

System and Method for Chiller Plant Optimisation, Abnormality Detection and Root-Cause Analysis

Background

5 Field of Invention

Embodiments of the invention relate to system and method for chiller plant energy efficiency optimization and monitoring, more particularly, to detecting abnormality, optimising operating parameters and identifying root-cause of the detected abnormality.

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Description of Related Art

Traditional Chiller Plant Energy Monitoring Systems collect and store chiller plant data (temperature, flow rate, power consumption) locally, extracted from key points and components of the chiller plant system. This can be accessed on site, and
15 can be manually used to extrapolate graphs and charts to generate trending data enabling building owners and operators to achieve better comfort and energy efficiency.

Diagnosis of issues or improvements to chiller plant system performance therefore requires engineer presence on site, site access and time consuming
20 analysis and display of trending data before even human hypothesis for improvement can be applied.

Additional information that may be applied in various aspects of chiller plant monitoring can be found in the following documents. US 6718779 B1 (Henry) discloses a method to optimize chiller plant operation. US 20130097306 A1
25 (Dhunay) discloses system and method for monitoring, managing and controlling a plurality of devices using cloud resources. US 20110161048 A1 (Sodem et al.) discloses a method to optimize prediction of threshold violation using baselines. US 8463899 B2 (Scarpelli et al.) discloses a system, method and computer program product for optimized root-cause analysis. US 7015911 B2 (Shaughnessy et al.)
30 discloses a computer-implemented system and method for report generation.

Summary

Embodiments of the invention relate to system and method for chiller plant energy efficiency optimization and monitoring, more particularly, to detecting
5 abnormality, optimising operating parameters and identifying root-cause of the detected abnormality.

The invention provides a method for optimising a chiller plant. The method comprises: providing a dataset library having a plurality of historical datasets, each of
10 the plurality of historical datasets at least including a historical wet bulb temperature, a historical cooling load, a plurality of historical parameter data and a historical system efficiency; selecting a first baseline and a first threshold correlation coefficient value; ascertaining a current correlation coefficient by comparing a plurality of current parameter data with the first baseline; if the current correlation
15 coefficient breaches the first threshold correlation coefficient value, based on a current wet bulb temperature and a current cooling load, identifying a subset from the plurality of historical datasets wherein the subset includes historical wet bulb temperature and historical cooling load which fall within a predetermined margin of the current wet bulb temperature and the current cooling load; based on the
20 identified subset, ascertaining a plurality of preferred parameter data for the current wet bulb temperature and the current cooling load; and altering at least one of the plurality of current parameter data in conformance with the plurality of preferred parameter data.

25 In the above, ascertaining a plurality of preferred parameter data may include identifying a most optimal historical system efficiency within the subset, and ascertaining historical parameter data corresponding to the most optimal historical system efficiency as the plurality of preferred parameter data. Alternatively, ascertaining a plurality of preferred parameter data may include curve-fitting
30 historical parameter data relating to condenser pump power and cooling tower power and historical system efficiencies which correspond to the subset, wherein the constructed curve is to estimate chiller power, and from the constructed curve, a combination of condenser pump power and cooling tower power which results in a

most optimal system efficiency is ascertained, and the combination is ascertained as the plurality of preferred parameter data.

The invention provides a system at least comprising a memory storage device and a computing device coupled thereto. The memory storage device at least stores
5 a dataset library and computer-executable instructions for performing the various methods described in this disclosure. The computing device may be a source terminal or a server terminal which is configured to implement the methods which are described in this disclosure and are stored in the memory storage device as computer-executable instructions.

10 **Brief Description of the Drawings**

Embodiments of the invention are disclosed hereinafter with reference to the drawings, in which:

FIG. 1 is a schematic representation of a system for secure database creation, abnormality detection and root-cause analysis for chiller plant monitoring;

15 FIG. 2A illustrates a flow chart illustrating secure database creation;

FIG. 2B is an example illustrating the contents of definition file, data files residing in a source terminal;

FIG. 2C is an example illustrating the contents of definition file, data files and parameter databases residing in a destination terminal;

20 FIG. 3 illustrates a flow chart for detection of abnormalities;

FIG. 4A illustrates a flow chart for optimisation analysis including ascertaining optimised parameter data and identifying root-cause of detected abnormality;

FIG. 4B illustrates a hierarchical approach for the optimization analysis; and

FIG. 5 is an example illustrating a dataset library, a subset identified from the dataset library, and preferred parameter data ascertained using two different methods.

Detailed Description

5 In the following description, numerous specific details are set forth in order to provide a thorough understanding of various illustrative embodiments of the invention. It will be understood, however, to one skilled in the art, that embodiments of the invention may be practiced without some or all of these specific details. In other instances, well known process operations have not been described in detail in
10 order not to unnecessarily obscure pertinent aspects of embodiments being described. In the drawings, like reference numerals refer to same or similar functionalities or features throughout the several views.

FIG. 1 is a schematic representation of a system for creating databases for a chiller plant. FIG. 1 illustrates a first source terminal (e.g. computer, any electronic
15 device with computer processor) which is configured to receive raw parameter data including but not limited to, temperature, power, flow, pressure, humidity readings, from various sensors and meters installed in a chiller plant. The first source terminal may be provided with an electronic storage device for data storage and retrieval. The raw parameter data may be converted and stored in the electronic storage device as
20 raw parameter data files. FIG. 1 also illustrates a second source terminal which may be configured to receive parameter data from another part of the chiller plant or a separate chiller plant. According to certain embodiments, the system may comprise multiple source terminals distributed across various locations. Each of the source terminals is configured to connect to one or more destination terminal(s) by wired or
25 wireless broadband, e.g. 3G and 4G mobile communication technology, or other suitable communication protocols. The destination terminal(s) is provided in a cloud-based environment or an Internet-enabled computing device.

Each source terminal may be provided with at least the following capabilities e.g. a chiller control system application for managing, adjusting and regulating the
30 sensors and meters, a definition file, a command file, data files containing raw

parameter data received from the sensors and meters, databases of individual parameters and a report generation and visualisation function. The destination terminal(s) may be provided with at least similar capabilities as the source terminal(s) and may further include a statistical analysis function and application for
5 generating actionable information.

According to one aspect of the invention, a method for creating databases from raw parameter data files is described with reference to a flow chart 200 of FIG. 2A and an illustrative example represented by FIGs. 2B and 2C.

At timed intervals, the measured readings from various sensors and meters
10 are received at a source terminal as raw parameter data (block 202). The raw parameter data may be received from at least one of temperature sensors, power meters and flow meters. The raw parameter data may be converted and stored, at the source terminal, as raw parameter data files and in association with corresponding time stamps. These data files may be character-separate values files
15 or text files. FIG. 2B illustrates data files "flow.csv" and "temp.csv" which contain the parameter data in unprocessed form.

At certain timed intervals, or as and when required, a synchronised copy of the raw parameter data files residing in the source terminal is created and stored in the destination terminal(s) (block 204). This synchronisation may be performed by
20 known methods file sharing methods. The synchronised raw parameter data files are stored in both the source terminal and the destination terminal(s).

A definition file and a command file are created and stored in either the source terminal (as source-based definition file and source-based command file) or the destination terminal (as destination-based definition file and destination-based
25 command file) (block 206). In certain embodiments, the definition file and the command file may be synchronised across the source terminal(s) and the destination terminal. Any subsequent changes to the definition file or the command file may be synchronised across the source terminal(s) and the destination terminal.

The definition file serves as a look-up or search table which provides reference pointers for locating data files, parameter names and their raw data values. Particularly, the definition file contains a plurality of entries. Each entry at least includes a data file name, a parameter name (whose raw data values are stored under specified data file name), a data type (of the corresponding raw data values) and a location reference (of the corresponding raw data values within the corresponding data file).

For example (see FIG. 2B), an entry "flow.csv, cwsflow, double, 6" indicates that the data file named "flow.csv" contains "cwsflow" parameter data which are presented in a double-precision floating-point format and stored in column six of the file "flow.csv". For example (see FIG. 2B), an entry "flow.csv, chsflow, double, 7" indicates that the data file named "flow.csv" contains "chsflow" parameter data which are presented in a double-precision floating-point format and stored in column seven of data file "flow.csv". For example, an entry "temp.csv, cwst, integer, 2" indicates that the data file named "temp.csv" contains "cwst" parameter data which are presented in an integer format and stored in column two of "temp.csv".

The command file may be an executable file or a script file or any instructions that can execute a function to read the definition file, look up the data as specified in the definition file entry and extracting the data into a database. Particularly, at a destination terminal, the destination-based command file looks up the destination-based definition file to read an entry therein (block 208). With this read or looked-up entry information, the destination-based command file then looks up the raw parameter data from within the corresponding data file as specified in the definition file entry that was read (block 210). The destination-based command file then extracts this raw parameter data together with associated time stamps, and stores them in a parameter database in the destination terminal (block 212). This destination-based parameter database created through blocks 208 to 210 corresponds to the particular one parameter name as specified in the destination-based definition file and located in the manner as described in block 208.

The above description related to blocks 208 and 210 may be repeated to create a plurality of destination-based parameter databases where each destination-

based database corresponds to one parameter name as specified in the entries of the destination-based definition file.

An example to illustrate blocks 208 to 212 is described with reference to FIG. 2C. To create a database corresponding to parameter “cwsflow”, a command file is executed which locates a first entry from the definition file, identifies the file name and location reference, and based on this identified information, extracts corresponding raw “cwsflow” data and associated time stamps from the identified data file and stores the extracted data and associated time stamps as a database for the specified parameter name in the destination terminal. FIG. 2C also illustrates a “chsflow” database whose contents are extracted from the “flow.csv” data file.

In certain embodiments, the description related to blocks 208 to 210 may further be performed at the source terminal(s) using raw parameter data files, source-based definition file, source-based command file to create source-based databases wherein each source-based database corresponds to one parameter as specified in the entries of the source-based definition file.

In certain embodiments, creation of the destination-based parameter databases and source-based parameter databases may be performed simultaneously, or performed based on synchronised set of raw parameter data files across the source and destination terminals. Subsequently, a destination-based report may be generated based on the destination-based parameter databases and a source-based report may be generated based on the source-based parameter databases. Such destination-based report and source-based report are substantially the same. The reports may include statistical or analytic information, a visualisation of the statistical information presented as, but not limited to, graphs and charts. The source-based report and the destination-based reports may be transmitted to different recipients. For example, the source-based report may be transmitted to a computer or mobile computing device of a chiller plant maintenance personnel; the destination-based report may be transmitted to a computer at a corporate office or a mobile computing device of a building manager. The reports may be updated as and when there are changes to the destination-based and source-based parameter databases.

In certain embodiments, at the source and/or destination terminal(s), one or more definition files may be created that contain different entries so that different sets of parameter databases can be created according to the different requirements of the target recipients. For example, a first definition file includes a first plurality of entries to allow creation of a first set of parameter databases which are accessible by a chiller plant maintenance team; a second definition file includes a second plurality of entries to allow creation of a second set of parameter databases which are accessible by a regulatory agency. Accordingly, having different definition files customized to the needs of different target recipients provides independent pathways of database creation for increased security. It follows that reports generated based on the different sets of parameter databases would be different and such reports may be transmitted to different recipients accordingly.

Certain variations to the above-described method may be envisaged:

- Storing of definition and command files (block 206) may precede receiving and storing of raw parameter databases (block 202);
- The above-described destination terminal may be connected to additional destination terminal(s) wherein the raw parameter data files, definition file and command file may be synchronised to the additional destination(s) and creation of parameter databases can take place independently within the additional destination(s).

With the above-described database creation method for chiller plant, certain advantages may be achieved:

- Synchronisation of data files, definition files and command files between source terminal(s) and destination terminal(s) creates redundancy which results in data reliability.
- Synchronisation methods that utilise encryption increase data security.
- Creation of databases in multiple locations (on each source terminal and the destination terminal) from the synchronised data files destination terminal provides independent pathways of database creation for increased security.

- Database creation on a destination terminal provides higher efficiency and increases the capability of real-time analysis through visualisation technologies.

Previously, data files which are in the form of text files contain an aggregation
5 of text data which are not useful for analysis until engineers or personnel dedicate substantial time and effort in extracting information from the data files and compiling databases for the various parameters. Due to this time-consuming nature, parameter databases are previously not available until hours, days or even weeks later by which time, the parameters databases may have outlived their usefulness. With the
10 above-described database compilation, there is a potential to achieve real-time database compilation and thereby providing immediate or fast access to parameter databases for analysis. Also, parameters of interest may be more conveniently selected and extracted resulting in greater flexibility in the choice of information extraction. Any synchronisation solely of parameter databases also leave space for
15 error; as any corruption in the raw data / parameter data files (which are typically only available on a local hard drive / destination) will destroy the capability of database creation or analytics in entirety.

According to a second aspect of the invention, a method for detecting abnormalities is described with reference to a flow chart 300 of FIG. 3. In FIG. 3, a
20 database of baselines is established (step 302). The baselines may be classified by performance indicators, e.g. chiller plant efficiency, sensor data integrity, energy intensity. The baselines may also be classified according to the prevailing independent factors affecting performance, e.g. wet bulb temperature, cooling load of the chiller plant (in RT), etc. Accordingly, different baselines corresponding to
25 different wet bulb temperature and/or cooling load may be established and made available for selection.

A baseline may be established based on historical data using any known methods. For example, when a chiller plant is newly-installed and optimized, its performance graph over a predetermined time period is recorded and set as the
30 baseline. This baseline may be averaged when more performance graphs or historical data on the chiller plant is recorded over a longer period of time. The

averaged baseline may be compared against the individual performance graphs to identify a range of correlation coefficients. A coefficient value may be established as a threshold correlation coefficient for detecting an abnormality. The above-described baselining procedures may be applicable to baselining flow rate, temperature, power and critical parameters such as gpm/rt.

Depending on the performance indicator to be evaluated and the prevailing independent factors affecting the performance of the chiller plant during the time period to be evaluated, an appropriate baseline (hereinafter “first baseline”) and its corresponding threshold correlation coefficient (hereinafter “first threshold correlation coefficient”) is selected and retrieved from the baseline database (step 304). A correlation analysis then takes place where current parameter data or performance graph is compared against the first baseline to ascertain a current correlation coefficient (step 306). This current parameter data may be retrieved from one or more appropriate parameter databases which were created as described with references to FIGs. 2A to 2C. The current correlation coefficient is then checked for a breach of the first threshold correlation coefficient (step 308). If the first actual correlation coefficient does not breach the first threshold correlation coefficient, it is ascertained that there is no breach and therefore no abnormality exists (step 310). However, if the current correlation coefficient breaches the first threshold correlation coefficient, it is ascertained that a threshold breach exists and, accordingly, an optimization analysis is performed to ascertain preferred parameter data (or preferred operating parameters) and/or ascertain root-cause of the detected abnormality (step 312). The methodology for optimization analysis will be described in subsequent paragraphs.

According to a third aspect of the invention, an optimization analysis, including ascertaining preferred parameter data and/or root-cause of the abnormality is described with reference to FIG. 4A and FIG. 5.

Referring to FIG. 4A, a dataset library is searched to identify historical datasets with independent conditions (i.e. wet bulb temperature and cooling load) that are similar to current independent conditions (block 402). The dataset library (see Table 1 of FIG. 5) comprises a plurality of historical datasets, where each

dataset at least includes a historical wet bulb temperature, a historical cooling load, a plurality of historical parameter data and a historical system efficiency. These historical datasets represent data collected during past chiller plant operation and the dataset library may be updated from time to time. The search criteria may specify a predetermined margin for sifting out irrelevant data. In the example of FIG. 5, current wet bulb temperature is 26.5°C and current cooling load is 400 RT. The search criteria specify a predetermined margin of +/- 0.5°C for wet bulb temperature and +/- 10% for current cooling load. Based on the current wet bulb temperature, current cooling load and specified search criteria, a subset from the plurality of historical datasets is identified (see non-shaded cells of Table 2 of FIG. 5). As illustrated, both wet bulb temperature and cooling load of the subset fall within the predetermined margin of the current wet bulb temperature and the current cooling load.

Based on this identified subset, a plurality of preferred parameter data are ascertained which would improve or optimise current chiller plant energy efficiency (block 404). Various methods for ascertaining the preferred parameter data may be available.

In one method for ascertaining preferred parameter data, based on the historical system efficiencies of the identified subset, the most optimal historical system efficiency is selected as the preferred dataset. Referring to the identified subset illustrated in Table 3 of FIG. 5, the most optimal system efficiency is 0.53 kW/RT (lowest condenser system efficiency value). Accordingly, the historical dataset corresponding to this most optimal system efficiency is ascertained as the preferred dataset and historical parameter data corresponding to this preferred dataset are ascertained as the plurality of preferred parameter data.

In another method for ascertaining preferred parameter data, historical parameter data relating to condenser pump power and cooling tower power and historical system efficiencies corresponding to the identified subset are curve-fitted (i.e. deriving a mathematical function). By curve-fitting, the mathematical relationship derived from historical data is able to predict the combination of operating parameters that would result in the most optimal system efficiency (kW/RT).

Particularly, the constructed curve is to estimate condenser system efficiency. From the constructed curve, a combination of condenser pump power and cooling tower power which results in a most optimal system efficiency is ascertained by known numerical analysis methods. This combination is ascertained as the preferred dataset and the corresponding condenser pump power and cooling tower power values are ascertained as preferred parameter data (see Table 4 of FIG. 5). If this combination obtained from numerical analysis methods does not exist in the dataset library, the dataset library may be updated to include this combination.

Available methods of curve fitting include, but are not limited to, interpolation, such as polynomial curve fitting. Curve-fitting and numerical analysis methods may be implemented by Mathematica[®], MATLAB[®] or other software packages.

With the plurality of preferred parameter data ascertained from one of the above or other methods, current operation, including current parameter data, is altered in conformance with the plurality of preferred parameter data (block 406). Particularly, instructions with the preferred parameter data are sent to variable speed drives and/or other components at the condenser pump and/or cooling tower. Altering current operation in conformance with the preferred parameter data may be performed manually by chiller plant personnel or by automated means through chiller plant control system application.

Optionally, the optimisation method of FIG. 4A may proceed to identify the root-cause(s) of the detected abnormality. Particularly, at least one of the current parameter data is ascertained as a root-cause based on a deviation of the at least one of the current parameter data from the plurality of preferred parameter data (block 408). A notification including the ascertained root-cause may be sent to inform one or more predetermined recipients about the detected abnormality or the identified root-cause(s) or both (step 410). The notification may be sent by Short Message Service (SMS), mobile application message, electronic mail or other suitable modes of communication.

A chiller plant optimization is based on the following condenser subsystem relationship:

$$\text{Cooling towers (kW/RT)} + \text{Condenser pumps (kW/RT)} + \text{Chillers (kW/RT)} = \text{Condenser System Efficiency (kW/RT)},$$

where RT is cooling load and kW is power.

It has been observed that chillers (power) is dependent on cooling towers (power) and condenser pumps (power). Based on statistics, higher cooling towers power and condenser pumps power deliver better condenser water supply temperature. Lower condenser temperature is correlated with lower chiller power. However, condenser water supply temperature is also correlated with cooling load and wet bulb temperature. Therefore, it is necessary to select datasets for cooling towers (kW/RT), condenser pumps (kW/RT), chillers (kW/RT) with “similar” cooling load and wet bulb temperature. From the datasets, any of various methods (including identifying lowest kW/RT value or applying a numerical method) may be used to ascertain most optimal cooling tower (kW/RT) and condenser pumps (kW/RT) conditions that would result in the lowest condenser system efficiency (kW/RT).

FIG. 4B illustrates a hierarchal approach for optimisation analysis. In the above-described, the performance indicator to be evaluated and optimised is chiller plant efficiency. As independent conditions affecting chiller plant efficiency include wet bulb temperature and cooling load, corresponding baseline and historical data stored in a dataset library are searched to identify a subset which has similar conditions to current independent conditions. The identified subset is further evaluated to ascertain a preferred dataset corresponding to current conditions. In FIG. 4B, based on the most optimal efficiency (e.g. lowest kW/RT value), the corresponding historical dataset is ascertained as the preferred dataset and the corresponding historical parameter data are ascertained as the preferred parameter data. The preferred parameter data are then applied to the chiller plant. It is to be appreciated other methods of ascertaining a preferred dataset may be applied in the invention.

In certain cases where the chiller plant may henceforth be unable to achieve the first baseline for reasons including but not limited to, deterioration of the chiller plant and replacements of certain components of the chiller plants, the first baseline may be revised according to the baselining procedures described above or other
5 suitable procedures. The revised first baseline and the revised first threshold correlation coefficient value may be applied for detecting abnormality in future analysis.

It is to be appreciated that the above-described detection of abnormality, optimisation and root-cause analysis may be performed at the destination terminal or
10 at the source terminals or both. Accordingly, the notification informing the detected abnormality and root-cause analysis may be sent by the respective destination terminal or source terminal which performed the analysis. The analysis results may be synchronized to the destination terminal or source terminals if required.

With the above-described method for abnormality detection, optimisation
15 and/or root-cause analysis, certain advantages may be achieved. The optimisation analysis ascertains a set of preferred parameter data which would optimise chiller plant operation. This set of preferred parameter data may be presented to chiller plant personnel to take the appropriate action manually and/or to a chiller plant system application to take the appropriate action automatically. If this set of preferred
20 parameter data were ascertained based on historical parameter data which yielded most optimal efficiency under similar wet bulb temperature and cooling load conditions, current system efficiency may be improved to the most optimal historical efficiency level. Alternatively, if this set of preferred parameter data were ascertained based on numerical analysis of historical parameter data under similar wet bulb
25 temperature and cooling load conditions, current efficiency may be improved to achieve higher optimisation than historical efficiency level.

Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the invention. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the
30 disclosed embodiments of the invention. The embodiments and features described

above should be considered exemplary, with the invention being defined by the appended claims.

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What is claimed is:

1. A method for optimising a chiller plant, the method comprising:

providing a dataset library having a plurality of historical datasets, each of the
5 plurality of historical datasets at least including a historical wet bulb temperature, a
historical cooling load, a plurality of historical parameter data and a historical system
efficiency;

selecting a first baseline and a first threshold correlation coefficient value;

ascertaining a current correlation coefficient by comparing a plurality of
10 current parameter data with the first baseline;

if the current correlation coefficient breaches the first threshold correlation
coefficient value, based on a current wet bulb temperature and a current cooling
load, identifying a subset from the plurality of historical datasets wherein the subset
includes historical wet bulb temperature and historical cooling load which fall within a
15 predetermined margin of the current wet bulb temperature and the current cooling
load;

based on the identified subset, ascertaining a plurality of preferred parameter
data for the current wet bulb temperature and the current cooling load; and

altering at least one of the plurality of current parameter data in conformance
20 with the plurality of preferred parameter data.

2. The method of claim 1, wherein ascertaining a plurality of preferred parameter
data includes

identifying a most optimal historical system efficiency within the subset, and
25 ascertaining historical parameter data corresponding to the most optimal historical
system efficiency as the plurality of preferred parameter data.

3. The method of claim 1, wherein the plurality of historical parameter data include
condenser pump power, cooling tower power and chiller power, and the system
30 efficiency includes condenser system efficiency, and

wherein ascertaining a plurality of preferred parameter data includes

curve-fitting historical parameter data relating to condenser pump power and cooling tower power and historical system efficiencies which correspond to the subset, wherein the constructed curve is to estimate chiller power, and

from the constructed curve, ascertaining a combination of condenser pump power and cooling tower power which results in a most optimal system efficiency, and ascertaining the combination as the plurality of preferred parameter data.

4. The method of claim 3, further comprising:

updating the dataset library to include the plurality of preferred parameter data.

5. The method of any of the preceding claims, further comprising:

ascertaining at least one of the current parameter data as a root-cause based on a deviation of the at least one of the current parameter data from the preferred parameter data; and

sending a notification including the ascertained root-cause to at least a predetermined recipient.

6. The method of claim 5, wherein the notification is sent by at least one of Short Message Service (SMS), mobile application message and electronic mail.

7. The method of claim 1, wherein the first baseline relates to at least one of chiller plant efficiency, sensor data integrity and energy intensity.

8. The method of claim 1, wherein selecting a first baseline, and a first threshold correlation coefficient value includes selecting the first baseline from a baseline database having a plurality of baselines established for different combinations of wet bulb temperature and cooling load.

9. The method of claim 1, wherein the plurality of historical parameter data include condenser pump power, cooling tower power and chiller power, and the system efficiency includes condenser system efficiency.

10. The method of claim 1, further comprising:

revising the first baseline and the first threshold correlation coefficient value and storing the revised first baseline and the revised first threshold correlation coefficient value in the baseline database.

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11. A system for optimising a chiller plant, the system comprising:

a memory storage which is configured to provide a dataset library having a plurality of historical datasets, each of the plurality of historical datasets at least including a historical wet bulb temperature, a historical cooling load, a plurality of historical parameter data and a historical system efficiency; and

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a computing device which is configured to select a first baseline and a first threshold correlation coefficient value; ascertain a current correlation coefficient by comparing a plurality of current parameter data with the first baseline,

the computing device is further configured, if the current correlation coefficient breaches the first threshold correlation coefficient value, to identify a subset from the plurality of historical datasets wherein the subset includes historical wet bulb temperature and historical cooling load which fall within a predetermined margin of a current wet bulb temperature and a current cooling load,

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the computing device is further configured, based on the identified subset, to ascertain a plurality of preferred parameter data for the current wet bulb temperature and the current cooling load, and

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the computing processor device is further configured to alter at least one of the plurality of current parameter data in conformance with the plurality of preferred parameter data.

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12. The system of claim 11, wherein the computing device is further configured to identify a most optimal historical system efficiency within the subset, and ascertain historical parameter data corresponding to the most optimal historical system efficiency as the plurality of preferred parameter data.

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13. The system of claim 11, wherein the plurality of historical parameter data include condenser pump power, cooling tower power and chiller power, and the system efficiency includes condenser system efficiency, and

wherein the computing device is further configured to curve-fit historical parameter data relating to condenser pump power and cooling tower power and historical system efficiencies which correspond to the subset, wherein the constructed curve is to estimate chiller power, and

5 the computing device is further configured to ascertain, from the constructed curve, a combination of condenser pump power and cooling tower power which results in a most optimal system efficiency, and ascertain the combination as the plurality of preferred parameter data.

10 14. The system of claim 13, wherein the computing device is further configured to update the dataset library in the memory storage to include the plurality of preferred parameter data.

15 15. The system of any of the preceding claims, wherein the computing device is further configured to ascertain at least one of the current parameter data as a root-cause based on a deviation of the at least one of the current parameter data from the preferred parameter data, and send a notification including the ascertained root-cause to at least a predetermined recipient.

20 16. The system of claim 15, wherein the notification is sent by at least one of Short Message Service (SMS), mobile application message and electronic mail.

17. The system of claim 11, wherein the first baseline relates to at least one of chiller plant efficiency, sensor data integrity and energy intensity.

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18. The system of claim 11, wherein the computing device is further configured to select the first baseline from a baseline database stored in the memory storage device, the baseline database having a plurality of baselines established for different combinations of wet bulb temperature and cooling load.

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19. The system of claim 11, wherein the plurality of historical parameter data include condenser pump power, cooling tower power and chiller power, and the system efficiency includes condenser system efficiency.

20. The system of claim 1, wherein the computing device is configured to revise the first baseline and the first threshold correlation coefficient value, and store the revised first baseline and the revised first threshold correlation coefficient value in the baseline database.

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