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Predictive Maintenance of Compressor Using Thingspeak IOT Platform

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Abstract
Any instrument or machine that needs to be monitored and inspected on a regular basis to ensure its long life and proper maintenance. Machine condition monitoring in the time and frequency domain is unquestionably required to ensure reliability. Condition monitoring is a method of observing a machine's condition parameter (vibration, temperature and etc.), with the explicit objective of detecting a substantial change that could indicate the onset of a malfunction It's an important part of compressor predictive maintenance and lowering compressor downtime. In today's world, the Internet of Things (IoT) is the most effective approach and technology for continuously monitoring the state of any machine. We've employed MEMS sensors to detect misalignment, non-linearity, and other anomalies., Through the Wi-Fi module ESP8266, vibrations and temperature in compressors, as well as changes in signals, will be communicated to the cloud. These signals are in order in the temporal domain. The Fast Fourier transform is used to examine and convert the time domain sequence into the frequency domain.

Keywords: Portable Reciprocating Air Compressor, Micro Electro Mechanical Systems (MEMS), ESP8266 WIFI Module, Vibration SENSOR.

Introduction

A compressor is a mechanical device that compresses air from a lower pressure to a greater pressure, which is used to power machinery such as turbines and generators. Compressors are used in a variety of sectors and for a variety of purposes. The safe asset-saving work of dangerous generation apparatus, particularly responsive compressors, is inexplicable without regular monitoring of their well-being. Vibration inquiry is one of the most widely used techniques. A wide range of procedures for preparing vibration signals have been presented, and they have been demonstrated to confine condition monitoring and diagnostics of different kinds of equipment [1]. Vibration [2] is the key parameter that serves to adequately and precisely measure the status of hardware basic characteristics. The most common cause of vibration in turning apparatus is rotor imbalance. Unreasonable unbalance can cause machine parts to wear out, as well as wear in the orientation or interior rubs, which can affect seals and degrade machine performance.

Condition monitoring has proven to be an effective method for lowering support costs and improving framework accessibility [3]. The assessment of the soundness of a framework and its segments is accomplished through the investigation and translation of signals obtained from sensors. The primary goal of condition monitoring is to detect the presence of hardware flaws at the earliest possible stage. It incorporates location, analysis, and guesses with the purpose of determining the machine's remaining safe working existence before breakdown or disappointment occurs. A successful checking and maintenance framework should be capable of inspecting a machine's functioning states, delivering advanced warnings of potential faults, and anticipating the lie traverse of a degraded machine segment before an aggregate breakdown. The framework's unchanging quality will be advanced if the correct condition is observed [4]. Major compressor failures [5].

Because compressors have a variety of headings, gears, and other mechanical parts, using excessive structures is often irrational and financially impractical, necessitating regular testing and diagnostics. The vibration signals were used as the primary source of data for the investigation because they are directly related to the compressor's operational condition. They can be used to identify problems before they do serious damage to the overall process or cause unplanned downtime. The vibration indicators can reveal information about deteriorating or insufficient orientation, mechanical detachment, as well as any worn or broken equipment Vibration testing can also detect misalignment or unbalance before these conditions lead to bearing or shaft failure [1]. Many process companies have learned that vibration-based condition checking is the most effective way to cut maintenance costs and stay away from unexpected production interruptions.

The main purpose of this article is to show the various flag handling methods and a PC application created for a compressor condition checking and blame forecast framework, using the MPU6050 sensor and Wi-Fi module, which includes temperature, vibration, and other processes.

Compressor and Data Acquisition System Brief Portrayal

Compressor

In petrochemical plants, compressors are essential equipment. Compressor malfunctions and breakdowns might result in a complete shutdown of the system, putting the company's finances in jeopardy. It's vital to keep an eye on their working conditions as they go about their day. A modernized checking and vibration data framework that takes into account the mechanical state of pivoting apparatus has been developed.

Figure 1: Portable Air Compressor Schematic Diagram.

The framework continuously monitors and measures a variety of framework elements (vibration, temperature, and other process parameters), providing essential data for early detection and identification of a hardware fault, such as unevenness, misalignment, shaft split, and bearing failures.

Data Gathering

Figure 3 depicts the basic setup of the information and procurement architecture.

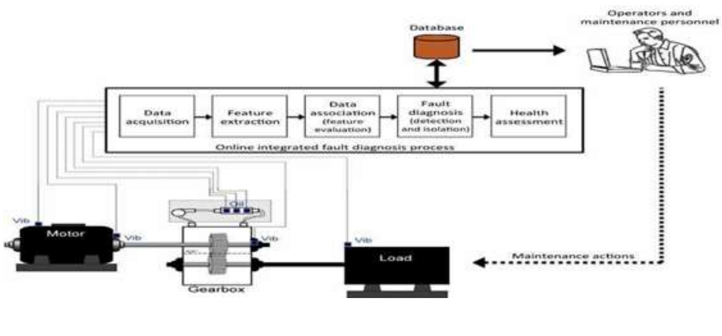

Figure 2: The Data Acquisition System's Configuration

The information that can be used to check the condition of a compressor includes of (1) vibration; (2) temperature.

The Objective

The main purpose of the project is to create a few flag handling methods and an Arduino application that will perform on-line, constant condition, monitoring, and fault diagnosis of the compressor using data from the mems sensor transmitted to the IOT checking framework. The following advancements have been made in order to achieve this goal:

- Create an Arduino program to communicate data from the mems sensor to the cloud.
- Use time domain signals from a mems sensor to predict upcoming failures and determine the optimum maintenance strategy.
- Those time domain signals were delivered to the Ubidots IOT platform Internet of Things by the Wi-Fi module ESP 8266.
- For the vibration and temperature [4] profile connected to different disappointment modes, convert those time domain signals to the frequency domain utilizing the Fast Fourier transform(FFT) to establish a learning base for itemized blame source conclusion.

Finally, from the frequency graphs, compare both ideal and fault signals for a variance of imbalance and temperature. So, if the signal reaches the peak value, we can pinpoint the location of the fault.

Vibration and Temperature Signals Are Measured with This Sensor

We utilized an IOT methodology because we needed continuous condition monitoring. For this project, we've chosen MEMS sensors. Sensor made of MEMS. Micro electro-mechanical systems (MEMS) are circuit boards that have accelerometers, gyroscopes, magnetometers, and thermometers printed on them. A 3-axis gyroscope and a 3-axis accelerometer are combined on a single silicon bite the dust, along with a locally available Digital Motion Processor, in the SW-420 devices. Figure 3 depicts the actual mem sensor.

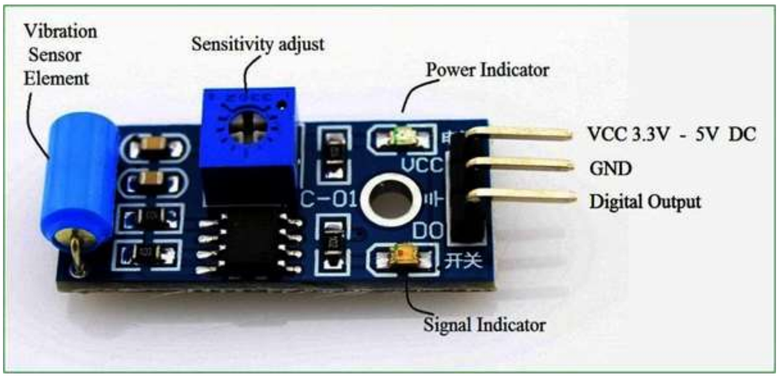

Figure 1: Vibration Sensor SW-420.

Communications from The Sensor to The Cloud

We utilized an ESP8266 as a Wi-Fi module in this project to send signals from MEMES to the cloud in order to display the results on a smartphone or laptop. WIFI (Wi-Fi) The ESP8266 is the most popular internet of things platform (IOT). The ESP8266 is a low-cost Wi-Fi microcontroller with a full TCP/IP stack and microcontroller functionality. It's a Shanghai-based Chinese manufacturer's product.

The ESP8266 Wi-Fi module can be used to send and receive data. Once everything is set up, you may start using it. It can function as both a client and an access point. It has the ability to handle numerous connections for sending and receiving data from several IP addresses [6].

SIGNAL ANALYSIS Is a Term Used to Describe the Process of Analysing Signals

Fourier transform in a hurry The signals produced by MEMS are analysed using FFT. The signals from MEMS will be relayed to the cloud over Wi-Fi, and the data from the cloud will be delivered to our smartphone or laptop. The data we receive will be in the time domain, which will be transformed to the frequency domain by an FFT analyser.

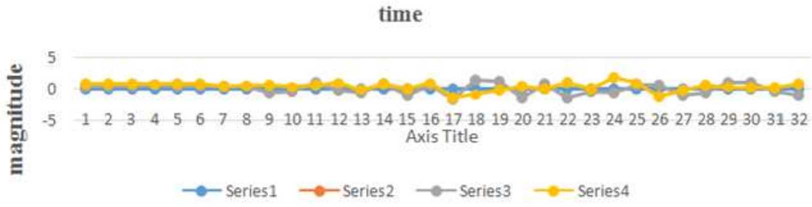

Figure 4: Displays Time Domain Signals from Mems which were Kept on the Motor without Load.

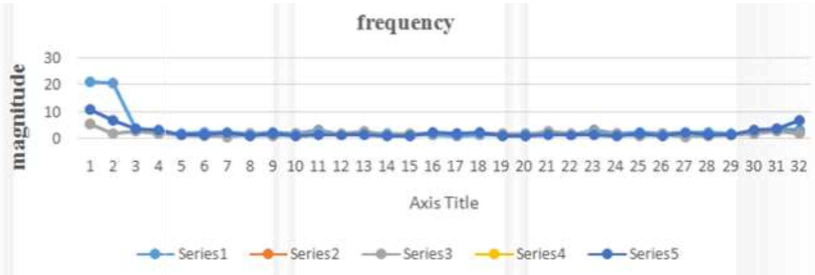

Figure 5: Displays Frequency Domain Signals Obtained from Fourier Transform of above Signal.

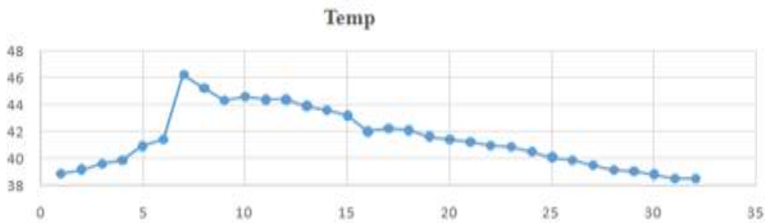

Figure 6: Displays Temperature Signals from Mems which were Kept on the Motor without Load

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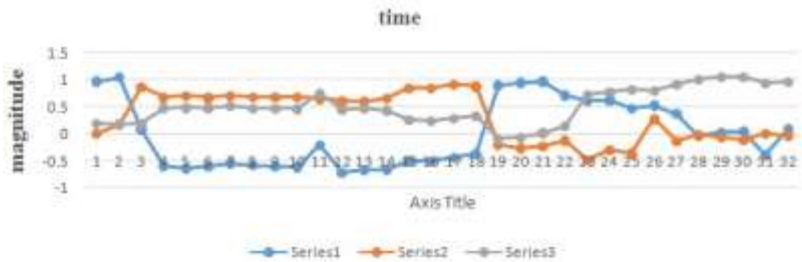

Figure 7: Displays Time Domain Signals from Mems which were kept on the Piston Cylinder without Load.

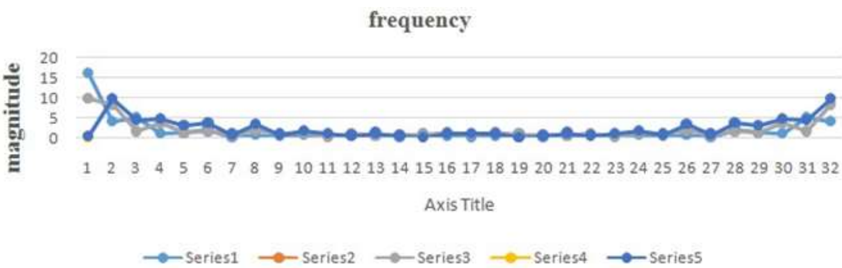

Figure 8: Displays Frequency Domain Signals Obtained from Fourier Transform of above Signal.

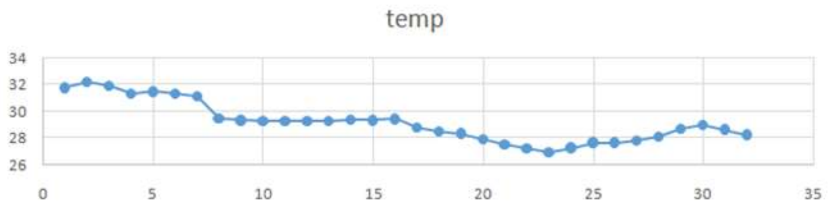

Figure 9: Displays Temperature Signals from Mems which were kept on the Piston Cylinder without Load

Processing of Data

The data obtained from the compressor via mems and other hardware is downloaded to the work area from the cloud and piled in the surpass expectations sheet. The data we obtained from the cloud is time-space related. As a result, perform the Fourier analysis while keeping in mind the underlying goal of shifting the data from time-space to the repeat region. A fast Fourier change (FFT) is a calculation that samples a flag across a given timeframe (or space) and divides it into its constituent recurring portions. These portions are single sinusoidal movements of varying frequencies, each with its own level of magnificence and stage. As seen in the diagram, the modification has occurred. The flag comprises three distinct transcendence frequencies across the time period studied.

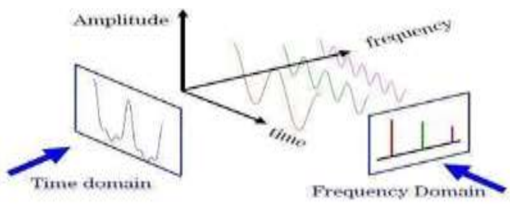

Figure 10: Displays Conversion of Time Domain to Frequency Domain

The capacity F(w) is the Fourier Transform (FT) of the capacity f (x).

$\infty = \infty$

The discrete Fourier change (DFT) of a progression, or its Inverse, is included in an FFT count (IFFT). The flag is transformed from its local area to a representation of the recurrence space via Fourier analysis, and vice versa. Because we can surely differentiate the most extreme recurrence esteem which signals the nearness of defects by looking at the recurrence esteems, it is critical to alter the time-space to a recurrence area.

Declaration and Results

When mems are established on the motor in Figure 5, Figure 6 shows recurrence space signals obtained by applying Fourier modifications to the time area flag. Because these signals are obtained when there is no load on the compressor, they are of higher quality than those obtained when the compressor is in the presence of a load, as shown in Figure 11.

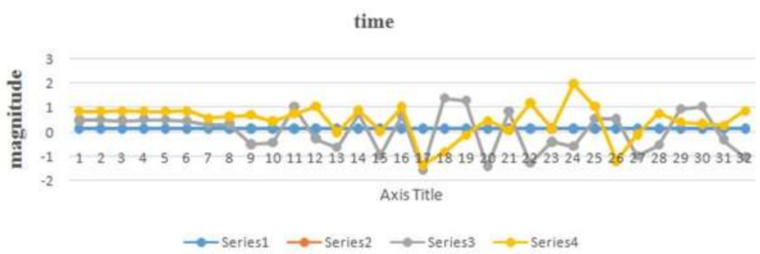

Figure 11: Displays Time Domain Signals from Mems that were held on a Load Motor

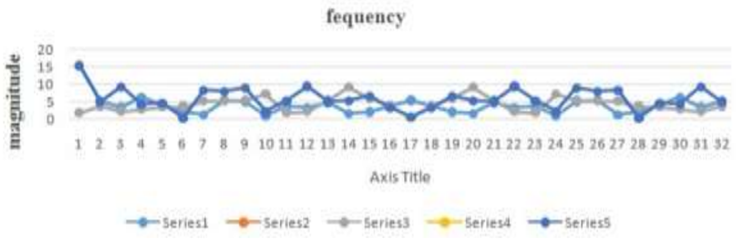

Figure 12: Displays Frequency Domain Signals derived from the Fourier Transform of the preceding Signal.

Figure 7 depicts the lower temperature when the mem sensor is placed on the motor without any load. When comparing Figures 7 and 13, it can be seen that when the motor is loaded, the temperature rises

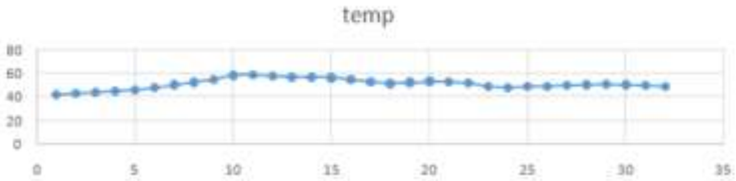

Figure 13: Displays Temperature Signals in the Motor with Load

When we set the mem sensor on the motor without any load, we get a lower temperature (see Figure 7). Figures 7 and 14 show that when the motor is loaded, the temperature rises

Figure 14: Displays Time Domain Signals from Mems on the Piston Cylinder with Load.

Figure 15: Displays Frequency Domain Signals which were Obtained from Fourier Transform of above Signal

Figure 10 shows the lower temperature when the mem sensor is placed on the exterior of the piston without a load. When comparing Figures 10 and 16, it can be seen that when the piston is loaded, the temperature rises.

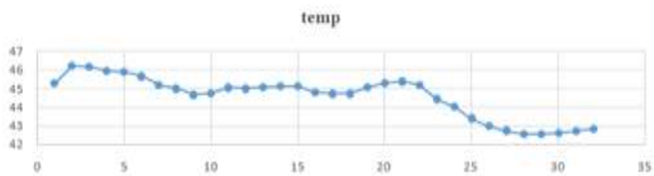

Figure 16: Temperature Signal in Piston Cylinder with Load is shown.

Table

Click on the table (Assembly Machine), when you click on the cell of the table (6- Bearing) (See Figure 10a), the motor bearing part will be separated, and the motor part name will be displayed.

Frequencies			
	On Motor		On piston
Axis	Ideal	Load	Ideal
x	21.2	6.26	16.2
y	5.2	9.08	9.8
z	10.7	15.27	9.69
Temp	46	58.7	42.2

Table 1: Take a look at the values from all of the recurrence plots, including both ideal and load conditions.

Conclusions

We are doing an experiment on a portable air compressor, and the machine is in good working order. As a result, we were unable to detect the misalignment in the experiment. By installing mems on both sides of the shaft, it can be found on motors with lengthy shafts. For the data acquisition system, vibration data from ubidots IOT software was used, a compressor status monitoring and fault detection program has been created. Frequency domain analysis and time domain analysis are two of the approaches used. By comparing both the ideal and load condition signals, we can see that the values increased in accelerometer readings and temperature readings, indicating that the vibrations are greater in the load condition and the temperature is also rising, indicating that incipient failure is detected at the exact location, reducing machine downtime and improving reliability. Upgrading current systems to IOT-based technology can minimize wiring, enhance simplicity of use, and accuracy, but it comes with a cost in terms of equipment and training.

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