

DATA MANAGEMENT SYSTEM FOR MONITORING THE WORKING ENVIRONMENT OF NONCONVENTIONAL EQUIPMENT

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ABSTRACT. Protection against data loss is one of the key objectives in ensuring the optimal functionality of processing equipment through unconventional technologies, such environments differ from a consumer, because multipolar restrictions on the type of equipment, its connections throughout the unit will generally have higher requirements. Data loss protection is one of the key objectives in securing the optimal functionality of such an industrial environment, such environments differ from a consumer one as multipole restrictions regarding the type of equipment, its connections throughout the facility will have generally higher requirements. These advanced features come with additional costs regarding the equipment prices, in most cases, a specialized industrial grade storage solution can be avoided by using a centralized data storage location, however, in the case of equipment that is out of the reach of a network interface, or the permanent network access is considered a risk this solution will not be feasible. The current paper presents a solution to avoid the cost of industrial-grade storage solutions by measuring the environmental conditions in which the equipment is installed and comparing it to a maximal threshold for which a nonindustrial grade solution is still applicable. The prototype design of an HW-SW combo application is presented that is capable of recording values for temperature, humidity, and vibrations and compare it to a database of storage mediums based on the environmental factors thus providing a tool for optimizing the cost it the deployment scenario permits it.

KEYWORDS: storage data protection, system, disk, temperature, humidity, environment monitoring, nonconventional equipment

1. INTRODUCTION

In most cases, the equipment that serves the application of nonconventional technologies, requires a guarantee on the maintenance of some parameter's characteristic of the working environment in well-specified parameters. In general, industrial environments feature increased requirements for the equipment being used, for example, machines deployed in a production facility might generate a considerable level of vibrations that disrupt the proper functioning of a storage medium. The effects of vibrations on HDD-based storage solutions are presented in: “Everything you need to know about hard drive vibration” [1]. Two additional factors are considered, the ones related to temperature and humidity while those are generally controlled through the climate control system of the industrial site in certain circumstances their control will not be possible for example in case a thermal process is involved like smelting or similar. The effects of these factors are described in: “How Will Humidity Damage Hard Disk Drive” [2]. While industrial-grade storage solutions exist and are advertised as such *Endurastar Series* [3], *Toshiba MK2060GSC*, *MK1060GSC* [4], *Exos E Series Hard Drives* [5] the cost offset might be compared to consumer-grade solutions, *WD Red Pro NAS Hard Drive* [6], *BarraCuda Hard Drive* [7], *Hitachi Deskstar 0F10381* [8]. In case a considerable amount of storage mediums is required for example in the case of a RAID configuration this cost is multiplied for each additional equipment thus generating an increased initial investment

together with the replacement cost at the end of the equipment lifecycle.

2 SOLUTION PRESENTATION

A. General description

The solution is based on the a priori knowledge of the environment, this allows to finetune the equipment being used. While a planning stage will for sure be required the solution features valuable information that can assist in the proper cost optimization, furthermore the solution can stay in place during the initial ramp-up of the production facility and beyond in case there is a shift in values that can have an impact in the proper functionality.

B. Temperature and humidity profiles for industrial environments

The design of climate change adaptation policy requires understanding the mechanisms responsible for these temperature-driven output losses. If they are due to costly factor reallocation, adaptation investments should focus on lowering factor adjustment costs. If they are due to direct productivity effects, investments should prioritize reducing the sensitivity of productivity to temperature. Specifically, we estimate the effects of temperature on manufacturing activity using plausibly exogenous year-to-year variation in a firm's exposure to the annual distribution of daily temperatures [9].

C. Vibration profiles

Hdd description	Normal vibration profile	Abnormal vibration profile
Seagate [10]	Vibration (5 to 500 Hz, Gs)	Vibration (501 to 900 Hz, Gs)
Western Digital [11]	Vibration (G RMS, 2 to 200Hz)	Vibration (G RMS, 201 to 600Hz)
Toshiba [12]	7.35 m/s ² (0.75 G) (5 to 300 Hz)	2.45 m/s ² (0.25 G) (300 to 500 Hz)

3. MEASUREMENT AND REPORTING

A. Embedded measurement system

For the prototype measurement device, a two-sensor the solution is used connected to a microcontroller development board to read the sensor data and forward it to the reporting application. At this stage, the reporting is done using a USB interface but for a production-grade measurement system, other solutions are more suitable like a Bluetooth or a Wi-Fi interface for the solution to be deployed more easily.

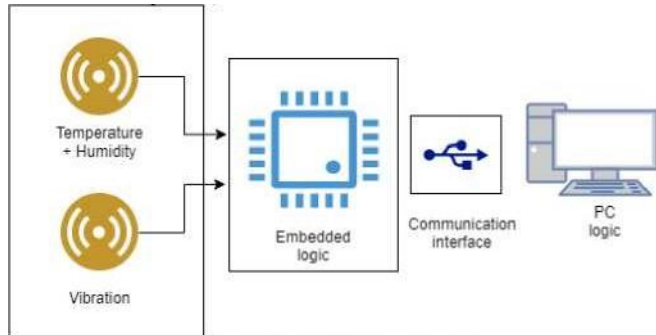


Figure 1. General diagram

In the general diagram of the prototype set-up presented in figure 1, the main features are separated into the following blocks:

1. Sensor block featuring the Temperature/Humidity sensor together with the vibration sensor.
2. The microcontroller block handling the embedded application logic
3. The reporting interface (currently USB with the possibility of extension)
4. The reporting target (currently in the form of a desktop PC with the monitoring application running)

The materials used are DH11 is a low-cost digital temperature and humidity sensor. It incorporates a capacitive humidity sensor and a thermistor to measure the surrounding air and gives a digital signal on the data pin. Although the sensors are more targeted towards a hobbyist sector for the range of values for which the measurement is being made, they are a viable option for a proof of concept at this stage, in future embodiments, and for a commercially viable solution a dedicated design needs to be created to consider factors like miniaturization, the protection against the environmental conditions measured and a communication method that can easily extend to

multiple measurement solutions. It is using 3 V to 5V power and I/O, the 2.5mA max current use during conversion [13]. A vibration sensor is a device that measures the amount and frequency of vibration in a given system, machine, or piece of equipment. Those measurements can be used to detect imbalances or other issues in the asset and predict future breakdowns [14]. The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino. cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts [15].

B. Desktop application

The developed SW features the following characteristics:

- a. It can communicate with the measurement device
- b. It can store the data acquired for the necessary analysis
- c. It can search an internal dataset with suitable components to indicate deployment

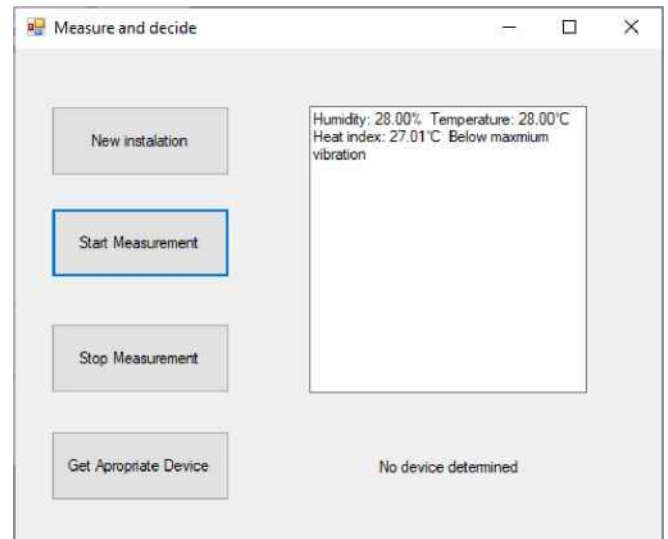


Figure.2. Desktop application

The photochemical machining process can be divided into four main stages: the photo-tool manufacturing, the cleaned metal coated with photoresist, the photoresist processing and the etching process [4]. As shown in fig.2, the photo-tool manufacturing and the photoresist coating can be carried out at the same time.

From an embedded target point of view, the subsystem will verify the connection to the reporting component in case the connection is visible to the measurement device, it will load configuration parameters specific to the measurement process (the most important being the measurement interval for

the sensor data) once a complete frame is acquired the data is transmitted to the reporting side for further processing. The flow is presented as a sequence diagram in figure 3

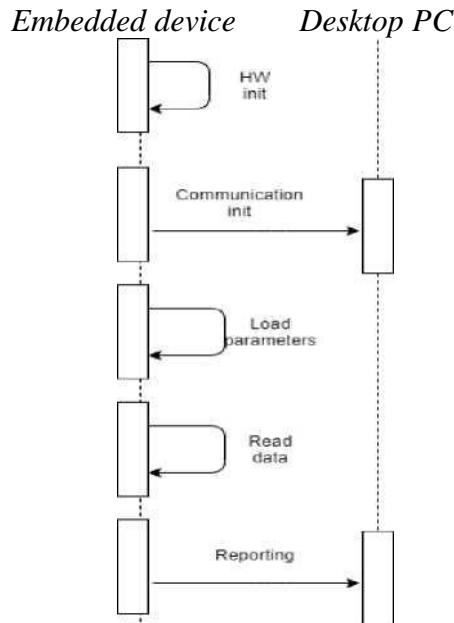


Figure 3. Sequence diagram

The desktop application upon start-up offers the option of starting a new measurement or stopping a measurement of an installed device, thus enabling the communication with the embedded target. Once the appropriate amount of data was gathered a recommendation is made. The minimal data amount is increased or decreased based on the maximal value deviations in the sense that no major variation is given for a tuned period the recommendation will be made to the user.

4. SYSTEM OPERATION

The motherboard based on Arduino UNO communicates with temperature sensor and vibration sensor on serial port and transmits to the computer via USB the information.

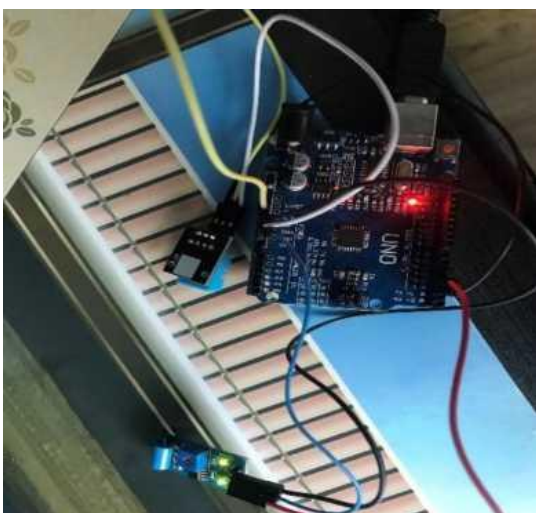


Figure 4. Hardware board

The hard disk connected to the computer is analyzed and then the information is sent to the computer from

Arduino via USB on the desktop application. The tests were performed under normal environmental conditions to determine the operation of the system, to simulate extreme conditions methods were used to generate external stimuli.

The history is reported inside an Excel file

Maximum Humidity	Maximum Temperature	Maximum Vibration
29.00%	28.00°C	Below maximum vibration
29.00%	28.00°C	Below maximum vibration
19.00%	23.00°C	Below maximum vibration
19.00%	23.00°C	Below maximum vibration
33.00%	32.00°C	Maximum vibration reached
33.00%	32.00°C	Maximum vibration reached
32.00%	31.00°C	Maximum vibration reached

An *sQLite* database was created with the appropriate characteristics was created for the application to pool for the suitable device.

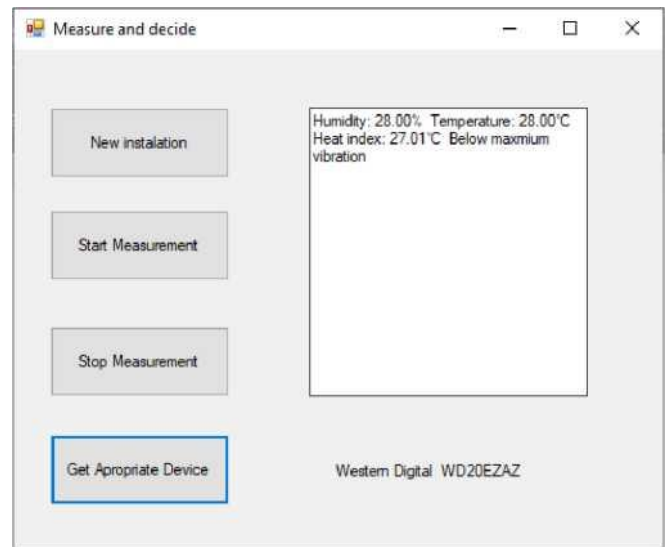


Figure 5.

5. CONCLUSIONS

The presented solution solves the technical aspects of data protection registered regarding the monitoring of the environmental conditions in which the equipment that serves the unconventional technologies works, with the possibility of extension to other industrial fields. At the same time, this is a cost optimization option without compromising data integrity for storage solutions that need to be in a location with potentially extreme conditions. The presented concepts can be used for the subsequent monitoring of the environment, so that, in case of variations of conditions, to change the equipment with an optimal one. The current solution has the prototype stage both in terms of hardware and software subsystem for its industrialization, being necessary hardware equipment that has a higher tolerance to environmental factors. In order to assure a calibrate system for industrial use, sensor calibration either on the sensor manufacture site or in the production site

needs to be assured. For data integrity a multi sensor approach can be used or a sensor model that's supports a protocol level verification for the measurement errors. In order to assure the transmission of data to the end user, a backend-based

solution would need to be deployed in order to send a notification either on browser side or a specific mobile app. For usage on industrial environments IE62061 should provide a guideline for component selection.

REFERENCES

- [1] "Everything you need to know about hard drive vibration – Electronic Products & Technology," Electronic Products & Technology, 2018. [Online]. Available: <https://www.ept.ca/features/everything-need-know-hard-drive-vibration/>. [Accessed: 18-May-2021]
- [2] AuthorCCW, "How Will Humidity Damage Hard Disk Drive (HDD)?," Data Recovery Blog, 03-Apr-2018. [Online]. Available: <https://www.datanumen.com/blogs/how-will-humidity-damage-hard-disk-drive-hdd/>. [Accessed: 19-May-2021]
- [3] "Endurastar Series," Western Digital, 2021. [Online]. Available: <https://www.westerndigital.com/products/internal-drives/endurastar-series-hdd>. [Accessed: 3-Jun-2021]
- [4] Toshiba Storage Device Division, "Toshiba Introduces Highest-Capacity Automotive-Grade HDD to Support Demand for Advanced In-Vehicle Storage," Prnewswire.com, 14-Apr-2010. [Online]. Available: <https://www.prnewswire.com/news-releases/toshiba-introduces-highest-capacity-automotive-grade-hdd-to-support-demand-for-advanced-in-vehicle-storage-90899189.html>. [Accessed: 3-Jun-2021]
- [5] "Exos E Series Hard Drives | Seagate UK," Seagate.com, 2020. [Online]. Available: <https://www.seagate.com/gb/en/products/enterprise-drives/exos-e/>. [Accessed: 10-Jun-2021]
- [6] "WD Red Pro NAS Hard Drive | Western Digital Store," Western Digital Store, 2021. [Online]. Available: <https://shop.westerndigital.com/products/internal-drives/wd-red-pro-sata-hdd#WD2002FFSX>. [Accessed: 10-Jun-2021]
- [7] "BarraCuda and BarraCuda Pro Internal Hard Drives | Seagate UK," Seagate.com, 2021. [Online]. Available: <https://www.seagate.com/gb/en/internal-hard-drives/hdd/barracuda/#specs-3-5>. [Accessed: 10-Jun-2021]
- [8] DiscTech, "Hitachi Deskstar 7K1000.C 0F10381/ HDS721050CLA362 500GB 3Gbps 7.2K SATA Hard Disk Drive," Disctech.com, 2021. [Online]. Available: <https://www.disctech.com/Hitachi-Deskstar-0F10381-500GB-SATA-Hard-Disk-Drive>. [Accessed: 10-Jun-2021]
- [9] "Toshiba - Internal Hard Drives - N300," EMEA Region - Toshiba Storage Solutions, 2017. [Online]. Available: <https://www.toshiba-storage.com/products/toshiba-internal-hard-drives-n300/>. [Accessed: 6-Jun-2021]
- [10] "SkyHawk Surveillance Hard Drives | Seagate UK," Seagate.com, 2021. [Online]. Available: <https://www.seagate.com/gb/en/products/surveillance-drives/skyhawk-hard-drive/>. [Accessed: 6-Jun-2021]
- [11] "Driving Up Capacity and Driving Down TCO for Cloud and Enterprise Data Centers," [Online]. Available: <https://documents.westerndigital.com/content/dam/doc-library/en-us/assets/public/westerndigital/product/data-center-drives/ultrastar-dc-hc500-series/data-sheet-ultrastar-dc-hc530.pdf>. [Accessed: 6-Jun-2021]
- [12] "Toshiba - Internal Hard Drives - N300," EMEA Region - Toshiba Storage Solutions, 2017. [Online]. Available: <https://www.toshiba-storage.com/products/toshiba-internal-hard-drives-n300/>. [Accessed: 12-Jun-2021]
- [13] "Modul senzor vibratie - ARDUSHOP," ARDUSHOP, 2021. [Online]. Available: https://ardushop.ro/ro/home/124-modul-senzor-vibratie.html?gclid=CjwKCAjwzMeFBhBwEiwAzwS8zMpg8THDm nVqolbavBu-j KB-QcATzWVcE6U s14Cz-dxL_caoXcaG9RoCTKUQAvD_BwE. [Accessed: 21-May-2021]
- [14] "What Is a Vibration Sensor?," onupkeep, 2021. [Online]. Available: <https://www.onupkeep.com/maintenance-glossary/vibration-sensor>. [Accessed: 29-May-2021]
- [15] Wikipedia Contributors, "Arduino Uno," Wikipedia, 11-May-2021. [Online]. Available: https://en.wikipedia.org/wiki/Arduino_Uno. [Accessed: 21-May-2021].