(12) INNOVATION PATENT
(19) AUSTRALIAN PATENT OFFICE

(11) Application No. **AU 2021105630 A4**

(54) Title
An autonomous device to monitor multiple pointer gauges and sensor data to perform predictive analysis.

(51) International Patent Classification(s)
G01D 7/00 (2006.01)
G01D 7/08 (2006.01)
G01D 7/12 (2006.01)
G01D 9/42 (2006.01)
G01D 15/06 (2006.01)
G01D 15/14 (2006.01)
G01D 18/00 (2006.01)

(21) Application No: **2021105630**
(22) Date of Filing: **2021.08.17**

(45) Publication Date: **2021.11.18**
(45) Publication Journal Date: **2021.11.18**
(45) Granted Journal Date: **2021.11.18**

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ABSTRACT:

An autonomous device to monitor multiple pointer gauges and sensor data to perform predictive analysis.

This invention describes a multiple gauge monitoring systems as shown in Figure-1 which can remotely analyze and provide the readings of pointer gauges attached to machines along with providing data analysis of all the sensor data obtained from the machine sensors to predict the maintenance requirement as showcased in Figure-2, of the gauges and the machines to which the gauge is attached. The monitoring device has been designed with artificial intelligence to analyze the reading obtained within a small time frame and large time frame to understand the possible performance of the machine and the probability of any dangerous circumstance which may occur due to the current working condition of the machine. Based on the data obtained from multiple sensors attached to the machine, it provides the possible life expectancy of the machinery to which the pointer gauge is attached.

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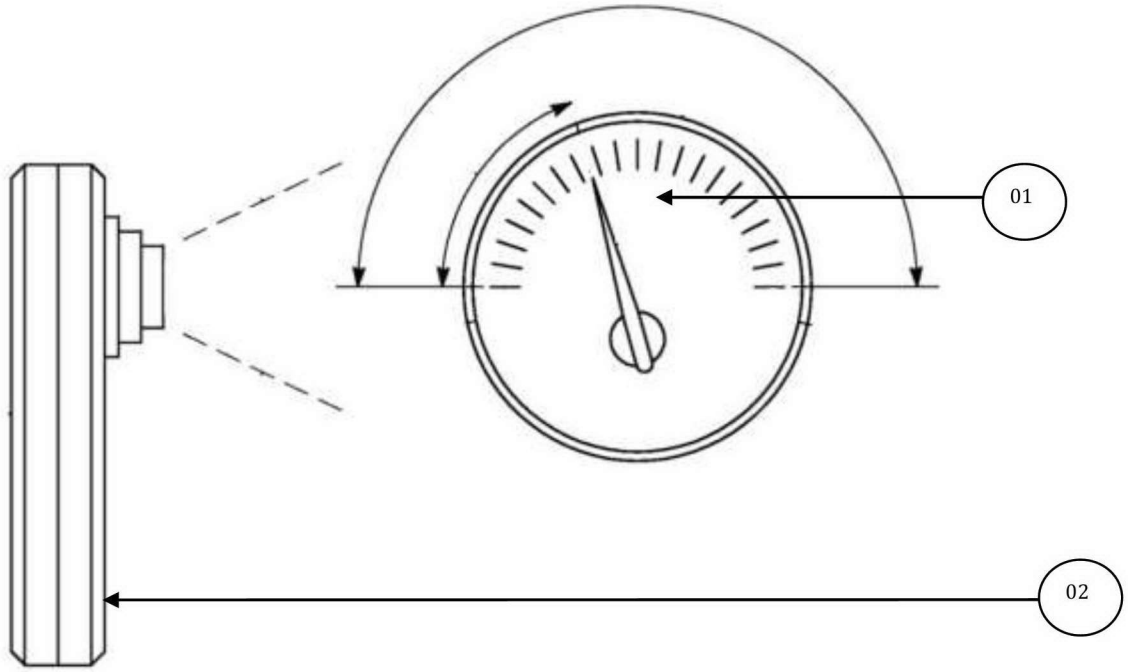

Figure – 1: Diagram of the Pointer Gauge Monitoring system with the Gauge

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TITLE

An autonomous device to monitor multiple pointer gauges and sensor data to perform predictive analysis.

FIELD OF INVENTION

[0001] This invention relates to the instrumentation and controls more particularly in the field of gauge reading system for monitoring an analogue meter using image sensors, and for providing alerts in response to the output of the sensor.

[0002] Here the device is capable of obtaining a precise reading of the analogue gauge using various sensors which reduces the manual effort of reading and the device is capable of reading multiple gauges at the same time. The device has been designed with artificial intelligence to analyze the reading obtained in the smaller time frame and larger time frame to understand the possible performance of the machines on which the gauge is attached and the probability of any dangerous circumstance that may occur due to its current working.

PRIOR ART AND PROBLEM TO BE SOLVED

[0003] Analogue meters have been used in conjunction with sensors to provide a visual display of the physical parameter that the sensor is designed to measure. Even though digital meters are now available, analogue meters are still used widely, especially for situations where the use of electricity is to be avoided for the reason of preventing electrical spark near the fuel storage tanks. These meters are usually installed in widely separated geographical regions so gathering the meter information requires a wide-area communication network. Fortunately, the cost of sending compact digital data such as the meter reading or meter conditions is becoming very inexpensive nowadays. One example is the use of the Short Message Service

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of the wireless GSM network. Therefore, it is desirable to equip an analogue meter installed in the field with a "non-contact" device that is capable of reading the meter digitally and sending the data or other conditions to a user or a computer system on the wired or wireless communication network. The reading device must be flexible to read different meters and must be able to perform a precise reading at a reasonable time. In addition, there is a requirement to predict the possible failure of the gauge along with the machine on which the pointer gauge is placed using various sensor-based readings. Previously, issues have been generally limited to diagnostics after a problem has occurred, as opposed to prognostics, that is, predicting a failure before its occurrence. It was usually done using the experience of an expert and trained personal who after looking through the log, use their accumulated experience and training in mapping incidents occurring in locomotive subsystems to problems that may be causing the incidents. If the incident-problem scenario is simple, then this approach works fairly well for diagnosing problems. However, if the incident-problem scenario is complex, then it is very difficult to diagnose and correct any failures associated with the incident and much less to prognosticate the problems before they occur.

[0004] To resolve the above problem where a device is designed which is capable of obtaining a precise reading of the analogue gauge using various sensors which reduces the manual effort of reading and the device is capable of reading multiple gauges at the same time. The device has been designed with artificial intelligence to analyze the reading obtained in the smaller time frame and larger time frame to understand the possible performance of the machine and the probability of any dangerous circumstance which may occur due to its present working conditions. It is capable of reading data from multiple sensors attached to the machine providing a machine-learning algorithm to understand the possible life expectancy of the machinery and the upcoming maintenance requirement due to any wrong activity.

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THE OBJECTIVES OF THE INVENTION:

[0005] In industrial plants, many analogue dial gauges are used for monitoring the pressure and temperature of various equipment. An operator is employed to monitor and record the readings of these gauges. The operators are typically required to note down the readings of the dial gauges multiple times in a day. They go to the place where the dial gauge is present and note down the readings on a handheld device.

[0006] It has already been proposed where image-based sensing is done to remotely obtain the reading on the pointer gauge, but there is no combined methodology involved that provides predictive analysis of the machine or the pointer gauge and that performs machine learning-based function. The mechanism used to detect errors have proven that the use of these techniques has been generally limited to diagnostics and thus even such computer-based systems have not been able to provide any effective solution of being able to predict failures before they occur.

[0007] The principal objective of the invention is a device that is capable of obtaining a precise reading of multiple analogue gauges in real-time; using various sensors which reduces the manual effort of reading the gauges.

[0008] Another objective of the invention is that the device has been designed with artificial intelligence to analyze the reading obtained in the smaller time frame and larger time frame to understand the possible performance of the machine and the probability of any dangerous circumstance which may occur due to its current and ongoing working conditions.

[0009] The further objective of the invention is that it is capable of reading different sensor data attached to the machine providing a machine-learning algorithm

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to understand the possible life expectancy of the machinery and the upcoming maintenance requirement due to any wrong activity.

[0010] The further objective of the invention is that the gauges are continuously monitored and the data is submitted to a computing device that can be read using the data in a graphical format or another form. The output from the device can be extracted to any computing device or a direct output like a speaker or screen where the user can be digitally or using sound indicated of the reading so that if due to any visual impairment or surrounding disturbance like fog, smoke, or other conditions where the readings can be well-read, the audio mechanism can be used to indicate the same.

[0011] The further objective of the invention is that it can continuously track the environmental factors which are impacting the performance of the gauge and it continuously calibrates the work to identify any errors in the reading which can create futuristic issues in the long working of the machines.

SUMMARY OF THE INVENTION

[0012] Gauges enjoy wide use in a variety of industries and applications. A gauge can typically include a measurement section and a display section. A measurement section can measure some conditions (e.g., pressure, temperature, rate, position, time, concentration, density, force, intensity, physical dimension, velocity, acceleration, or other quantities, to name but a few). A display section can display the measured value. Many gauges, typically analogue gauges, include a display intended for human eyes. As but a few examples, a gauge can represent a measurement value with a deflected needle (or arrow), a variable bar size, or another geometric shape that varies according to a measured value. Here in this invention, an autonomous device is designed which is capable of obtaining a precise reading of the analogue gauge using various sensors which reduces the manual effort of reading and

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the device is capable of reading multiple gauges at the same time It has been designed with artificial intelligence to analyze the reading obtained in the smaller time frame and larger time frame to understand the possible performance of the machine and the probability of any dangerous circumstance which may occur due to the working. Based on different sensor data received from the sensor attached to the machine it provides the possible life expectancy of the machinery and the upcoming maintenance requirement due to any wrong activity. The monitored data is submitted to a computing device that can be read using the data in a graphical format or another form. The output from the device can be extracted to any computing device or to a direct output like a speaker or screen where the user can be digitally or using sound indicated of the reading so that if due to any visual impairment or surrounding disturbance.

DETAILED DESCRIPTION OF THE INVENTION

[0013] While the present invention is described herein by way of example, using various embodiments and illustrative drawings, those skilled in the art will recognize that the invention is neither intended to be limited to the embodiment of drawing nor drawings described nor designed to represent the scale of the various components. Further, some components that may form a part of the invention may not be illustrated with specific figures, for ease of illustration, and such omissions do not limit the embodiment outlined in any way. The drawings and a detailed description of it are not intended to restrict the invention to the form disclosed, but on the contrary, the invention covers all modification/s, equivalents, and alternatives falling within the spirit and scope of the present invention as defined by the appended claims. The headings are used for organizational purposes only and are not meant to limit the scope of the description or the claims. As used throughout this specification, the word "may" be used in a permissive sense (i.e., meaning having the potential to), rather than the mandatory sense (i.e., meaning, must).

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[0014] Further, the words "an" or "a" means "at least one" and the word "plurality" means one or more unless otherwise mentioned. Furthermore, the terminology and phraseology used herein are solely used for descriptive purposes and should not be construed as limiting in scope. Language such as "including," "comprising," "having," "containing," or "involving," and variations thereof, is intended to be broad and encompass the subject matter listed thereafter, equivalents and any additional subject matter not recited, and is not supposed to exclude any other additives, components, integers, or steps. Likewise, the term "comprising" is considered synonymous with the terms "including" or "containing" for applicable legal purposes. Any discussion of documents acts, materials, devices, articles, and the like are included in the specification solely to provide a context for the present invention.

[0015] In this disclosure, whenever an element or a group of elements is preceded with the transitional phrase "comprising", it is also understood that it contemplates the same element or group of elements with transitional phrases "consisting essentially of, "consisting", "selected from the group comprising", "including", or "is" preceding the recitation of the element or group of elements and vice versa.

[0016] Before explaining at least one embodiment of the invention in detail, it is to be understood that the present invention is not limited in its application to the details outlined in the following description or exemplified by the examples. The invention is capable of other embodiments or of being practised or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for description and should not be regarded as limiting.

[0017] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art

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to which the invention belongs. Besides, the descriptions, materials, methods, and examples are illustrative only and not intended to be limiting. Methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention.

[0018] The present invention provides a device that is capable of obtaining a precise reading of the analogue gauge using various sensors which reduce the manual effort of reading and the device is capable of reading multiple gauges at the same time along with a reading of different sensor data attached to the machine providing a machine-learning algorithm to understand the possible life expectancy of the machinery and the pointer gauge and the upcoming maintenance requirement due to any wrong activity.

[0019] The device includes an electro-optical image sensor, i.e., a pixilated array of optical sensors for generating electrical signals indicative of the visual image of the pointer of the analogue gauge, and means for taking various actions responsive to the position of the pointer, indicative of the magnitude of the monitored parameter.

[0020] The electrical signals from the pixilated array provide a digital signal that corresponds to the analogue output of the analogue gauge, i.e., the position of the pointer thereof. The analogue gauge can thus be electronically monitored continuously, in real-time

[0021] For an image, the sensor can receive an image of one or more gauges and convert such an image into data values. Preferably, an image sensor can convert an image into digital data. More preferably, an image sensor can convert an image into an array of multi-bit pixel values. An image sensor can take various forms, including but not limited to a charge-coupled device (CCD) type sensor, or a complementary metal-oxide-semiconductor (CMOS) type sensor. Further, such a sensor may provide pixel values in monochrome format or a colour format.

[0022] A gauge parameter store can store parameter data corresponding to gauge(s) read by an autonomous pointer gauge monitoring device. In particular, a gauge parameter store can store data values that can enable an image processing section to generate a final gauge reading value from received gauge image data. More detailed examples of such data and functions will be described below.

[0023] An image processing section can receive image data from the image sensor, and perform one or more predetermined image processing operations on such data. Preferably an image processor section includes no more than one integrated circuit device. An image processing section can analyze selected portions of the received image data, determine which data values represent significant gauge reading data, and convert such data into an intermediate gauge reading. Utilizing values within the gauge parameter store and the intermediate gauge reading, the image processing section can generate a final gauge reading value that is output to the transmitting section.

[0024] The transmitting section can transmit a final gauge reading value to a remote location, and thereby enable remote monitoring of the gauge values. In this way, an autonomous pointer gauge monitoring device can read a gauge image with an image sensor attached to the gauge, generate a gauge reading from such an image, and transmit the gauge reading to a remote location. Here the device is capable to obtain readings from a vibrating dial gauge reading according to an example embodiment. In one embodiment, accurate readings of the gauge may be obtained while it is vibrating (such as from gauges that are installed on a vibrating platform). In some embodiment, automatic gauge reading may utilize video analytics, where the hand-held device captures a digital video of the gauge.

[0025] The image stabilization operates to obtain a sequence of images from the vibrating dial gauge. At, successive images of the vibrating dial gauge are

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captured. Harris corner or SIFT may be used to detect the corresponding points on the dial gauge. Since only the dial gauge is moving concerning a background part of the image, corners may be detected for image registration and stabilization. The display of the dial gauge is extracted from the image and the needle position is identified from each dial gauge.

[0026] In the case of motion blur, motion blur estimation (point spread function) methods may be used to remove the blur from the image. At, images of vibrating gauge taken from a far distance. The region that is vibrating is found starting at using optical flow. At, the motion blur is estimated and removed using standard image processing techniques such as blind deconvolution.

[0027] As this device is placed at a distance from the pointer gauge assembly there is a need to detect blur images or the images obtained from a vibrating gauge. For the dial gauges that are vibrating and images taken from a long distance as indicated, multiple images of the vibrating gauge are taken. The vibrating image region is detected using optical flow. At, the motion blur for each image is estimated and is de-convolved with the estimated kernel. At, the best corner points on the extracted dial gauges in the sequence of images of the same dial gauge are detected. The corresponding corner points in successive images are found using local template matching or SIFT. The images are registered at and combined to form a single image using bilinear interpolation. An alternative is to use super-resolution to improve the resolution of the image by using the bilinear interpolation image as an initial estimate.

[0028] Such an arrangement is advantageously non-invasive, as no replacement process is needed for the existing gauge. The gauge monitoring system can include several electronic components attached to an assembly structure. In particular, a control IC includes an image processing section and an "on-board" storage circuit -. The image processing section can include a processor

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configured to execute several predetermined steps, including acquiring image data, processing selected portions of the image data to distinguish relevant data points from non-relevant data points, generating an intermediate gauge reading from the relevant data points, and then generating a gauge reading value from the intermediate gauge reading and gauge parameter data. An onboard storage circuit - can store instructions for executing the image processing and other operations. In addition, an onboard storage circuit - can store gauge parameter data, and thus form all or a portion of gauge parameter store.

[0029] A control IC can control the activation of all or any of the other circuits of the autonomous pointer gauge monitoring device. For example, circuits can be activated only when needed for a given function, and then returned to a deactivated state. A deactivated state can be a standby state or an off state, for example. Even more particularly, a control IC can activate circuits periodically to generate and transmit a gauge reading and then deactivate such circuits. In addition, or a control IC can activate such circuits when requested by user input, and then return such circuits to a deactivated state. Such an approach can advantageously conserve power consumption, which can be particularly beneficial in battery-powered embodiments.

[0030] In addition to the mechanism of reading multiple pointers gauge, the system is designed to predict the life of the pointer gauge attached to the machine along with the performance of the machines to which it is attached. The analysis of the same will be in real-time.

[0031] A real-time IOT based determination mechanism of machine reliability comprises, one or more sensors associated with a communications network, an internet of things (IoT) sensor network communicatively coupled to the communications network, an ERP system communicatively coupled to a distributed computer database over the communications network, a real-time data feed platform associated with a distributed real-time computation system

communicatively coupled to the internet of things (IoT) sensor network over the communications network, and a machine learning engine coupled to a predictive analytics engine over the communications network. One or more machine operational condition data, machine historical operational data and machine-specific information from one or more locations are received through an internet of things (IoT) sensor network. The one or more machine operational condition data, machine historical operational data and machine-specific information is stored in a distributed computer database communicatively coupled to an enterprise resource planning (ERP) system. The one or more machine operational condition data, machine historical operational data and machine-specific information is analyzed, through a real-time data feed platform associated with a distributed real-time computation system. A set of analytical predictions for machine maintenance is generated, through a machine learning engine coupled to a predictive analytics engine, for one of the repair and operation of the machine. This ensures a prescriptive, preventative and predictive maintenance possibility for a machine. Big data methodologies may be employed to analyze data obtained from various locations through the IoT sensor network. Based on the set of analytical predictions, one of maintenance and a repair may be scheduled for the machine.

[0032] Here a machine wearable sensor may be one of a MEMS or a single silicon sensor. The device extracts physical parameters from sensor data such as total energy of vibration, multiple axes (X, Y, Z-axis) of vibration, azimuthal and polar angle of vibration rotation, RMS (Root Mean Square) value of vibration, shape factor of vibration, and the like to perform the machine learning functionality. The sensor data is one or more of a vibration, magnetic field, power factor, and temperature. Each sensor is capable of transmitting captured data wirelessly over a communications network. The system may further include a sensor network for receiving and transmitting the captured data over a communications network and a machine learning algorithm engine capable of receiving data from the sensor network. The machine

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learning algorithm engine may process the received data to recognize one of a pattern and a deviation, to issue control commands about the machine. Lastly, the system may include one or more control modules disposed of in operative communication with a control panel of the machine, the control module is capable of receiving, over a communications network, one or more control commands, and executing the control commands. The reading and the images of each pointer gauge are also sent to perform predictive analysis of its health to identify whether is providing an accurate reading or not.

[0033] The autonomous gauge of the monitoring device has been provided with additional indications. It includes a value display that can preferably be an alphanumeric liquid crystal display (LCD) but may take alternate forms, such as an LED alphanumeric display, as but one example. A status display can be provided to indicate a status of a gauge. Preferably, a status display can indicate a low battery condition or nearby condition of the pointer gauge being monitored. However, either the value display and/or status display can indicate numerous other possible conditions, including but not limited t: normal operation of the gauge(s), abnormal operation of the gauge(s), gauge reading outside of limit(s), gauge reading within the limit(s), gauge out of alignment, or maintenance/inspection due.

[0034] The device may be associated with colour schemes such as red, yellow and green depending on the predictive analysis to notify the condition, for example, red may indicate the worst maintenance condition, yellow may indicate an intermediate condition and green may indicate the best maintenance condition.

[0035] In addition, it has been provided with multiple alarms to send out alerts. It features one or a combination of devices from the group of devices including an audible buzzer, a visual warning light, or a transmitter configured to transmit information to a remote receiver configured to receive and process such information. information to a remote receiver configured to receive and

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process such information. The warning light works best using a light-emitting diode (LED) due to the low current draw of such devices allowing for longer battery life. Also, an LED would be the best model to provide a powerful light that could be included in the device to show that the device is activated. Activation and deactivation of the device is accomplished using the conventional switching means such as an on/off switch

[0036] While there has been illustrated and described embodiments of the present invention, those of ordinary skill in the art, to be understood that various changes may be made to these embodiments without departing from the principles and spirit of the present invention, modifications, substitutions and modifications, the scope of the invention being indicated by the appended claims and their equivalents.

FIGURE DESCRIPTION

[0037] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate an exemplary embodiment and, together with the description, explain the disclosed embodiment. In the figures, the left and rightmost digit(s) of a reference number identify the figure in which the reference number first appears. The same numbers are used throughout the figures to reference features and components. Some embodiments of the system and methods of an embodiment of the present subject matter are now described, by way of example only, and concerning the accompanying figures, in which:

[0038] Figure – 1 illustrates the Diagram of the Pointer Gauge Monitoring system (02) with the Gauge monitoring and obtaining the pointer gauge (01) reading.

[0039] Figure – 2 illustrates the Architecture of the working of the pointer gauge monitoring and sensor data extracting system. It consists of the Monitoring device (02) which is used to monitor the gauges (01) along with being linked to the machine sensors (03) attached to the machines (04) to obtain their

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readings. The data obtained is communicated to the communication network (09) using the IoT sensor network (07) in real-time using the real-time data feed (12). The communication network (09) is capable to perform predictive analysis using the predictive analysis engine (05) and it is also connected to various distributed computer databases (06) to perfume machine learning functionality (08) to predict the life expectance of the machine and the gauge. Further, the analysis data is stored in a computation system (11) and it can be accessed using a computing device (10).

[0040] Figure -3 shows the flowchart is showcasing the flow to perform the predictive analysis for the maintenance.

[0041] Figure – 4 shows the Flowchart to obtain the gauge reading even when it is Vibrating

[0042] Figure – 5 shows the Flowchart to obtain data from the blurred gauge Images.

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WE CLAIM:

1. Monitoring and analyzing device capable of obtaining a precise reading of multiple analogue gauges and the machines to which the gauges are attached, working remotely in real-time and providing the reading autonomously where the device consists of ;
   A monitoring device (02)
   Machine sensors (03)
   The communication network (09)
   IoT sensor network (07)
   Predictive analysis engine (05)
   Distributed computer databases (06)
   Computation system (11)
2. The monitoring and analyzing device as claimed in claim – 1, is designed with artificial intelligence to analyze the reading obtained in the smaller time frame and larger time frame to understand the possible performance of the pointer gauges and the machines to which the gauge is attached to understand the probability of any dangerous circumstance that can occur due to its current and ongoing working conditions.
3. The monitoring and analyzing device as claimed in claim – 1, is capable of reading different sensor data attached to the machine providing a machine-learning algorithm to understand the possible life expectancy of the machinery and the upcoming maintenance requirement due to any wrong activity.
4. The monitoring and analyzing device as claimed in claim – 1, the gauges are continuously monitored and the data is submitted to a computing device that is displayed on to the screen in a graphical format or another form for easy readability.
5. The monitoring and analyzing device as claimed in claim – 1, the output readings of the gauge and the machine analysis report is extracted to any computing device or to a direct output comprising of a speaker or screen where the data is displayed digitally or using sound mechanism like a reading, serving helpful in case of any visual impairment or surrounding disturbance like fog, smoke, or other conditions where the readings can't be well-read.

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6. The monitoring and analyzing device as claimed in claim – 1, can continuously track the environmental factors that are impacting the performance of the gauge and it continuously calibrates the work to identify any errors in the reading which can create futuristic issues in the long working of the machines.

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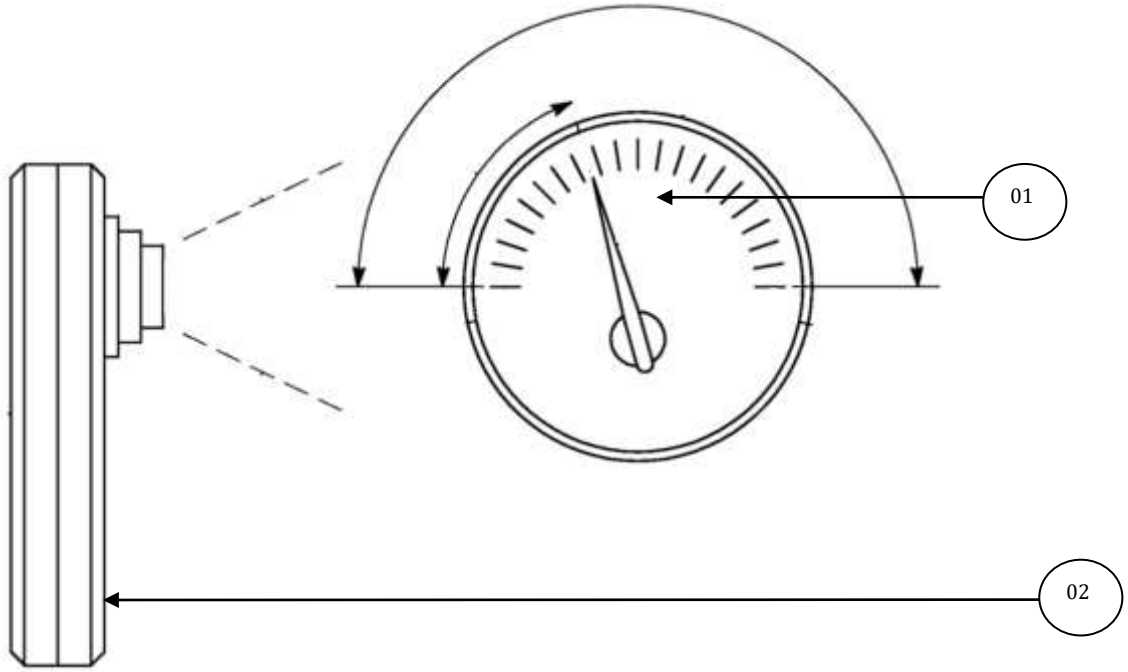

Figure – 1: Diagram of the Pointer Gauge Monitoring system with the Gauge

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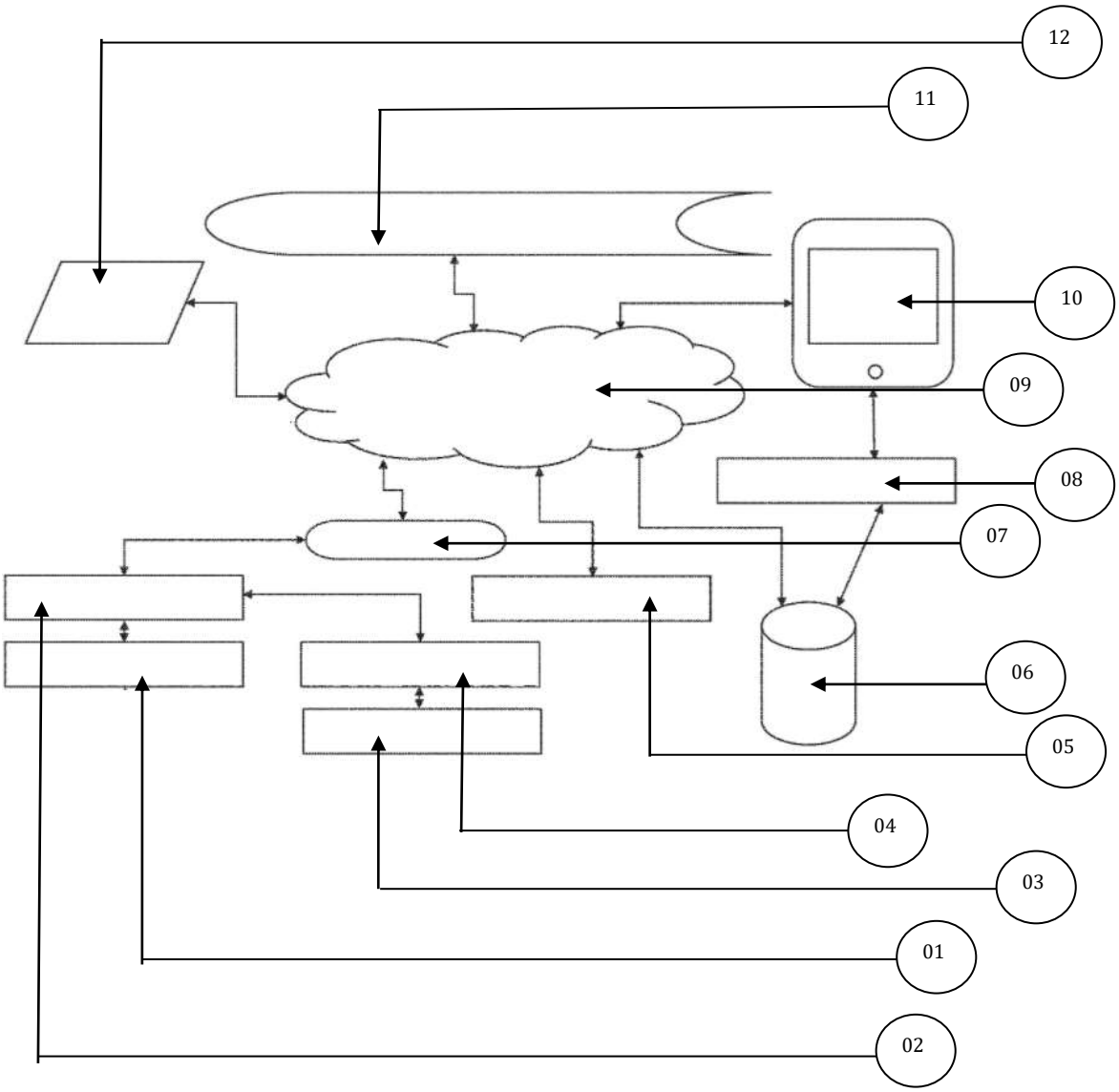

Figure – 2 : Architecture of the working of the pointer gauge monitoring and sensor data extracting system

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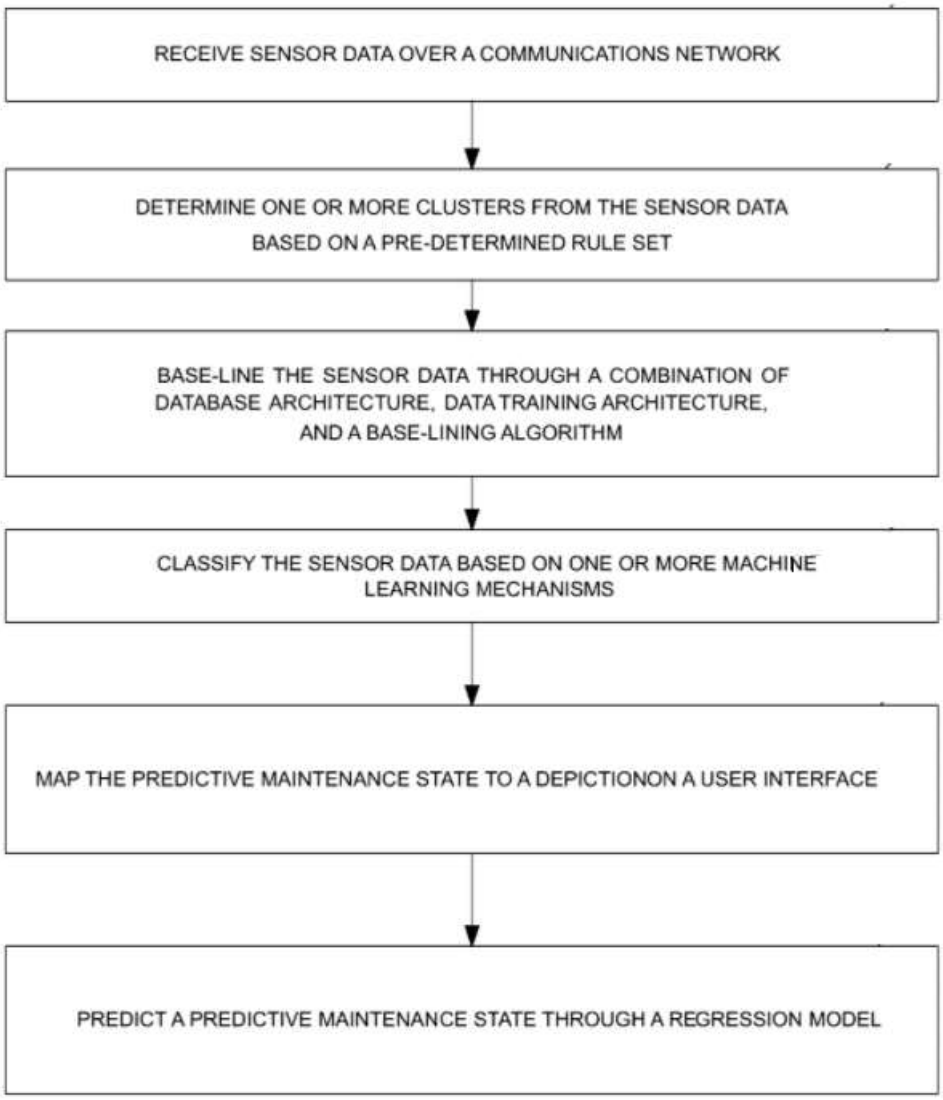

Figure – 3 : Flow chart to perform the predictive analysis for the maintenance.

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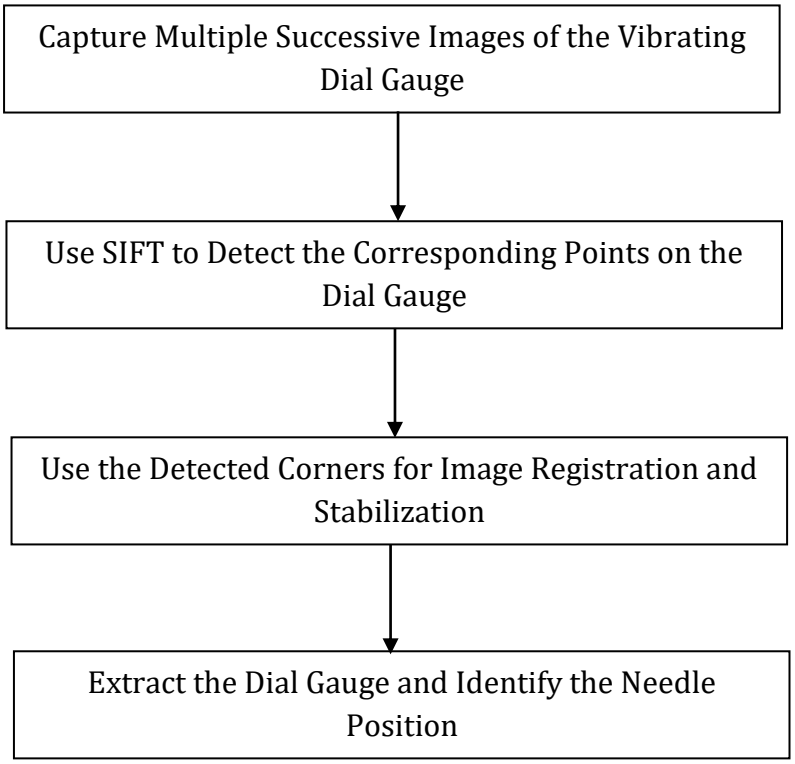

Figure – 4 : Flow chart to obtain the gauge reading even when it is Vibrating

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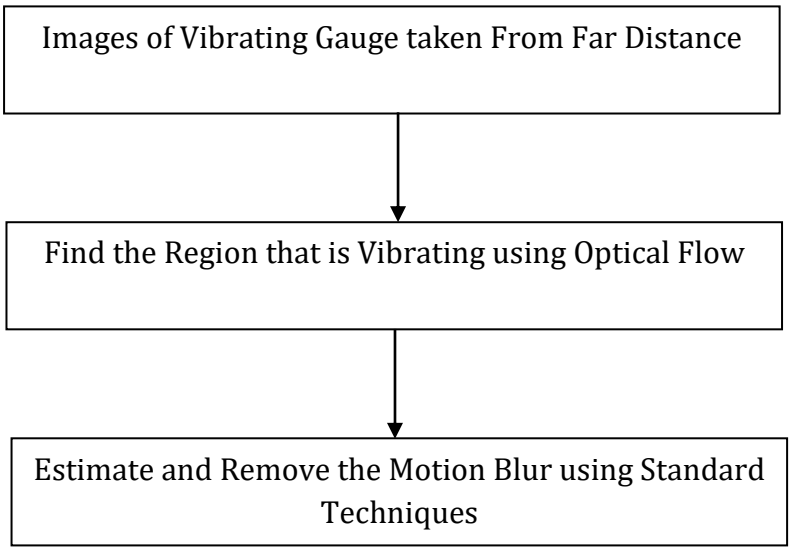

Figure – 5 : Flow chart to obtain data from the blurred gauge Images.

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