

IoT Enabled Industrial Gearbox

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Abstract—Internet of Things (IoT) has provided a promising opportunity to build powerful industrial systems and applications by leveraging the growing ubiquity of Industry 4.0 and Industrial IOT. An application is created to remotely monitor the gearbox to gather information from the database where the information is stored which is primarily uploaded by the sensors employed. With the aid of Google's Firebase database the data is analyzed and maintained on a regular basis.

Keywords—*IoT, IIoT, Gearbox, Cloud, Gateway.*

I. INTRODUCTION

Today the Internet has become ubiquitous, has touched almost every corner of the globe, and is affecting human life in unimaginable ways. The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect and exchange data, creating opportunities for more direct integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits, and reduced human exertions.

Industrial Gear-box

The Industrial Internet of Things originally described the IoT (Internet of Things) as it is used across several industries such as manufacturing, logistics, oil and gas, transportation, energy/utilities, mining and metals, aviation and other industrial sectors and in use cases which are typical to these industries

The top 5 use cases are:

- Predictive maintenance
- Smart metering
- Asset tracking
- Connected vehicles
- Fleet management

Planetary Gear-box

Planetary Gear Box: An epicyclic gear train (also known as planetary gear) consists of two gears mounted so that the center of one gear revolves around the center of the other. A carrier connects the centers of the two gears and rotates to carry one gear, called the planet gear, around the other, called the sun gears.

The planet and sun gears mesh so that their pitch circles roll without slip. A point on the pitch circle of the planet gear traces an epicycloid curve. In this simplified case, the sun gear is fixed and the planetary gear(s) roll around the sun gear.

An epi-cyclic gear train can be assembled so the planet gear rolls on the inside of the pitch circle of a fixed, outer gear ring, or ring gear, sometimes called an annular gear. In this case, the curve traced by a point on the pitch circle of the planet is a hypocycloid. The combination of epicycle gear trains with a planet engaging both a sun gear and a ring gear is called a planetary gear train. In this case, the ring gear is usually fixed and the sun gear is driven.

Basically, the planetary gear box has: sun gear, planet gears, ring gear and carrier. With the correct speed between the gears the planetary gear system creates wonders in various fields. We need to monitor the ratio of the output speed and the input speed to make sure that the gear system works properly.

With this basic knowledge we proceed with implementing the gearbox with IOT which ultimately leads us to IIoT. The sensors are used to read the temperature, viscosity and other critical factors inside and outside the gearbox to remotely monitor and control the planetary gear box.

Raspberry Pi 3

- The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse.
- It can be programmed in languages like Scratch and Python.
- It's capable of doing everything you'd expect a desktop computer to do.
- The Raspberry Pi 3 Model B is the earliest model of the third-generation Raspberry Pi. It replaced the Raspberry Pi 2 Model B in February 2016.

Temperature Sensor

The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed).

II. EASE OF USE

With the advent of technology humans have heavily relied on machines to get their job done faster and more efficiently. With IoT booming in the industries for the past two decades it is more than obvious that the ease of use of IoT for general public has been greatly increased. IoT can be designed and developed with the simplest of tools and machines nowadays. The end user only has to have the creativity and a bit of technical knowledge to create wonders using IoT.

III. MOTIVATION

Nowadays industries are growing rapidly and there is a paradigm shift towards smart manufacturing. In order to save a lot of time and energy in the maintenance of the industrial gearboxes, it would be adept to monitor all the parameters on a mobile application or a dashboard and predict the lifetime. It would be very efficient to use Industrial Internet of Things (IIoT) to connect the hardware to the cloud and monitor the data remotely. This will uplift the throughput of the manufacturing process. Using Industrial Internet of Things (IIoT) we can achieve predictive maintenance and lean management. This will benefit the business to cut down unnecessary cost and act as an alimony in order to augment the profits.

IV. PROBLEM STATEMENT

Design, develop and test a prototype that can monitor temperature, pressure and viscosity accurately through a software application and to achieve predictive maintenance of the gear box.

V. OBJECTIVES

- Remote surveillance of the parameters of the gear box.
- Predictive maintenance to achieve efficiency of the gear box to the fullest.
- Development of a software/ android application to monitor the gear box wirelessly.

VI. METHODOLOGY

- Exhaustive testing and idealization of the gear box parameters.
- Setting different Threshold for different parameters.
- Initial data acquisition, monitoring and storage.
- Periodic monitoring and comparison of the data acquired.
- If abnormal values are detected, an alert is generated.

VII. SYSTEM LEVEL BLOCK DIAGRAM

As we can infer from the block diagram shown (Fig. 1) the project is classified into three specific environments:

- Physical Environment: The sensors play a vital role in capturing the physical parameter such as temperature, viscosity and pressure.

1). Temperature sensors like RTD and NTC are used for the acquisition of temperature values. The temperature changes due to the frictional heat produced by the gearbox.

2) Viscosity sensors like 374-Inline and 501-Miniature viscometers are used to measure the viscosity of the oil used to lubricate the gearbox.

3). Pressure sensors like strain gauge, capacitive sensors and piezoelectric sensors are used to measure the pressure exerted by the gearbox.

- Embedded Environment: Digital data from the sensors are received through a gateway wirelessly by the microcontroller. The required data values are stored in a database for immediate purpose and cloud for the end user to access the data through an internet link.

- Application Environment: The analysis of the data values received from the cloud. Through a desktop or an application developed on an android platform the user can remotely monitor the functioning of the gearbox through a click of a button. The application developed at the user end consists of a control panel.

Firebase is a mobile and web application development platform developed by Firebase, Inc. in 2011, then acquired by Google in 2014.

Hardware interfacing features provided by firebase.

- Real-time Database
- Authentication
- Storage
- Remote Configuration

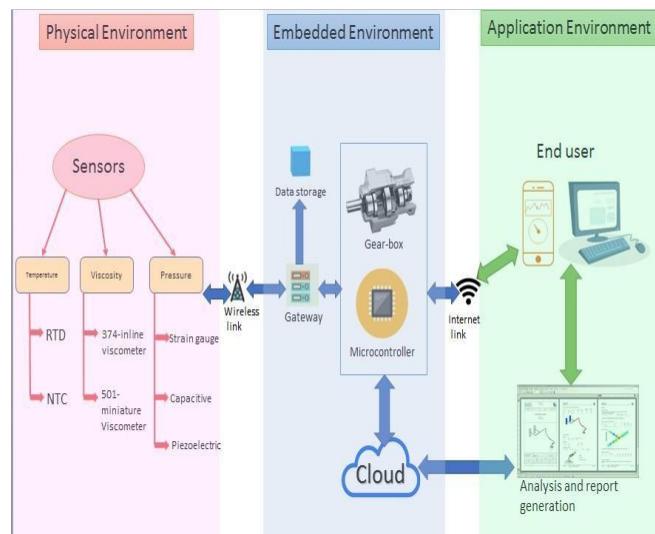


FIG. 1 SYSTEM BLOCK DIAGRAM

BLE Gateway

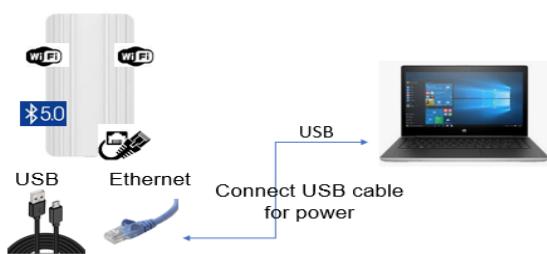


Fig 2: BLE Gateway

A BLE gateway shown in Fig 2 works as a broker between device and the cloud. With the help of MQTT broker, data can be synced real-time and stored in a database. This Wi-Fi enabled device connects to the RPi and then establishes connection in order sync data and upload. The gateway has the capability to connect to a number of Raspberry pi's. All the data collected from the sensors and published to its specific subscribers.

Android Application

The application created by Android Studio is used to calculate and analyze the parameters of the gearbox under observation. The information recorded using the sensors is sent to the Firebase database provided by Google, and then retrieved using the application launched in an android device. With the help of this application many industries can remotely monitor the progress and help in the maintenance as well thus revolutionizing the concept of Industry 4.0.

VIII. ADVANTAGES

- Access information: You can easily access data and information that is sitting far from your location, in real time. This is possible because of the network of devices; a person can access any information sitting from any part of the globe. This makes it very convenient for people to go about their work, even if they are not physically present.
- Communication: Better communication is possible over a network of interconnected devices, making the communication of devices more transparent, which reduces inefficiencies. Processes, where machine have to communicate with each other, are made more efficient and produce better, faster results. The perfect example for this is machinery at a manufacturing or production unit.
- Cost-effective: As mentioned in the point above, communication between electronic devices is made easier because of IoT. This helps people in daily tasks. Transferring data packets over a connected network save time and money. The same data that would take a long time to transfer can now be done much faster, thanks to IoT.

Automation: Automation is the need of the hour to manage

everyday tasks without human intervention. Automating tasks in a business helps boost the quality of services and reduce the level of human intervention.

IX. DISADVANTAGES

- Privacy & security: In today's tech-driven world, each and every device that an individual use is connected via the internet. This increases the risk of any leakage of data that might be important. This is a major drawback of sharing information, as confidential information might not be safe & could be hacked by third parties easily.
- Complexity: A diverse network that connects various devices is what we call IoT. A single loophole can affect the entire system. This is by far the most complicated aspect of the internet of things that can have a tremendous effect.
- Lesser jobs: With every task being automated, the need for human labor will reduce drastically. This will have a direct impact on employability. As we head into the future of IoT, there will be a visible decline in the hiring process of professionals.
- Dependability: We may not notice it, but we are witnessing a major shift in technology and its implementation in everyday lives. There is no doubt that technology is dominating our lifestyle, reflecting a human's dependability on technology. In case of a bug in the system, there are high chances of every related device getting corrupted.

X. APPLICATIONS

- Digital/connected factory: IoT enabled machinery can transmit operational information to the partners like original equipment manufacturers and to field engineers.
- Facility management: The use of IoT sensors in manufacturing equipment enables condition- based maintenance alerts.
- Production flow monitoring: IoT in manufacturing can enable the monitoring production lines starting from the refining process down to the packaging of final products.
- Inventory management: IoT applications permit the monitoring of events across a supply chain. Using these systems, the inventory is tracked and traced globally on a line-item level and the users are notified of any significant deviations from the plans.
- Plant Safety and Security: IoT combined big data analysis can improve the overall workers' safety and security in the plant.
- Quality control: IoT sensors collect aggregate product data and other third-party syndicated data from various stages of a product cycle.

XI. CONCLUSION

In today's industry scenario time plays a very crucial role and affects productivity to a great extent. Industrial IOT aims at cutting down maintenance time by predicting life of the machine and reducing costs. Hence, the data acquired from the sensors are stored in the cloud and analysed to further process and interpret meaningful data. Using a behavioural model, data acquired is analysed and used to predicts the life of the machine.

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