Experimental Study and Failure Analysis of Speedometer Pointer

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Abstract*-This paper describes an ongoing effort to Develop mechanical speedometer instrumentation, The basic operating principles for odometers cup drag and axel alignment , The growing demands for high-quality products with improved specifications increase the requirements for condition monitoring and quality evaluation to ensure that no defective or below specification products to reach the customer. This paper presents a low-cost condition-monitoring system using acoustics to evaluate the quality of mechanically driven automotive speedometers during manufacture.*

Keywords*-*Automotive, speedometers, condition monitoring, Artificial Intelligence, Quality Control,Catia

I. INTRODUCTION

Competition among cars /two wheeler manufacturers and the increasing requirements of more comfortable modern cars has raised standards in terms of quality, reliability and performance. At the same time, the costs of today's cars are expected to be reduced due to the continuous drive of manufacturers for market share. In order to survive in such an environment, manufacturers need to develop sophisticated quality control and condition-monitoring systems in order to avoid any defective parts from reaching the consumer. The process of correcting faults once the car is assembled is time consuming and warranty rectifications after the vehicle has reached the customer are both expensive and damaging to a manufacturer's reputation. The background cabin noise in road vehicles has been continuously reducing due to improvements in suspension, noise vibration and harshness, upholstery and insulation. The point has been reached where some of the `carry-over' designs of speedometers from old models are now becoming too noisy to be used in modern vehicles without a proper condition-monitoring and quality control system during manufacture. One such design is the mechanical cable-driven speedometer. Despite its noise, it is still one of the popular and low cost subsystems in some sectors of the car industry.

However, these speedometers need to be tested before reaching the assembly line. Defective products have the potential to reach the final customer, which would damage the reputation of the company. Therefore, the main target is to have `zero defects' for the monitoring strategy to be successful. The suggested monitoring strategy is to examine whether the tested devices are `normal' or `defective' via the measurement of the noise level. When a speedometer is found to be defective, the type of fault is detected and the problem (if consistent) is fed back to the manufacturing process for improvement. The monitoring and inspection process could be performed by an operator. However, humans are often subjective and human errors could not be tolerated in a `zero-defect' manufacturing environment. An automated methodology which could include a `knowledge' database for quality control could also be implemented. The problems in using a human operator to perform the monitoring process can be summarized as follows:

(a) The variation in the hearing performance of different operators;
(b) The variation in an individual operator's hearing, during a shift and between shifts;
(c) back-ground noise in the factory which could mask the speedometer noise;
(d) The inherent tendency of an operator to make human errors.

An automated inspection system is proposed in this paper. By automating the monitoring process, it is possible to remove human error and thus to increase efficiency and confidence in the output quality. A process which could identify defective speedometers and categorize them into defect classes would give some valuable feedback for the quality control strategy. The types of defect are those which cause unacceptable noise in the product. Although this could result in speedometers with other types of defect that have no apparent noise emission, other monitoring systems could be integrated with the proposed system to cover such faults.

This paper reports a novel low-cost approach for automated monitoring system and inspection of automotive speedometers that can be performed in the factory to ensure non-defective products.

II. LITRATURE REVIEW

Jaeger/Smiths decided the first issue is to decide whether the speedometer itself is actually the cause of the problem. Some faults that are thought to be due to a malfunctioning speedometer are actually due to a problem with the cable running to the speedometer, or with the drive gear in the transmission. Frequently the cable itself is the cause of a wavering speedometer pointer. It is unfortunately somewhat difficult to service the cable. It must be prepared to get under the car and remove the cable from the transmission. However, it is sometimes possible to service the cable simply from the speedometer end. It need to remove the speedometer, then pull up some slack in the cable so the end of the cable is protruding slightly from the dash. Then you may pull out the wire cable from the outer sheath. Lubricate the cable with white lithium grease or gear oil and then slide the cable back into the sheath. As it get to the last couple of inches it need to slowly spin the cable as you insert it. This will allow the square end of the cable to seat in the square orifice in the transmission drive gear. If, after multiple attempts, it cannot get the cable to seat, then you will have to get under the car, and unscrew the cable from the transmission. Then press the cable fully in the sheath, and attach the speedometer. Then, back under the car, you must gently seat the cable into the drive on the transmission and screw it down securely. Test the speedometer with the newly lubricated cable. Test this before fully re-installing the speedometer in the dash. Other causes of a wavering speedometer needle lie inside the speedometer itself. binding of the input shaft cause wavering as it slows down, then breaks free and turns faster briefly. Binding can also occur between the shaft and the retaining flange. have also seen binding in the odometer wheels (particularly the “old” style) cause cyclic resistance against turning, resulting in wavering. There can also be a dirt or lack of lubrication in the needle bushing between the magnet wheel and the pointer spindle. Binding odometer wheels and needle bearings often will cause speedometer wavering that is proportional to road speed.

Repairs of the speedometer and odometer sub-sections can be made by exchange with intact/functional parts from other Smiths or Jaeger speedometers. Many parts will be a broad range of models and years. There are four main variations that of exchange. Within a specific type, parts seem to be . Old models have all metal for the worm gear and also have separately driven main and trip odometers. “Intermediate” has plastic odometer wheels, and the trip odometer wheels are more widely spaced. New models have mostly plastic construction and the trip odometer is driven by a gear from the main odometer, so there is only one worm and pawl. The spindle bearing in the magnet wheel is more shallowly set in the new type of speedometers.

Triumph seem to have had a slightly different variant speedometer than the MGs. The primary difference is that the spindle to which the pointer is attached is longer (. 180" vs.. 150") and has a somewhat narrower taper (.035 to .032 vs .035 to .030). This makes it less than optimal to move the works from an MG to a Triumph because the Triumph fits slightly loosely. The move of a Triumph works to an MG is even less possible due to the MG pointer being too tight to fit on the TR works. The diameter of the base of the short is approximately the same, so the longer one reaches a tip. It is possible to the MG to the Triumph length and thereby have the diameter correct for the pointer. Use a file or stone on a dremel tool to shorten the spindle by a 30 thousandths or, and try the pointer. If it will not slide on, there may be a burr on the tip, so use a fine file to chamfer the edge. Depending on the calibration required, the worm on the 20, 25It appears that 32 teeth were very commonly used on the “old” and “intermediate” versions, with 20 and 25 are also seen. 20 and 32 used on the “new” styles. There was a wide variety of gears used on the odometer wheels to the final calibration. The calibration of the odometer is the number of teeth on the worm by the number of teeth on the odometer wheel gear. This gives the number of input shaft turns for each odometer shaft turn. Of course parts are completely interchangeable between identical units, but many parts are carried across a broad range of, and will be completely interchangeable. For instance there are only two types of magnet wheels that I have identified. One type has a shallowly set spindle bearing, and the other is more deeply set, so the magnet wheel can be interchanged quite freely with a similar type from any source. The main speedometer frame is identical across all models as far as I can tell, and are completely interchangeable. In the “old” and “intermediate” units, the spindle/main odometer frames are interchangeable as long as the pointer fits. In the end, it is usually possible to obtain sufficient parts to repair speedometer without great difficulty or expense by visiting the tables of instruments at flea markets. KPH and MPH speedometers are essentially the same and parts exchange.

Al-Habaibeh and R M Parkin The research work is to develop a low-cost monitoring system for mechanically driven automotive speedometers that can be implemented on the shop floor of a manufacturing plant. By its nature, such an environment can be noisy and hence an automated monitoring system is needed. The selected set-up does not need to be compatible with a mass production Environment and with low cost so that it can be implemented easily. The sensor to be used does not need to be in direct contact with the speedometers to ease the testing process. Therefore, a microphone was selected to measure the noise level via sound waves. In order to reduce the background noise the experiments were screened in a sound booth. A Brueel and

Kjnr condenser microphone type 4165 was used for this test connected to a 16 bit mono computer sound card to capture the sound waves. Special software was used to capture the digitized signals and to save them to the hard disk for further analysis. A sampling rate of 25 000 samples/s was used to capture the signals. A total of 5020 samples/signal were acquired. A total of 24 different speedometers was used to test the system. These consist of four different groups of six. The four groups are good speedometers, speedometers lacking watch oil, speedometers lacking grease on the magnetic shaft and speedometers with out-of-tolerance bushes. Six consecutive signals were recorded for each speedometer to increase the confidence in the detection process. It has been empirically determined that the maximum noise from the speedometers occurs at wheel speed of 40 km/h. Therefore, it was decided to use this speed to test the health of the speedometers.

The training process for novelty detection was found to be slow and divergent when using the complete signals without the aid of signal-processing methods. This could be due to the limited number of training samples. Therefore, fast Fourier transform was used to extract the frequency information in the signals and a discrete cosine transform was used to simplify the data by reducing the number of samples. This made the features that characterize every type clearer. Figure 3 shows the effect of using a partial number of the coefficients to reconstruct the original frequency spectrum. It should be noted that less than 1 per cent of the samples was used to construct the same signal with sufficient detail. The novelty detection NETLAB software [was used to analyses the acquired signals. The response of the Gaussian kernels [see Fig. 2] is defined by a covariance matrix (a spherical matrix in this case) and a centre (i.e. the centroid of the input clusters). A single variance parameter for each Gaussian component was calculated using a different number of centres in the mixture model in order to select the most suitable structure based on the speed and the accuracy of results. This configuration implies that the model assumes that the input variables are all uncorrelated and independent, hence requiring only one variance parameter to be found for each Gaussian. More details have been described in reference [8]. Two healthy speedometers were used to define the `normal' conditions. Six samples of every speedometer were used to define the normality. The rest of the samples were used to evaluate the novelty detection algorithm and to select the number of kernels and the length of the input vectors. Figure 4 shows the results obtained for different numbers of kernels and different dimensions of vectors. The training Process for novelty detection was found to be slow and divergent for vectors that contain more than 140 elements. The logarithmic values are used to simplify the presentation of data. The x axis presents the length of the input vectors (i.e. number of samples). The y axis presents the difference between the minimum probability values of the normal data and the maximum probability values of the novel data. Therefore, the higher the difference, the more accurate the results are expected to be. It has been found that for all number of kernels the optimum number of length for the input data is between 20 and 30 inputs. Also the most accurate result is found for 12 kernels. The average results of the tested speedometers for the 25 inputs and 12 kernels are shown in Fig. 4. The maximum differenced, shown in Fig. 4, is presented as the y axis in Fig. 4. The threshold value can be selected to achieve the required type-I and type-II errors (i.e. the error of rejecting a normal speedometer and the error of accepting a faulty speedometer respectively). As shown in Fig. 4b, the sound signals fail to detect the oscillation in the pointer of the speedometers due to lack of watch oil. However, the other two faults are clearly below the threshold value. In most cases, it is necessary to have a large number of training samples in order to accurately construct the PDF of the normal case. However, the processing of the original signals has made the features that differentiate between every type of speedometer clearer and has thus reduced the required number of samples to construct the PDF. The extraction of six sound signals from each speedometer was found useful to characterize normal and faulty speedometers. Theoretically, the difference between the signals from the same class is the presence of uncorrelated independent noise. The experimental work conducted has proven that it is necessary to acquire more than one signal since the behaviour of the speedometer could change during rotation. This has become clearer when monitoring faulty speedometers with intermittent faults. The lack of watch oil which causes the pointer to oscillate could be detected using an optical or an image analysis system, but not via the methods discussed in this paper. The paper has presented a quality control problem which involves the monitoring of the noise level of mechanically driven automotive speedometers. A low cost system using sound waves has been shown to be effective in detecting the quality of the automotive speedometers. A frequency spectrum of signals combined with a data reduction approach using discrete cosine transformation was used to simplify the information contained in the signals. A novelty detection approach was utilized to detect noisy speedometers from normal speedometers. Oscillatory pointers in some speedometers caused by the lack of watch oil would need to be detected using a visual means such as image processing or other optical techniques. Future work will consist in comparing the results obtained in this research work with the application of a principal component analysis. The authors will also be reporting on the implementation of the suggested approach for detecting noise level combined with visual detection of oscillatory speedometers in the production line of a speedometer manufacturer.

III.METHODOLOGY

1. Finding the root cause of the problem, design and check all parts
2. Comparing with existing speedometer
3. Material property and finding manufacturing defects
4. Bench marking and Calibration
5. Analysis of design

IV. EXPERIEMENTAL SET UP

Fig:1 Experimental set up Speedometer

SR NO.	INDICATION SPEED INKM/ hr	INPUT RPM	TOLERANCE IN Km/Hr		ACTUAL OBSERVED SPEED		RESULT
			MIN.	MAX.	BEFORE TEST	AFTER TEST	
1	20	467	20.0	22.5	21	21	Accepted
2	40	934	41.0	45.0	43	43	Accepted
3	60	1400	62.5	67.5	64	65	Accepted
4	80	1868	84.0	90.0	86	87	Accepted
5	100	2333	105.5	112.5	108	109	Accepted

Fig:2 test Images of Speedometer

Fig:3 After test Images of Speedometer

Table: Test Parameter

Test Parameters	Conditions
Temperature, oC	Room temperature
Voltage, V	8 V to 16 V, 15 V for 12 V, 28 V for 24 V systems
Speed, *km/h*	80 percent fun-range
Frequency, cycles/minute (Hz)	1 500-2000 [10-55-10 (Hz)]
Vertical acceleration, g	4·4 (peak to peak)
Time. H	1 h in each axis
Frequency, cycles/min (Hz)	1 500-2 000 (10-55-10)
Longitudinal acceleration, g	4·4 (peak to peak)
Time; h	2
Frequency, cycles/min (Hz)	Resonance 4·4 (peak to peak)
Time, h	0·5

Table: Pointer Response time at ambient temperature 23+/-2 Deg. C:-

PARAMETERS	SPEICFICATION	ACTUAL OBSERVED TIME (SEC.)		RESULT
		BEFORE TEST	AFTER	
Pointer Response Time	From 95% of Max. Scale to 0% of Max. Scale within 0.5 to 5 Seconds	2.18	2.13	Accepted

Table: Observation result

SR. NO	PARAMETER	ACTUAL OBSERVATIONS	REMARKS
1	Indication Change of Speedometer	Observed less than +5/-3 %	Accepted
2	No unusual vibrating sound from Case/Dial/Pointer	Not observed	Accepted
3	Pointer Deflection of speedometer	Observed less than 2 Km/h	Accepted
4	Mechanical Odo meter	Odometer operation observed smoothly & no remarkable vibration observed	Accepted

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