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DEVELOPMENT OF WHOLE BODY VIBRATION MEASUREMENT SYSTEM USING INTEL CURIE

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Abstract— ***The general reason with this ace proposal is to anchor a superior inclination and maintain a strategic distance from back pain problems in truck drivers with regard to vibration comfort properties amid motor begin, stop and moving in various terrains. Work-related musculoskeletal disorders (WMSDs) are a group of painful disorders of tendons, muscles and nerves. Carpal tunnel syndrome, tendonitis, and tension neck syndrome. Among business related musculoskeletal problems, low back pain (LBP) is the most common among drivers driving for 8-10 hour daily which is further extended to 10-12 hour sometimes. Lower back is the area regularly influenced because of sitting on the seat for long hours and being subjected to mechanical vibrations coming out of the engine and depending upon the type of road. There has been constrained research to decide the variables influencing WBV. Along these lines, the reason for this examination was to portray WBV exposures amid consistent truck driving (8-12 hours) and decide if there are any factors such as type of truck, road conditions, BMI and operating conditions such as idling condition when the engine is on but truck is not moving and many more, which may influence WBV exposures.***

Keywords— Musculoskeletal Disorder, Back Pain, Whole Body Vibration, Low Back Pain, Truck Driver

INTRODUCTION

Whole-body vibration (WBV) is transmitted through the seat or feet of employees who drive mobile machines, or other work vehicles, over rough and uneven surfaces as a main part of their job. Large shocks and jolts may cause health risks including back-pain. Drivers of some mobile machines, including certain tractors, fork lift trucks and quarrying or earth moving machinery, may be exposed to WBV and shocks, which are associated with back pain. Other work factors, such as posture and heavy lifting, are also known to contribute to back problems for drivers.

Studies have shown that WBV elevates spinal load (i.e., static pressure on the soft tissues that can lead to discomfort), causes muscle fatigue, and is linked to the thinning of the intervertebral discs and subsequent disc herniation. Given that pain can increase fatigue, both directly and indirectly, by reducing sleep quality and duration and by exacerbating muscle exertion, WBV may be an important, understudied risk factor for driver fatigue, however further study is needed into the impact of WBV. A number of studies for whole body vibration (WBV) have been proposed by researchers for analysis and evaluation of the impact of WBV on human body. The review of such works has been presented in this section.

Eger et.al in predicted health risks, associated with the operation of load-haul-dump (LHD) vehicles, based on ISO 2631-1 criteria are limited and have not yet been determined according to ISO 2631-5 criteria. Therefore, health risks predicted by ISO 2631-1 and 2631-5 criteria are reported and compared in this paper. Whole-body vibration (WBV) exposure was measured according to procedures established in ISO 2631-1. A tri-axial seat pad accelerometer was used to measure vibration exposure at the operator/seat interface. According to ISO 2631-1 criteria, calculated 8-h equivalent vibration dose values placed three of the seven LHD operators above the health guidance caution zone (HGCZ) boundaries and four LHD operators within the HGCZ. However, health risks predicted by the ISO 2631-5 criteria were always lower than the risks predicted by ISO 2631-1 criteria

Eger et.al in presented a study to measure WBV exposure levels at the vehicle seat interface and the operator seat interface, during the operation of both small and larger LHD vehicles. Results were compared to the ISO 2631-1 health guidance caution zones to determine safe exposure durations. Preliminary test results indicated that LHD operators were exposed to whole-body vibration levels putting them at risk for injury. ISO 2631-1 exposure guidelines for the health caution zone were exceeded during the operation of several different vehicles. Some seats were also found to amplify the vibration signal resulting in a reduction in the recommended exposure duration

Marin et.al in characterized whole-body vibration exposures in a set of vehicles that operate in open-pit mines and compared three different daily exposure parameters based on the ISO 2631-1:1997 and ISO 2631–5:2004 standards. Full-shift, 6 to 12-hour, continuous whole-body vibration measurements were collected from 11 representative types of vehicles in terms of hours of operation and number of vehicles used. For each type of vehicle, the exposure parameters A(8), VDV(8), and Sed(8) were calculated for each axis (x, y, and z), and in addition, shear or horizontal (∑xyz) and vector sum (∑xyz) whole-body vibration exposure. Findings showed that: (i)substantially higher shear and vector sum whole-body vibration exposures indicated relatively high levels of exposure on the non-predominant axis;(ii) the predominant axis of exposure varied across the different type of vehicles; (iii)there were differences in whole-body vibration exposure parameters regarding the standards-based predictions of potentially adverse health outcomes (the impulsive exposure parameters VDV(8) and Sed(8) were higher and reduced acceptable vehicle operation times by one-half to two-thirds relative to A(8) exposures); and (iv) based on the predominant exposures and the time to reach daily vibration action limits, the operation of most mining vehicles would be limited to less than 8 hours a day. Differences in whole-body vibration exposure parameters impact the prediction of potentially adverse health outcomes and may introduce some uncertainty regarding how to best characterize a vehicle operator‘s actual exposure.

Ozkaya et.al in proposed to measure mechanical vibrations transmitted to the seated train operators, to calculate daily whole-body vibration exposure levels, and to compare these levels with maximum acceptable exposure levels recommended by the international standard on whole-body vibration (ISO 2631). The study also sought to identify factors that may influence mechanical vibrations transmitted to the operators and quantify their effects on the measured vibration levels. The study was carried out by dividing the subway system into subway lines, each line into southbound and northbound directions, and each direction into station-to-station observations. Tri axial measurements were made on all subway lines and for all car types used in the system. For each line, at least two round trips of data were collected. Time-weighted averages of the two sets of data were used for final presentation. A total of 48 round trips were made and more than 100 hours of vibration data was collected and analysed. All phases of the study were carried out in accordance with the procedures outlined in ISO 2631. It was determined that 6 out of 20 subway lines had vibration levels higher than daily exposure limits recommended by ISO 2631. It was also determined that train speed was the most significant factor influencing vibration exposure levels..

The problem of whole body vibration can cause serious damage to the health of the individuals who are subjected to it for long hours. Long duration Truck driving can cause this problem to rise, making the drivers more vulnerable to it. Poor conditions of vehicles or sometimes poor condition of roads can be a major cause for many health issues like lower back pain, knee joint pain, neck problems and other problems with a particular part of the body etc. The quality and support for the seats of the trucks is secondary to the quality of light transport vehicles. The problem of whole body vibrations has been considered a serious health threat to the drivers of the trucks who are exposed to these whole body vibrations through their feet and their buttocks. This problem can cause discomfort and blur vision as short-term ailments and some permanent body part damage as a long term or chronic problem

Objectives of proposed research work

1. To study the existing system of WBV analysis.
2. To modify the system using wireless technology for taking accelerometer readings.
3. To analyse the results with different models of trucks.
4. To analyse the results in different terrains.
5. To compare and analyse the results on the basis of age, weight, BMI, exposure, terrain, operating conditions.

Methodology

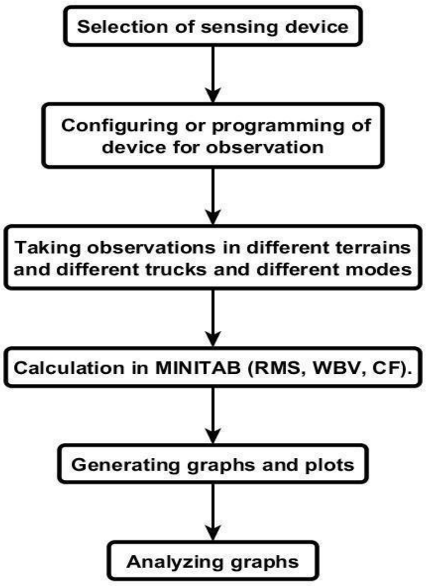

Figure 1. Methodology

Step 1: Select the Controller

A learning and development board Arduino 101 that delivers the performance and low-power consumption of the Intel Curie Module with the simplicity of Arduino. It keeps the same robust form factor and peripheral list of the UNO with the addition of onboard Bluetooth LE capabilities and a 6-axis accelerometer/gyro to help easily expand the creativity into the connected world.

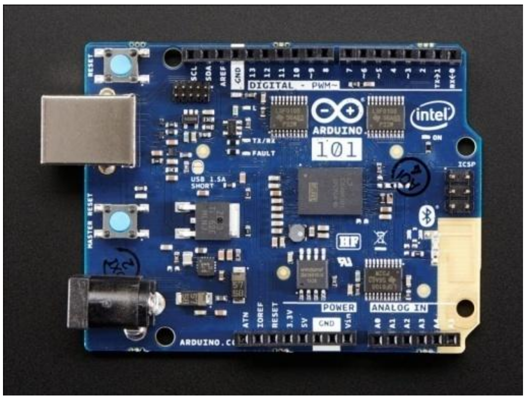

Fig.1 Arduino 101

Step 2: Develop the sketch in Arduino IDE using inbuilt libraries.

The Arduino Integrated Development Environment or Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them

Step 3: Upload the sketch in the device and run it, this will initiate the accelerometer and bluetooth of the device.

Step 4: Place the device at the point of interest (POI) that is at the connecting interface between human body and the driver seat

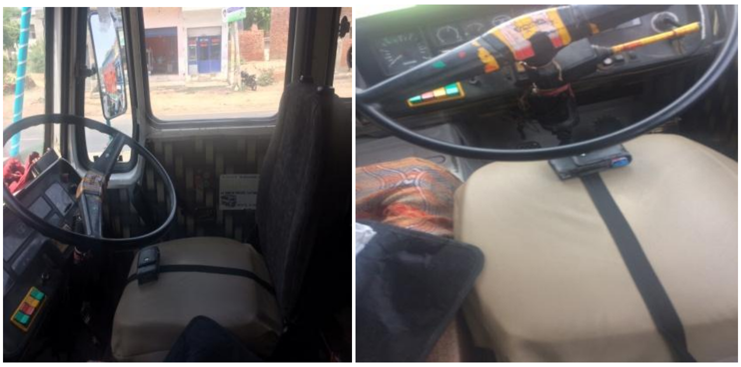

Fig.2 Placement of Device at POI

Step 5: Use a 9v Battery or any power bank to give power to the device and connect the device with phone to take vibration data.

Step 6: Collect vibration data of different models by running the sketch uploaded in the arduino 101. The sketch will initiate the bluetooth and accelerometer and connect it with NRF connect app to collect data. Collect the the data in different terrains i.e. Off road, Highway and Mountaineous

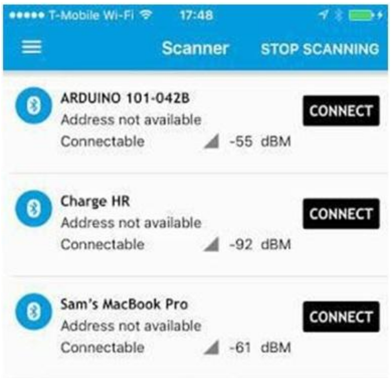

Fig.3 NRF connect

Step 7: Analyse using Minitab

MiniTab is a software product that helps you to analyse the data. This is designed essentially for the Six Sigma professionals. It provides a simple, effective way to input the statistical data, manipulate that data, identify trends and patterns, and then extrapolate answers to the current issues. RMS, VDV, Crest Factor, BMI, P values were calculated using minitab.

Results

Total 75 number of drivers are selected for analysis purpose whose average weight, height, experience are shown in table with effective time of WBV measures.

Table 1: Average age, height, weight, experience of drivers

Type of Truck	TATA	Ashok Leyland	EICHER
No. of drivers	25	25	25
Age	41.5	51.1	35.6
Height	5'63	5'71	5'69
Weight	78.26	81.56	74.23
Experience	12	13	9
Period	400 effective minutes	400 effective minutes	400 effective minutes

The table above shows the average value of age, weight, height and experience of drivers(in years) and 400 effective minutes of each driver were taken.

Daily Eight Hour Exposure

Table 2: Resulting values of A(8) and VDV for different trucks

Condition	Truck	RMS (m/s^2)			VDV ($m/s^{1.75}$)			Crest Factor			A(8)	VDV
		X	Y	Z	X	Y	Z	X	Y	Z	(m/s^2)	($m/s^{1.75}$)
Idling	TATA	0.21	0.23	0.24	2.54	2.56	2.18	4.59	6.53	2.9	0.45	4.56
	ASHOK LEYLAND	0.25	0.19	0.18	3.01	2.72	1.85	2.45	3.25	4.01	0.56	4.23
	EICHER	0.29	0.31	0.27	2.76	2.62	1.69	1.56	1.39	4.58	0.36	4.96
	P value	0.061	0.006	0.003	0.003	0.004	0.026	0.001	0.001	0.003	0.08	0.011
Driving	TATA	0.25	0.52	0.68	2.13	2.62	4.56	6.89	7.45	2.85	0.59	4.46
	ASHOK LEYLAND	0.45	0.61	0.78	3.52	2.73	5.89	7.85	7.89	4.45	0.89	4.74
	EICHER	0.61	0.71	0.81	2.85	2.85	6.10	7.99	8.61	4.59	0.52	4.25
	P value	0.045	0.00	0.001	0.003	0.003	0.023	0.001	0.002	0.003	0.08	0.011

In Table 2.2 it can be observed that in Idling state VDV for Eicher is greatest among other trucks Eicher produces more vibrations in idling state that is engine on and no movement. Though the value is under the European Limits for both Eicher and TATA but Ashok Leyland A(8) value is above European Limits that is action must be taken. Ashok Leyland produces the least vibrations in idling state (VDV is least) but in driving state Ashok Leyland produces more vibrations than TATA and Eicher.

WBV value in different terrains

On analysing the data for each driver in different terrains and different operating conditions the following graphs were plotted.

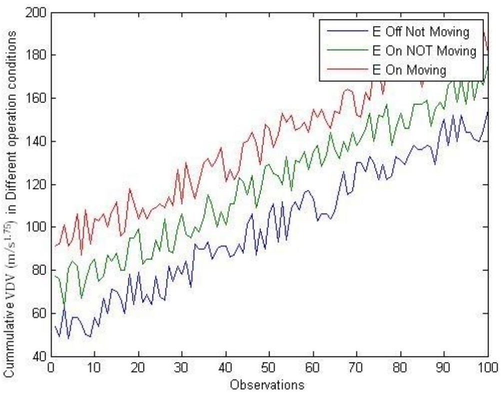

Fig.4 Comparison between operating conditions

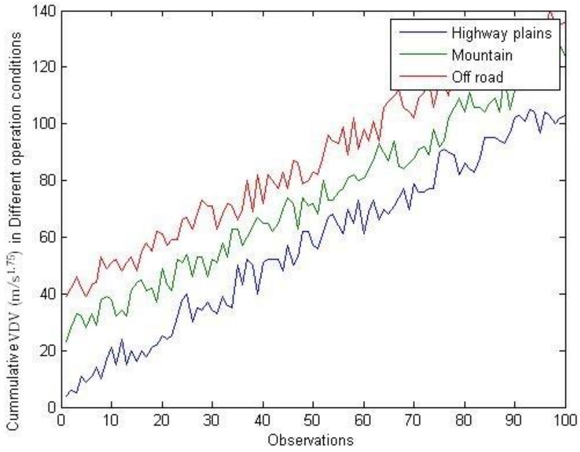

Fig.5 Comparison of Road Terrains

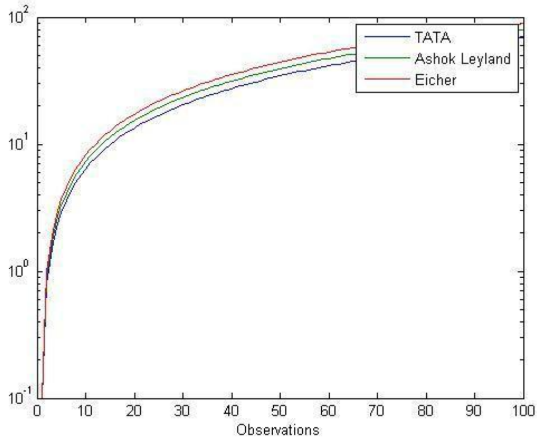

Fig.6 Comparison of vibration values of each truck

CONCLUSIONS

From the study a conclusion of mainly three points can be drawn.

1.The different types of trucks show different WBV values of which the drivers are affected. Values of WBV can be seen in the all three types out of which the TATA trucks seen to produce a bit less vibrations than the Ashok Leyland and Eicher..

2.The different terrains also show the variations in WBV and it can be seen that off Road driving produces more vibrations than the highway and mountain terrain.

3.The different operating conditions in terms of engine on or off also show effects in WBV and put some analysis forward. It was observed that the engine running in a moving truck produces more vibartions than other conditions.

In general the purpose of the research was to develop a portable system to evaluate whole body vibration system. Using an IOT device also shows future prospects of real time analysis. We can say the experiment performed coincide the interview of the drivers taken. The problem they face with reason of them which give lower back pain as the main problem faced by them and other problem which they face are pain in thighs, feet and shoulders.

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