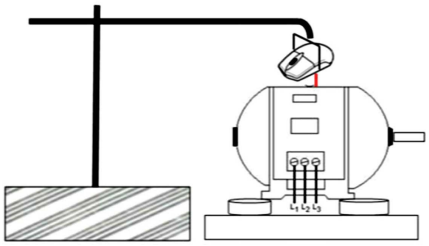

Fig. 1 *Experimental configuration of the adapted mouse illuminating the electrical motor.)*

The electrical motor was in turn prepared with its bearings in perfect state, and as well as with damage bearings. The Cartesians coordinates of the cursor position on the screen were detected and stored at a rate of 100 coordinates per second by specifically designed software (`http://repositorio.ufla.br/handle/1/4564`).

In Fig. 2 the mouse path is presented as it appears in the computer screen when the motor is running.

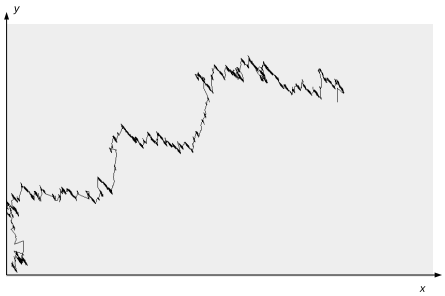

Fig. 2 *The path of the mouse in the screen recorded from an electrical motor running.*

The signal representing the mouse path was processed in order to obtain the *Y* projection, and thus the behaviour of the motor in the two situations of the bearings compared.

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3 Results and Discussions

The results presented the ability of the method to distinguish the differences between a motor with damaged bearings and a motor with new bearings. See Fig. 3 for an example of the outcome of the signal related to the projection of the mouse path in the axis *Y*. The projection in axis *X* provided a similar result, though a composition of both could be an alternative way to create an outcome. The use of an adapted mouse as a sensor of vibration offers the possibility to build a new sensor using the mouse core, in order to take advantage of the signal processing as well as of the flexibility its use. The monitoring of the vibration of rotating machines done by means of non-contact technique the main advantage of this new approach.

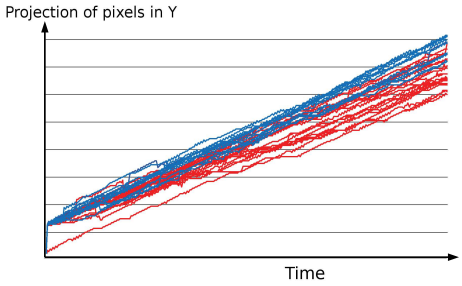

Fig. 3 *Projection of mouse path in Y axis with red curves meaning the replications of the signal of damaged bearings, and the blue curves meaning the healty bearings in the running motor.)*

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5 Bibliography

References

[1] T.W. Ng, M. Carne “Optical mouse digital speckle correlation,” *Opt. Comm.* **280** 435–437 (2007).

[2] P. Popov, S. Pulov, V. Pulov, “A laser speckle pattern technique for designing an optical computer mouse,” *Opt. Laser Eng.* **42** 21–26 (2004).

[3] J. S. Figueira; In XVII Simposio Nacional de Ensino de Fisica, Sao Luis, (2007).

[4] T.W. Ng, T.L. Cheong, “The optical mouse as an inexpensive region-of-interest position recorder in optical microscopy,” *Microsc. Res. Tech.* **63** 203–205 (2004).

[5] T.W. Ng “Measuring viscoelastic deformaton with an optical mouse,” *J. Chem. Educ.* **81** 1628–1629 (2004).

[6] T.W. Ng, K.T. Ang, “The optical mouse for harmonic oscillator experimentation,” *Am. J. Phyc. 73* 793–5 (2005).

[7] T.W. Ng, “The optical mouse as a two-dimensional displacement sensor,” *Sen. Act. A Phys.* **107** 21–25 (2003).

[8] M.M. Silva, J.R.A. Nozela, M.J. Chaves, R.A. Braga, H.J. Rabal, “Optical mouse acting as biospeckle sensor,” *Opt. Comm.* **284**, 1798–1802 (2011).

[9] K. Li, X. Ping, H. Wang, P. Chen, Y. Cao, “Sequential Fuzzy Diagnosis Method for Motor Roller Bearing in Variable Operating Conditions Based on Vibration Analysis,” *Sensors* **13**, 8013–41 (2013).

[10] M. Pacas, S. Villwock, R. Dietrich, “Bearing damage detection in permanent magnet synchronous machines,” *Proceedings of the IEEE Energy Conversion Congress and Exposition, ECCE*, San Jose, CA, USA, **20**, 1098-âĂŞ1103 (2009).

[11] J.R. Stack, T.G. Habetlerand, R.G. Harley, “Fault-signature modeling and detection of inner-race bearing faults,” *IEEE Trans. Ind. Appl.*, **42**, 61-âĂŞ68 (2006).

[12] J.R. Stack, T.G. Habetlerand, R.G. Harley, “An amplitude modulation detector for fault diagnosis in rolling element bearing,” *IEEE Trans. Ind. Electron.*, **10**, 1097-âĂŞ1102, (2004).

[13] C. Bianchini, C. Immovilli, M. Cocconcelli, R. Rubini, A. Bellini, “Fault detection of linear bearings in brushless AC linear motors by vibration analysis,” *IEEE Trans. Ind. Electron.* **5**, 1684-âĂŞ1694 (2011).

References