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(54) Title: FUEL GAUGE VISUALIZATION OF IOT BASED PREDICTIVE MAINTENANCE SYSTEM USING MULTI-CLASSIFICATION BASED MACHINE LEARNING

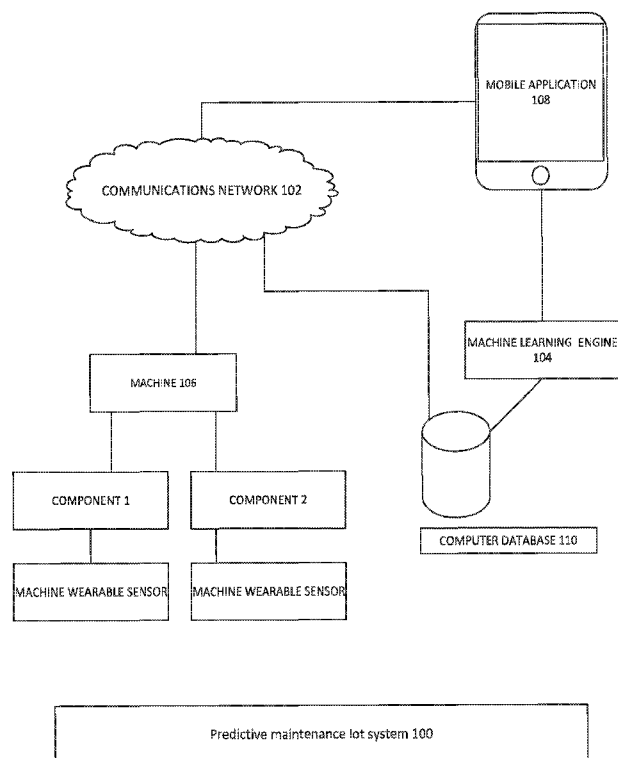


FIG. 1

(57) Abstract: A method and system of a predictive maintenance IoT system comprises receiving a plurality of sensor data over a communications network and determining one or more clusters from the sensor data based on a pre-determined rule set. Further, the sensor data is classified through a machine learning engine and the sensor data is further base-lined through a combination of database architecture, data training architecture, and a base-lining algorithm. Intensity or degree of fault state is mapped to a fuel gauge to be depicted on a user interface and a predictive maintenance state is predicted through a regression model and appropriate alarm is raised for user action.



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AMENDED CLAIMS

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CLAIMS

What is claimed is:

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21. In an apparatus for maintaining a machine based on measurement of machine physical parameters, the improvement comprising:
 - a. a plurality of physical parameter IoT sensors, each being mounted on or associated with the machine;
 - b. a communications network for receiving data from the sensors in real time;
 - c. a computing device having at least one database for the sensor data;

- d. a clustering module executable on the computing device for determining one or more clusters from the sensor data, based on a pre-determined rule set stored on the data base;
 - e. a machine learning engine executable on the computing device for classifying the sensor data;
 - f. a base-lining architecture module executable on the computing device for base-lining the sensor data, the base-lining architecture comprising database architecture, data training architecture, and a base-lining algorithm;
 - g. a regression module executable on the computing device for predicting a machine maintenance state; and
 - h. a gauge for visually displaying the predicted maintenance state when mapped thereonto by the computing device.
22. Apparatus of claim 21 wherein the data training architecture receives as input one of a baseline reading and an anomalous reading from a machine component having one of the sensors associated therewith.
23. Apparatus of claim 21 further comprising at least one of a mobile computing device, an Internet-based computing device, and a desktop computing device, acting as mobile middleware, and wherein the mobile middleware calibrates and base-lines the sensor data.
24. Apparatus of claim 21 wherein the communications network further comprises an alarm actuable over the communications network by notification on the mobile computing device, the Internet computing device and/or the desktop computing device by a short message service communication, email, or a combination thereof.
25. Apparatus of claim 21 wherein the alarm is set by a user based on a field calibration of the gauge.
26. In a method for maintaining a machine based on measured machine operating parameters, the improvement comprising:

- a. positioning a plurality of IoT physical parameter sensors on and in association with the machine;
 - b. receiving real time physical parameter data from the sensors on a communications network;
 - c. clustering the sensor data according to a predetermined rule set;
 - d. baselining the sensor data; and
 - e. applying the sensor data to a regression algorithm to predict machine maintenance state.
27. In apparatus for maintaining a machine based on machine physical parameter performance, the improvement comprising:
- a. a plurality of IoT sensors providing machine performance data;
 - b. a communications network receiving the IoT sensor data;
 - c. a real time data processing system with associated distributed databases;
 - d. a clustering module for defining at least one cluster from the sensor data based on a pre-determined rule set;
 - e. a computer database, connected to the communications network, to store the pre-determined rule set;
 - f. a processor communicatively connected to the database;
 - g. a machine learning engine for classifying the sensor data;
 - h. a base-lining architecture engine for base-lining the sensor data, the base-lining architecture comprising:
 - i. a database architecture;
 - ii. a data training architecture; and
 - iii. a base-lining algorithm; and
 - i. a regression module associated with the processor for determining a predictive maintenance state and mapping the predictive maintenance state onto a user interface as a visible depiction of a fuel gauge.
28. Apparatus of claim 27 wherein the data training architecture receives as input one of a baseline reading and anomalous reading from a component associated with a sensor.

29. Apparatus of claim 27 wherein the improvement further comprises at least one of a mobile, a web and a desktop application acting as mobile middleware, and wherein the mobile middleware calibrates and base-lines the sensor data.
30. Apparatus of claim 27 wherein an alarm is raised over the communications network through notification on the mobile application, short message service, email, or a combination thereof.
31. Apparatus of claim 27 wherein a user defined alarm system is set based on a field calibration of the fuel gauge representation.
32. In a method for maintaining a machine based on measured machine operating parameters, the improvement comprising:
 - a. positioning a plurality of IoT physical parameter sensors on and in association with the machine;
 - b. providing a communications network for receiving real time physical parameter data from the sensors;
 - c. providing a computing device connected to the communications network, the computing device including a database for the sensor data;
 - d. providing a machine learning engine for execution by the computing device to classify the sensor data;
 - e. clustering the sensor data by executing a clustering algorithm on the computing device according to a predetermined rule set;
 - f. baselining the sensor data using a baselining algorithm executed on the computing device; and
 - g. applying the sensor data to a regression algorithm operating against the baseline to predict the performance and maintenance state of the machine.