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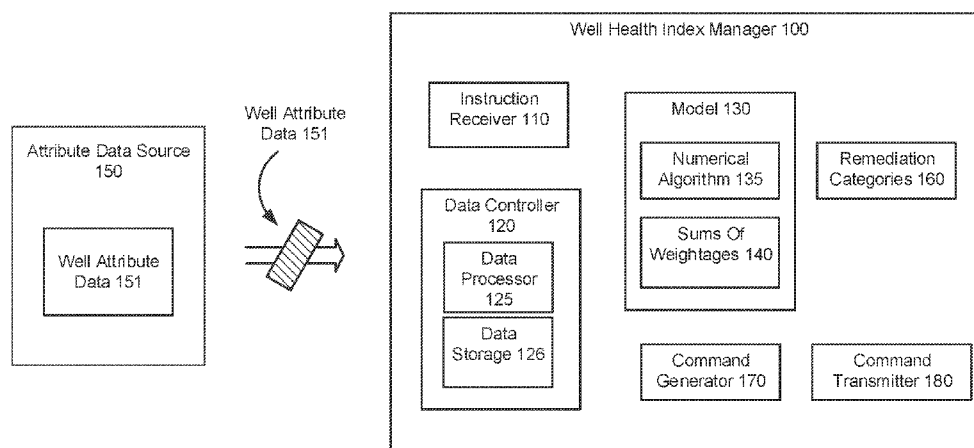


FIG. 1

(57) Abstract: A method, system, and non-transitory computer readable medium storing instructions executable by a computer processor, the instructions comprising functionality for determining remediation categories for a plurality of wells include: obtaining, by a computer processor, a plurality of attributes for the plurality of wells; obtaining, by the computer processor, a set of weightages for each of the plurality of attributes for the plurality of wells; generating, by the computer processor, a first Well Health Index (WHI) set for a well among the plurality of wells; generating, by the computer processor, a second WHI set for the well; determining, by the computer processor, a sum of weightages (140) of the second WHI set for the well; determining, by the computer processor, a remediation category (160) among a plurality of remediation categories (160) for the well based on the sum of weightages (140); and generating, by the computer processor, tracking notifications and action reports for the well.

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SYSTEM AND METHOD FOR IDENTIFYING PRODUCTIVE HEALTH OF WELLS WHILE ENSURING SAFE OPERATING CONDITIONS

BACKGROUND

[0001] Well production problems are caused by various reasons. For example, oil, gas, water, steel, and rock are chemically non-inert under oil/gas production conditions, and may cause accumulation of solids, deterioration and corrosion of metals, and other issues within the production system due to their mutual interactions, which will result in well production impairment. Traditionally, experienced engineers identify wells with production impairment, and take proper actions in order to bring the wells back to their full potential. However, the current inspection and remediation procedures heavily dependent on engineers' experience and awareness, as well as time-consuming human labor. As a result, many of the wells end up being left unattended for years without further notices and proper remediation procedures.

SUMMARY

[0002] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0003] In one aspect, embodiments disclosed herein relate to a method for determining remediation categories for a plurality of types of wells comprising: obtaining, by a computer processor, a plurality of attributes for the plurality of wells; obtaining, by the computer processor, a set of weightages for each of the plurality of attributes for the plurality of wells; generating, by the computer processor, a first Well Health Index (WHI) set for a well among the plurality of wells; generating, by the computer processor, a second WHI set for the well; determining, by the computer processor, a sum of weightages of the second WHI set for the well; determining, by the computer processor, a remediation category

among a plurality of remediation categories for the well based on the sum of weightages; and generating, by the computer processor, tracking notifications and action reports for the well.

[0004] In one aspect, embodiments disclosed herein relate to a system comprising: a plurality of attributes of a plurality of wells, and a Well Health Index (WHI) manager comprising a computer processor, wherein the WHI manager is configured to: obtaining the plurality of attributes for the plurality of wells; obtain a set of weightages for each of the plurality of attributes for the plurality of wells; generate a first Well Health Index (WHI) set for a well among the plurality of wells; generate a second WHI set for the well; determine a sum of weightages of the second WHI set for the well; determine a remediation category among a plurality of remediation categories for the well based on the sum of weightages; and generate tracking notifications and action reports for the well.

[0005] In one aspect, embodiments disclosed herein relate to a non-transitory computer readable medium storing instructions executable by a computer processor, the instructions comprising functionality for: obtaining a plurality of attributes for a plurality of wells; obtaining a set of weightages for each of the plurality of attributes for the plurality of wells; generating a first Well Health Index (WHI) set for a well among the plurality of wells; generating a second WHI set for the well; determining a sum of weightages of the second WHI set for the well; determining a remediation category among a plurality of remediation categories for the well based on the sum of weightages; and generating tracking notifications and action reports for the well.

[0006] Other aspects and advantages of the claimed subject matter will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0007] Specific embodiments of the disclosed technology will now be described in detail with reference to the accompanying figures. Like elements in the various figures are denoted by like reference numerals for consistency.

[0008] FIG. 1 shows a system in accordance with one or more embodiments.

[0009] FIG. 2A-2E show examples of pre-defined attribute sets for oil production wells, gas production wells, water injection/disposal wells, water supply wells, and observation wells, respectively.

[0010] FIG. 3 shows an example in accordance with one or more embodiments.

[0011] FIG. 4 shows a flowchart in accordance with one or more embodiments.

[0012] FIG. 5 shows a flowchart in accordance with one or more embodiments.

[0013] FIG. 6 shows a computer system in accordance with one or more embodiments.

DETAILED DESCRIPTION

[0014] Specific embodiments of the disclosure will now be described in detail with reference to the accompanying figures. Like elements in the various figures are denoted by like reference numerals for consistency.

[0015] In the following detailed description of embodiments of the disclosure, numerous specific details are set forth in order to provide a more thorough understanding of the disclosure. However, it will be apparent to one of ordinary skill in the art that the disclosure may be practiced without these specific details. In other instances, well-known features have not been described in detail to avoid unnecessarily complicating the description.

[0016] Throughout the application, ordinal numbers (e.g., first, second, third, etc.) may be used as an adjective for an element (i.e., any noun in the application). The use of ordinal numbers is not to imply or create any particular ordering of the elements nor to limit any element to being only a single element unless expressly disclosed, such as using the terms "before", "after", "single",

and other such terminology. Rather, the use of ordinal numbers is to distinguish between the elements. By way of an example, a first element is distinct from a second element, and the first element may encompass more than one element and succeed (or precede) the second element in an ordering of elements.

[0017] In general, embodiments of the disclosure include a system and a method for identifying productive health condition of wells while ensuring safe operations. More specifically, the present disclosure relates to a method for analyzing well health condition, evaluating well production enhancement potential, and tracking remediation procedures. In some embodiments, the method may utilize a plurality of attributes of a plurality of wells to generate a numerical model. Further, the method may utilize the model to generate a plurality of values representing health condition of the plurality of wells, and determine a remediation category for each of the plurality of wells based on the values.

[0018] Furthermore, the method may generate notifications and reports for the plurality of wells, and transmit them to users. In some embodiments, the notifications and reports may be transmitted to the users via e-mails generated by the method. Moreover, the method may include tracking procedures to ensure that proper remediation actions are taken in order to bring back full production potential of the wells. Accordingly, timely analysis of health condition of the wells and proper remediation procedures are achieved.

[0019] Fig. 1 shows a block diagram of a system in accordance with one or more embodiments. As illustrated in Fig. 1, an attribute data source (e.g., attribute data source (150)) provides various data for a Well Health Index (WHI) manager (e.g., Well Health Index Manager (100)). A data source may refer to any location where data that is being used originates or is stored. More specifically, a data source may be a database located in a disk or a remote serve, live measurements from physical devices, or a(n) file/data sheet/XML file within a computer program, etc. Types of data sources may differ according to the purposes or

functions of an application. In one or more embodiments, the attribute data source (150) may be stored on a computer. The attribute data source (150) may include well attribute data (e.g., well attribute data (151)). In some embodiments, the well attribute data (151) may be collected from a plurality of wells.

[0020] In one or more embodiments, the well attribute data (151) may include various well attributes. For example, the well attributes (151) may include, well names, well types, reservoir types, historical production data, reservoir pressure data and trends, shut-in well head pressure data, productivity index and skin factors, scaling tendency, produced fluid type properties, water cut, fill accumulation, formation or fraction sand production, etc. The well attributes are not limited to the above examples. Detailed contents of the attribute data (151) will be further explained below.

[0021] Keeping with FIG. 1, the WHI manager (100) may be software and/or hardware implemented on a network, such as a network controller, and include functionality for detecting and/or managing the WHI. For example, a WHI manager may collect attribute data of various of wells, process the collected attribute data, evaluate health condition of the wells, and/or manage well remediation procedures.

[0022] In some embodiments, the WHI manager (100) may include a instruction receiver (e.g., instruction receiver (110)) that receives instructions and/or inputs from users. More specifically, the users may enter various types of instructions and/or inputs via the instruction receiver (110) to start certain actions, such as calculating, evaluating, selecting, and/or updating data or parameters.

[0023] In some embodiments, the WHI manager (100) may include a data controller (e.g., data controller (120)) that collects, processes, and stores various data obtained from the attribute data source (150). The data controller (120) may be software and/or hardware implemented on the same or different computing device as the WHI manager (100), and may include functionalities for collecting,

processing, and storing the well attributes data (151) from the well attributes source (150). For example, the data controller may collect a plurality of well attribute data of a plurality wells and store the collected data in a data storage (e.g., data storage (126)) for further use and process. Further, the data controller (120) may include a data processor (e.g., data processor (125)) that sorts and processes the collected data, as well as data generated by other sections of the WHI manager (100) and data stored in the data storage (126). In other words, the data storage (126) may include not only the well attribute data (151) collected from the attribute data source (150), but also other data and parameters, such as pre-defined data correspondences, pre-defined weightages of the well attribute data (151), and/or data generated during operation of the WHI manager (100). In addition, the data processor (125) may include functionalities of generating flags for the well attributes (151) according to pre-defined conditions stored in the data storage (126). For example, the pre-defined conditions may be automatically generating flags for certain of the well attributes (151) for each type of the plurality of wells. More specifically, the last columns in FIGs. 2A-2E show examples of the well attributes (151) that are automatically flagged for each type of the plurality of wells. Moreover, the data controller (120) may include functionalities of removing flags upon receiving certain instructions.

[0024] In some embodiments, the data storage (126) may include pre-defined correspondences between well types and well attributes. Specifically, the WHI manager may be applied to different types of wells, including oil wells, gas wells, water injection/disposal wells, water supply wells, and observation wells. Each of the well type has a pre-defined set of well attributes. That is, each well type corresponds to a particular set of well attributes that are identified by experts to classify the well types. In particular, FIGs. 2A-2E show examples of pre-defined sets of well attributes for different types of wells. Additionally, the data storage (126) may include pre-determined weights for the collected well attribute data (151). For example, FIGs. 2A-2E also show examples of the pre-determined weights for each well attributes of different types of wells.

[0025] Continuing with the data controller (120), the data controller (120) may include functionalities of automatically generating lists of pre-defined well attributes for the plurality of wells. In particular, FIGs. 2A-2E show examples of the pre-defined well attributes to be used for the automatic list generation.

[0026] Keeping with FIG. 1, the WHI manager (100) may include a model (e.g., model (130)) that utilizes one or more numerical algorithms (e.g., numerical algorithm (135)). Specifically, the model (130) may include functionality to calculate sums of weightages of a plurality of selected well attributes (e.g., sums of weightages (140)) utilizing the numerical algorithm (135). Further, the WHI manager (100) may include functionalities of determining remediation categories (e.g., remediation categories (160)) for the wells utilizing the sums of weightages (140). Detailed contents of the remediation categories (160) will be further explained below.

[0027] Specifically, the numerical algorithm may refer to one or more algorithms that use numerical approximation for analyzing mathematical problems. Some major areas of the numerical algorithm may include computing values of functions; interpolation, extrapolation, and regression; solving equations; optimization; and evaluating integrals, etc. In particular, the numerical algorithm may be realized by computing applications, such as MATLAB, and programming languages, such as R and Python.

[0028] Moreover, the WHI manager (100) may include a command generator (e.g., command generator (170)). The command generator may include functionalities of generating tracking notifications and various reports of the wells. For example, the tracking notifications may refer to notifications reminding the users that one or more wells require certain remediation actions. Further, the well reports may refer to reports notifying the users that modifications or changes are applied to the well attribute data (151) of the plurality of wells. Additionally, the well reports may reflect actions applied to the wells. For example, the actions may indicate action date, action content,

organization code representing the action, planned completion date of the remediation actions, and actual completion date of the remediation actions.

[0029] Keeping with FIG. 1, the WHI manager (100) may include a command transmitter (e.g., command transmitter (180)). The command transmitter (180) may include functionalities of transmitting the notifications and reports generated by the command generator (170) to the users. For example, the command transmitter (180) may transmit the tracking notifications and action report via e-mails. In particular, the tracking notifications may be repeatedly transmitted to the users for purposes of reminding. In some embodiments, the tracking notifications may be set to be sent to the users ahead of a certain time (e.g., 10 days) before a target date of completion of the remediation actions.

[0030] In some embodiments, the attribute data source (150) and the WHI manager (100) may be implemented on the same computing device, or different computing systems connected by a network. In some embodiments, the attribute data source (150), the WHI manager (100) and/or other elements, including but not limited to network elements, user equipment, user devices, servers, and/or network storage devices may be implemented on computing systems similar to the computing system (500) shown and described in FIG. 5 below.

[0031] While FIG. 1 shows various configurations of components, other configurations may be used without departing from the scope of the disclosure. For example, various components in FIG. 1 may be combined to create a single component. As another example, the functionality performed by a single component may be performed by two or more components.

[0032] Turning to FIG. 3, FIG. 3 provides an example of utilizing a model to identify a remediation category for a well. The following example is for explanatory purposes only and not intended to limit the scope of the disclosed technology. In FIG. 3, a model (e.g., model (330)) may be one or more models utilizing numerical algorithms (e.g., numerical algorithm (335)). Similar to the description in FIG. 1, the model (330) may obtain well attribute data of a well

(e.g., well attribute data of a well (351)) as inputs. In particular, the well attribute data of the well (351) may include the automatically generated lists of pre-defined well attributes for the plurality of wells as described above in FIG. 1, as well as additional well attributes selected and approved by the users. In particular, the well attributes selected and approved by the users may refer to additional well attributes that contribute to production impairment of the well. The model (330) may generate a sum of weights (e.g., sum of weightages (340)) utilizing the numerical algorithm (335). The sum of weightages represents health condition of the plurality of wells. Further, the model (330) may include functionalities of determining a remediation category (e.g., remediation category (360)) for the well as an output based on the sum of weightages (340). Detailed contents of the remediation category (360) will be described below.

[0033] Turning to FIG. 4, FIG.4 shows a flowchart in accordance with one or more embodiments. Specifically, FIG. 4 describes a general method for determining a remediation category for a well. One or more blocks in FIG. 4 may be performed by one or more components as described in FIG. 1, for example, the WHI manager (100). While the various blocks in FIG. 4 are presented and described sequentially, one of ordinary skill in the art will appreciate that some or all of the blocks may be executed in different orders, may be combined or omitted, and some or all of the blocks may be executed in parallel. Furthermore, the blocks may be performed actively or passively.

[0034] In Block 410, a plurality of attributes for a well are obtained. For example, the plurality of attributes may be obtained by a data controller and include, but not limited to well names, well types, reservoir types, historical production data, reservoir pressure data and trends, shut-in well head pressure data, productivity index and skin factors, scaling tendency, produced fluid type properties, water cut, fill accumulation, formation or fraction sand production, surface facility restrictions, etc. Furthermore, Figs. 2A-2E show examples of the plurality attributes that are required to be obtained for each type of wells.

[0035] In Block 420, a first WHI set is generated for the well. For example, the first WHI may be generated by the data controller. More specifically, the first WHI set may be generated in accordance with pre-defined correspondences between well categories and well attributes that may be stored in a data storage in the data controller.

[0036] In Block 430, attribute flags are generated for the well. For example, the attribute flags may be automatically generated in accordance with pre-defined conditions stored in the data storage in the data controller. Furthermore, the generation may be executed by the data controller.

[0037] In Block 440, a second WHI set based on the first WHI set and user's selections is obtained. For example, upon generating the first WHI set, the user reviews all the parameters in the first WHI set, and select additional well attributes that contribute to production impairment. As such, a second WHI set including the first WHI set and the additionally selected well attributes are obtained. The second WHI set may be obtained by the data controller.

[0038] In Block 450, a sum of weightages of the second WHI set is generated utilizing a model. For example, the second WHI set may be generated by the model comprising numerical algorithm, wherein the numerical algorithm calculates a sum of weightages of the second WHI set. In particular, the weightages of each well attribute are pre-defined and may be stored in the data controller. Examples of the weightages of the well attributes may be as shown in FIGs. 2A-2E. Moreover, the model may be couple to the data controller.

[0039] In Block 460, a remediation category for the well is determined utilizing the sum of the weightages and the model. For example, based on a pre-defined standard, the sum of weightage of the well represent a remediation category of the well. Specifically, one remediation category may correspond to a range of values of the sum of weightages. More details would be described in the descriptions for FIG. 5 below.

[0040] In Block 470, tracking notifications and action reports for the well are generated and transmitted to the user. For example, upon adjusting well attributes (such as water cut, reservoir pressure, etc.) and/or receiving remediation actions, tracking notifications and action reports will be sent to the user so that the changes and pending actions are reviewed and approved by the user for managements and tracking purposes.

[0041] In Block 480, the attribute flags generated in Block 430 are removed upon detecting remediation of the well. For example, upon receiving tracking notifications, the users are forced to take remediation procedures so that the well production level would be brought back to normal or the well's full potential. After the remediation procedures are done and the wells are evaluated as in good health, the previously generated attribute flags are removed. The remove may be executed by the data controller.

[0042] Those skilled in the art will appreciate that the process of FIG. 4 may be repeated for any existing wells.

[0043] Turning to FIG. 5, FIG. 5 shows a flowchart in accordance with one or more embodiments. Specifically, FIG. 5 describes a general method for determining remediation category for a well. More specifically, FIG. 5 describes detailed procedures of Block 460 in FIG. 4. One or more blocks in FIG. 5 may be performed by one or more components as described in FIG. 1, for example, the WHI manager (100). While the various blocks in FIG. 5 are presented and described sequentially, one of ordinary skill in the art will appreciate that some or all of the blocks may be executed in different orders, may be combined or omitted, and some or all of the blocks may be executed in parallel. Furthermore, the blocks may be performed actively or passively.

[0044] In Block 510, a determination is made whether sum of weightages is between 0 and 15. If the determination is Yes, the process proceeds to Block 515, and identify a remediation category of the well as Good Health Well, and

the process ends after Block 515. If the determination is No, the process proceed to Block 520.

[0045] More specifically, the Good Health Well refers to the wells that are currently healthy without being identified issues. In particular, with annual indexing update, health condition of the Good Health Wells may change. Therefore, regular monitoring on the wells that are identified as Good Health Well are still necessary

[0046] In Block 520, a determination is made whether the sum of weightages is between 16 and 40. If the determination is Yes, the process proceeds to Block 525, and identify the remediation category of the well as Prospective Production Enhancement Well. If the determination is No, the process proceeds to Block 530.

[0047] Specifically, the Prospective Production Enhancement Well refers to those wells that have some defined attributes and will need further evaluation from users (e.g., Production Engineers) including one or more of the evaluation techniques like Evaluation though various software (e.g., PipeSim, Prosper), running gauge cutter to confirm flow restriction, installed choke valve evaluation, subsurface safety valve (SSSV) functionality and restriction, reservoir pressure changes and water cut increase.

[0048] In Block 530, a determination is made whether the sum of weightages is between 41 and 500. If the determination is Yes, the process proceeds to Block 535, and identify the remediation category of the well as Priority Remedial Well. If the determination is No, the process proceeds to Block 540.

[0049] Specifically, the Priority Remedial Well refers to those wells that need immediate action from users (e.g., the Production Engineers) for production enhancement. For example, the actions for production enhancement, *i.e.*, the remediation actions, may include one or more of the solutions such as proceeding acid stimulation, proceeding water shut-off, proceeding fill clean-out, retrieving fish in the wellbore, repairing/replacing defective choke valves, fixing electrical

submersible pump (ESP) related issues, reviving dead wells, etc. In particular, production of the wells fall in this category is directly impacted by one or more well attributes. Wells under this category have the highest remediation priorities and require necessary well services work.

[0050] In Block 540, a determination is made whether the sum of weightages is larger than 500. If the determination is Yes, the process proceeds to Block 545, and identify a remediation category of the well as Special Category Well.

[0051] Specifically, the Special Category Well refer to those wells that are critical from Well Integrity Risk Ranking (WIRR), or the wells which are dead wells that may require decisions and/or actions of other entities in an organization for sidetrack, workover, abandonment, suspension, log interpretation, etc. The Special Category Well may also refer to dead wells that are on long-term waiting for reservoir pressure to increase for well self-revival.

[0052] Further, if the process proceeds to either one of Blocks 525, 535, and 545, remediation actions that would bring the well back to its full potential would be required. The process further proceeds Block 580 upon receiving proper remediation actions. Therefore, in Block 580, an updated sum of weightages is generated utilizing updated WHI sets. Afterwards, the determination process restarts with the updated sum of weightages until the well is categorized as Good Health Well.

[0053] Those skilled in the art will appreciate that the process of FIG. 5 may be repeated for any existing wells.

[0054] Turning to FIG. 6, FIG. 6 shows a computing system in accordance with one or more embodiments. Embodiments disclosed herein may be implemented on a computing system. Any combination of mobile, desktop, server, router, switch, embedded device, or other types of hardware may be used. For example, as shown in FIG. 6, the computing system (600) may include one or more computer processors (602), non-persistent storage (604) (e.g., volatile memory, such as random access memory (RAM), cache memory), persistent storage (606)

(e.g., a hard disk, an optical drive such as a compact disk (CD) drive or digital versatile disk (DVD) drive, a flash memory, etc.), a communication interface (612) (e.g., Bluetooth interface, infrared interface, network interface, optical interface, etc.), and numerous other elements and functionalities.

[0055] The computer processor(s) (602) may be an integrated circuit for processing instructions. For example, the computer processor(s) may be one or more cores or micro-cores of a processor. The computing system (600) may also include one or more input devices (610), such as a touchscreen, keyboard, mouse, microphone, touchpad, electronic pen, or any other type of input device. In one or more embodiments, the computer processor(s) (602) and the input device(s) (610) may be included in the WHI manager (100) as described in FIG. 1 and the accompanying description.

[0056] The communication interface (612) may include an integrated circuit for connecting the computing system (600) to a network (not shown) (e.g., a local area network (LAN), a wide area network (WAN) such as the Internet, mobile network, or any other type of network) and/or to another device, such as another computing device.

[0057] Further, the computing system (600) may include one or more output devices (608), such as a screen (e.g., a liquid crystal display (LCD), a plasma display, touchscreen, cathode ray tube (CRT) monitor, projector, or other display device), a printer, external storage, or any other output device. One or more of the output devices may be the same or different from the input device(s). The input and output device(s) may be locally or remotely connected to the computer processor(s) (602), non-persistent storage (604), and persistent storage (606). Many different types of computing systems exist, and the aforementioned input and output device(s) may take other forms. In one or more embodiments, the one or more output devices (608) may be included in the WHI manager (100) in order to output the tracking notifications and action reports as described in FIG. 1 and the accompanying description.

[0058] Software instructions in the form of computer readable program code to perform embodiments of the disclosure may be stored, in whole or in part, temporarily or permanently, on a non-transitory computer readable medium such as a CD, DVD, storage device, a diskette, a tape, flash memory, physical memory, or any other computer readable storage medium. Specifically, the software instructions may correspond to computer readable program code that, when executed by a processor(s), is configured to perform one or more embodiments of the disclosure.

[0059] The computing system (600) in FIG. 6 may be connected to or comprise a computer that further comprises the attribute data source (150) and the WHI manager (100) as described in FIG. 1 and the accompanying description.

[0060] The computing system of FIG. 6 may include functionality to present raw and/or processed data, such as results of comparisons and other processing. For example, presenting data may be accomplished through various presenting methods. Specifically, data may be presented through a user interface provided by a computing device. The user interface may include a GUI that displays information on a display device, such as a computer monitor or a touchscreen on a handheld computer device. The GUI may include various GUI widgets that organize what data is shown as well as how data is presented to a user. Furthermore, the GUI may present data directly to the user, e.g., data presented as actual data values through text, or rendered by the computing device into a visual representation of the data, such as through visualizing a data model.

[0061] For example, a GUI may first obtain a notification from a software application requesting that a particular data object be presented within the GUI. Next, the GUI may determine a data object type associated with the particular data object, e.g., by obtaining data from a data attribute within the data object that identifies the data object type. Then, the GUI may determine any rules designated for displaying that data object type, e.g., rules specified by a software framework for a data object class or according to any local parameters defined

by the GUI for presenting that data object type. Finally, the GUI may obtain data values from the particular data object and render a visual representation of the data values within a display device according to the designated rules for that data object type.

[0062] Data may also be presented through various audio methods. In particular, data may be rendered into an audio format and presented as sound through one or more speakers operably connected to a computing device.

[0063] Data may also be presented to a user through haptic methods. For example, haptic methods may include vibrations or other physical signals generated by the computing system. For example, data may be presented to a user using a vibration generated by a handheld computer device with a predefined duration and intensity of the vibration to communicate the data.

[0064] The above description of functions presents only a few examples of functions performed by the computing system of FIG. 6. Other functions may be performed using one or more embodiments of the disclosure.

[0065] While the disclosure has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the disclosure as disclosed herein. Accordingly, the scope of the disclosure should be limited only by the attached claims.

[0066] Embodiments of the present disclosure may provide at least one of the following advantages: reducing dependencies on human labor, reducing human errors, improving budgetary allocation, and improving effectiveness of drilling planning and forecasting, etc.

[0067] Although only a few example embodiments have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the example embodiments without materially departing from this

invention. Accordingly, all such modifications are intended to be included within the scope of this disclosure as defined in the following claims.

CLAIMS

What is claimed is:

1. A method for determining remediation categories for a plurality of types of wells comprising:
 - obtaining, by a computer processor (602), a plurality of attributes for the plurality of wells;
 - obtaining, by the computer processor (602), a set of weightages for each of the plurality of attributes for the plurality of wells;
 - generating, by the computer processor (602), a first Well Health Index (WHI) set for a well among the plurality of wells;
 - generating, by the computer processor (602), a second WHI set for the well;
 - determining, by the computer processor (602), a sum of weightages (140; 340) of the second WHI set for the well;
 - determining, by the computer processor (602), a remediation category (160; 360) among a plurality of remediation categories (160; 360) for the well based on the sum of weightages (140; 340); and
 - generating, by the computer processor (602), tracking notifications and action reports for the well.
2. The method of claim 1, further comprising:
 - obtaining, by the computer processor (602), a first set of correspondences between the plurality of types and a plurality of well attribute sets,
 - wherein the first WHI set is generated based on the first set of correspondences;
 - and
 - wherein the second WHI set is generated based on the first WHI set and users' selections.
3. The method of any of claims 1-2, further comprising:

obtaining, by the computer processor (602), a second set of correspondences between the plurality of types and a plurality of attribute flags; and generating, by the computer processor (602), attribute flags for the well, wherein the attribute flags are generated for attributes comprised in the first WHI set.

4. The method of any of claims 1-3, wherein the sum of weightages (140; 340) of the second WHI set is generated based on the set of weightages for each of the plurality of attributes for the plurality of wells.
5. The method of any of claims 1-4, further comprising:
 - generating, by the computer processor (602), a plurality of tracking notifications and action reports; and
 - transmitting, by the computer processor (602), the plurality of tracking notifications and action reports.
6. The method of any of claims 1-5, wherein the plurality of types of wells comprise oil wells, gas wells, water injection and disposal wells, water supply wells, and observation wells.
7. The method of any of claims 1-6, wherein each of the plurality of remediation categories correspond to a plurality of values of the sum of weightages (140; 340).
8. A system comprising:
 - a plurality of attributes of a plurality of wells of a plurality of types, and
 - a Well Health Index (WHI) manager (100) comprising a computer processor (602), wherein the WHI manager (100) is configured to:
 - obtaining the plurality of attributes for the plurality of wells;
 - obtain a set of weightages for each of the plurality of attributes for the plurality of wells;
 - generate a first Well Health Index (WHI) set for a well among the plurality of wells;

generate a second WHI set for the well;
determine a sum of weightages (140; 340) of the second WHI set for the well;
determine a remediation category (160; 360) among a plurality of remediation categories (160; 360) for the well based on the sum of weightages (140; 340); and
generate tracking notifications and action reports for the well.

9. The system of claim 8, wherein the WHI manager (100) is further configured to:
obtain a first set of correspondences between the plurality of types and a plurality of well attribute sets,
wherein the first WHI set is generated based on the first set of correspondences;
and
wherein the second WHI set is generated based on the first WHI set and users' selections.
10. The system of any of claims 8-9, wherein the WHI manager (100) is further configured to:
obtain a second set of correspondences between the plurality of types and a plurality of attribute flags; and
generate attribute flags for the well,
wherein the attribute flags are generated for attributes comprised in the first WHI set.
11. The system of any of claims 8-10, wherein the sum of weightages (140; 340) of the second WHI set is generated based on the set of weightages (140; 340) for each of the plurality of attributes for the plurality of wells.
12. The system of any of claims 8-11, wherein the WHI manager is further configured to:
generating a plurality of tracking notifications and action reports; and
transmitting the plurality of tracking notifications and action reports.

13. The system of any of claims 8-12, wherein the plurality of types of wells comprise oil wells, gas wells, water injection and disposal wells, water supply wells, and observation wells.
14. The system of any of claims 8-13, wherein each of the plurality of remediation categories (160; 360) correspond to a plurality of values of the sum of weightages (140; 340).
15. A non-transitory computer readable medium storing instructions executable by a computer processor (602), the instructions comprising functionality for:
 - obtaining a plurality of attributes for a plurality of wells of a plurality of types;
 - obtaining a set of weightages for each of the plurality of attributes for the plurality of wells;
 - generating a first Well Health Index (WHI) set for a well among the plurality of wells;
 - generating a second WHI set for the well;
 - determining a sum of weightages (140; 340) of the second WHI set for the well;
 - determining a remediation category (160; 360) among a plurality of remediation categories (160; 360) for the well based on the sum of weightages (140; 340); and
 - generating tracking notifications and action reports for the well.
16. The non-transitory computer readable medium of claim 15, wherein the instructions further comprising functionality for:
 - obtaining a first set of correspondences between the plurality of types and a plurality of well attribute sets,
 - wherein the first WHI set is generated based on the first set of correspondences;
 - and
 - wherein the second WHI set is generated based on the first WHI set and users' selections.

17. The non-transitory computer readable medium of any of claims 15-16, wherein the instructions further comprising functionality for:
- obtaining a second set of correspondences between the plurality of types and a plurality of attribute flags; and
 - generating attribute flags for the well,
- wherein the attribute flags are generated for attributes comprised in the first WHI set.
18. The non-transitory computer readable medium of any of claims 15-17, wherein the sum of weightages (140; 340) of the second WHI set is generated based on the set of weightages (140; 340) for each of the plurality of attributes for the plurality of wells.
19. The non-transitory computer readable medium of any of claims 15-18, wherein the instructions further comprising functionality for:
- generating a plurality of tracking notifications and action reports; and
 - transmitting the plurality of tracking notifications and action reports.
20. The non-transitory computer readable medium of any of claims 15-19, wherein the plurality of types of wells comprise oil wells, gas wells, water injection and disposal wells, water supply wells, and observation wells.

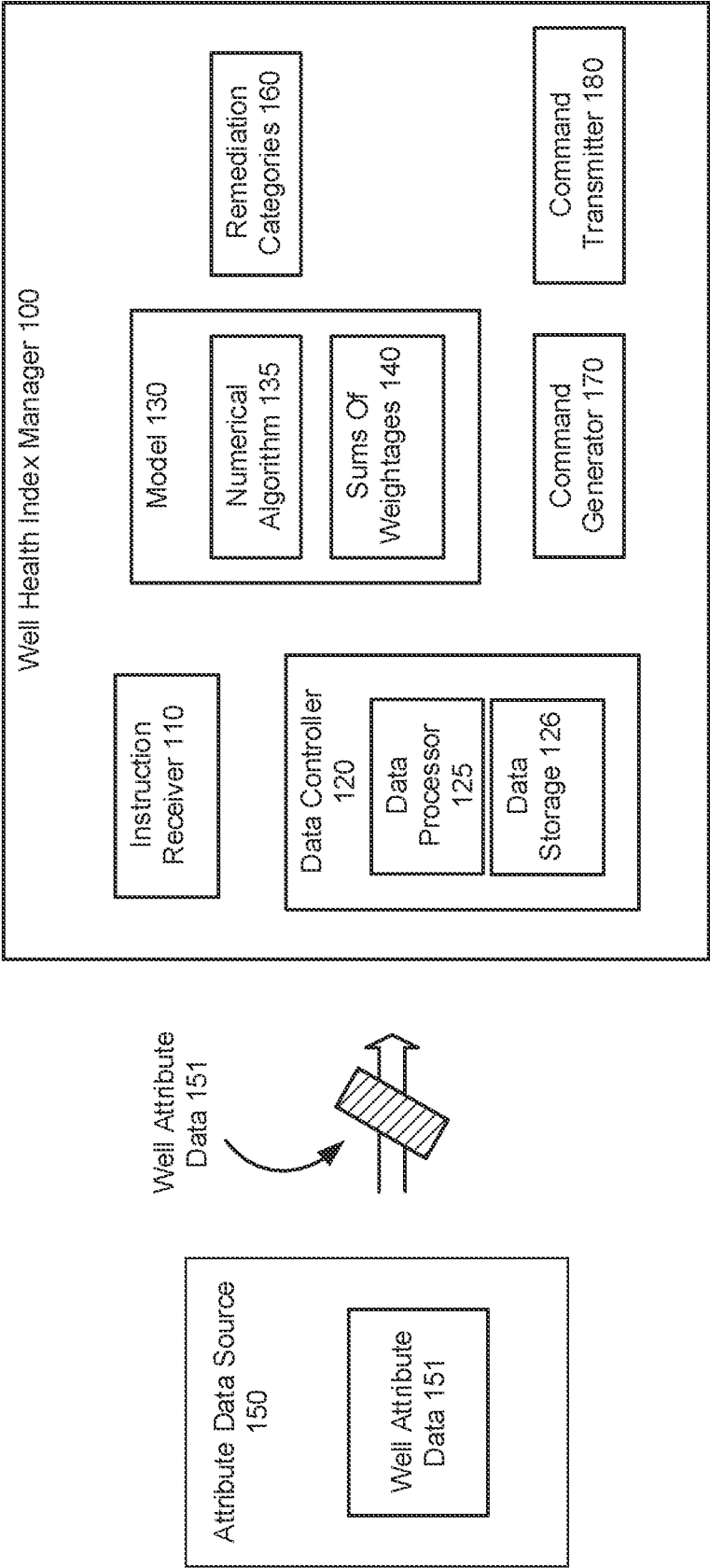


FIG. 1

ATTRIBUTE DESCRIPTION	DEFINITION	WEIGHT	CAT	CAT DESC	AUTO CALC
Is the well NOT meeting Production/Injection Targets / NOT Rate Compliant (Requires mandatory selection of another contributing attribute)?	Is the well NOT meeting production target? Not rate compliant? Requires another attribute to be selected that would define reason for non-compliance of rate	15	PROD	PRODUCTIVITY	Y
Is the well flowing Below bubble point pressure?	Is the well flowing bottom hole pressure below the bubble point pressure of the wellbore? To be confirmed through PTA test (PI)	80	PROD	PRODUCTIVITY	Y
Is the PI/I of the well in declining trend?	Is the PTA test result confirmed decline in in PI/I?	15	PROD	PRODUCTIVITY	
Is the damaged Skin factor positive or is in increasing trend?	Is the Skin damaged factor positive or showing increasing trend?	15	PROD	PRODUCTIVITY	Y
Is the well ranked as Critical Well in WIRR?	Is the well ranked as Critical Well in WIRR?	501	INT	INTEGRITY	Y
Is the well dead well and there is NO action plan by PE?	Is the well not able to flow inspite of reviving using test trap at reduced pressure due to low reservoir pressure?	501	PROD	PRODUCTIVITY	Y
Is the well dead and a remedial action plan is in place?	Is the well not able to flow inspite of reviving using test trap at reduced pressure and damaged is foreseen due to drilling fluid/ water loading in the wellbore?	60	PROD	PRODUCTIVITY	Y
Is there commingling of flow in the reservoir (Cross Flow)?	Is there cross flow in the reservoir confirmed through production log?	4	PROD	PRODUCTIVITY	
Does the well require frequent shut-ins to flow (Cyclic well)?	Is the well flowing intermittently for some period of time and then die and after a period of build up, the well start to flow again for a short period of time?	20	PROD	PRODUCTIVITY	
Is the well under performing or closed due to ESP related issues?	Is the Well under producing or closed due to ESP related issues?	45	PROD	PRODUCTIVITY	Y
Is the flow of the well getting restricted due to high viscous fluid (TAR/Sticky material)?	Is there restriction of flow due to presence of tar/sticky materials?	30	PROD	PRODUCTIVITY	
Is there issue in the ICV Functionality with no impact on oil production?	Is there leak in the ICV control line without impacting production?	4	PROD	PRODUCTIVITY	

Fig. 2A

ATTRIBUTE DESCRIPTION	DEFINITION	WEIGHT	CAT	CAT DESC	AUTO CALC
Is the ICV functionality issue leading to reduction in oil Production?	Is there leak in the ICV control line reducing production? Is there stuck ICV reducing production?	30	PROD	PRODUCTIVITY	
Is fill accumulation impacting production?	Is well production impacted due to fill (for eg. Debris, formation sand, proppant, etc.) accumulation in the wellbore?	45	WB	WELLBORE ISSUES	
Is the production restricted due to sand production ?	Is there production of formation sand which is restricting production?	15	WB	WELLBORE ISSUES	
Is there restriction in production due to surface flowline restrictions?	Is there restriction due to defective choke valve/smaller size pipeline?	20	SURF	SURFACE / FACILITIES	
Is production impacted due to Tubing / Flowline scale?	Is there restriction in production due to scale build up in the tubulars?	45	SURF	SURFACE / FACILITIES	
Is there Wellbore restriction (fish, SSSV issue)?	Is wellbore restriction due to fish in the tubulars or closed/partially closed SSSV, which is impacting production?	20	WB	WELLBORE ISSUES	
Is there yearly decline in SBHP from 20-50 psi?	Is there yearly decrease in reservoir pressure from 20 to 50 psi?	4	PROD	PRODUCTIVITY	Y
Is there yearly decline in SBHP from 51-100 psi?	Is there yearly decrease in reservoir pressure from 51 to 100 psi?	10	PROD	PRODUCTIVITY	Y
Is there yearly decline in SBHP more than 100psi?	Is there yearly decrease in reservoir pressure more than 100 psi	30	PROD	PRODUCTIVITY	Y
Is the water cut between 10-30 %?	Is the well producing with water cut between 10 to 30 %?	4	PROD	PRODUCTIVITY	Y
Is the water cut between 31-70 %?	Is the wells producing with water cut between 31 to 70 %?	10	PROD	PRODUCTIVITY	Y
Is the water cut more than 70 %?	Is the wells producing with water cut more than 70 %?	30	PROD	PRODUCTIVITY	Y
Is the incremental quarterly increase in water cut from 1 to 5 %?	Is the incremental quarterly increase in water cut from 1 to 5 %?	4	PROD	PRODUCTIVITY	Y
Is the incremental quarterly increase in water cut from 6 to 10 %?	Is the incremental quarterly increase in water cut from 6 to 10 %?	10	PROD	PRODUCTIVITY	Y
Is the incremental quarterly increase in water cut more than 10 %?	Is the incremental quarterly increase in water cut more than 10 %?	30	PROD	PRODUCTIVITY	Y

Fig. 2A(cont.)

ATTRIBUTE DESCRIPTION	DEFINITION	WEIGHT	CAT	CAT DESC	AUTO CALC
Is the well NOT meeting Production/Injection Targets / NOT Rate Compliant (Requires mandatory selection of another contributing attribute)?	Is the well NOT meeting production target? Not rate compliant? Requires another attribute to be selected that would define reason for non-compliance of rate	15	PROD	PRODUCTIVITY	Y
Is the PI/II of the well in declining trend?	Is the PTA test result confirmed decline in in PI/II?	15	PROD	PRODUCTIVITY	
Is Skin factor in increasing trend?	Are trends of Skin damaged factor showing increasing trend due to which production is impacted	15	PROD	PRODUCTIVITY	
Is the well ranked as Critical Well in WIRR?	Is the well ranked as Critical Well in WIRR?	501	INT	INTEGRITY	Y
Is the well dead well and there is NO action plan by PE?	Is the well not able to flow inspite of reviving using test trap at reduced pressure due to low reservoir pressure?	501	PROD	PRODUCTIVITY	Y
Is the well dead and a remedial action plan is in place?	Is the well not able to flow inspite of reviving using test trap at reduced pressure and damaged is foreseen due to drilling fluid/ water loading in the wellbore?	45	PROD	PRODUCTIVITY	Y
Is well production restricted due to surface facility (e.g. gas plant) liquid handling limitations?	Is well production restricted due to surface facility (e.g. gas plant) liquid handling limitations?	4	SURF	SURFACE / FACILITIES	
Is well productivity effected due to liquid Loading?	Is production impacted due to liquid loading, proven by gradient surveys / PLTs, etc.	30	PROD	PRODUCTIVITY	
Does the well require frequent shut-ins to iflow (Cyclic well)?	Is the well flowing intermittently for some period of time and then die and after a period of built up, the well start to flow again for a short period of time?	20	PROD	PRODUCTIVITY	
Is the well completed in multiple payzones with pressure contrast (Conningled zones - Cross Flow)?	Is there cross flow in the reservoir confirmed through production logs?	4	PROD	PRODUCTIVITY	

Fig. 2B

ATTRIBUTE DESCRIPTION	DEFINITION	WEIGHT	CAT	CAT DESC	AUTO CALC
Is fill accumulation impacting production?	Is well production impacted due to fill (for eg. Debris, formation sand, proppant etc.) accumulation in the wellbore?	45	WB	WELLBORE ISSUES	
Is the production restricted due to sand production?	Is there production of formation sand which is restricting production?	10	WB	WELLBORE ISSUES	
Is there restriction in production due to surface flowline restrictions?	Is there restriction due to defective choke valve/smaller size pipeline?	4	SURF	SURFACE / FACILITIES	
Is production impacted due to Tubing / Flowline scale?	Is there restriction in production due to scale build up in the tubulars?	45	SURF	SURFACE / FACILITIES	
Is there Wellbore restriction (fish, SSSV issue)?	Is wellbore restriction due to fish in the tubulars or closed/partially closed SSSV, which is impacting production?	4	WB	WELLBORE ISSUES	
Is the well shut-in due to tendency hydrates at choke / PCV due to high pressure drops during start ups?	Is well start-up an issue due to hydrate formation and hence is shut-in? This may require addition / change of surface setup and / or procedures	45	SURF	SURFACE / FACILITIES	
Is there a decline in SBHP?	Is SBHP trend of the well on a decline mode?	4	PROD	PRODUCTIVITY	

Fig. 2B(cont.)

ATTRIBUTE DESCRIPTION	DEFINITION	WEIGHT	CAT	CAT_DESC	AUTO_CALC
Is the well NOT meeting Production/Injection Targets / NOT Rate Complaint (Requires mandatory selection of another contributing attribute)?	Is the well NOT meeting production target? Not rate compliant? Requires another attribute to be selected that would define reason for non-compliance of rate	15	PROD	PRODUCTIVITY	Y
Is the PI/I of the well in declining trend?	Is the PTA test result confirmed decline in in PI/I?	15	PROD	PRODUCTIVITY	
Is the damaged Skin factor positive or is in increasing trend?	Is the Skin damaged factor positive or showing increasing trend?	15	PROD	PRODUCTIVITY	Y
Is the well ranked as Critical Well in WIRR?	Is the well ranked as Critical Well in WIRR?	501	INT	INTEGRITY	Y
Is fill accumulation impacting production?	Is well production impacted due to fill (for e.g. Debris, formation sand, proppant, etc.) accumulation in the wellbore?	45	WB	WELLBORE ISSUES	
Is there scale in Casing / Tubing / flowline which is impacting injection?	Is there restriction in injection due to scale build up in the casing/tubers?	45	WB	WELLBORE ISSUES	
Is there restriction in production due to surface flowline restrictions?	Is there restriction due to defective choke valve/smaller size pipeline?	4	SURF	SURFACE / FACILITIES	
Is there Wellbore restriction (fish, SSSV, issue)?	Is wellbore restriction due to fish in the tubers or closed/partially closed SSSV, which is impacting production?	20	WB	WELLBORE ISSUES	
Is the yearly SBHP increasing between 20 - 50 psi?	Is there yearly increase in reservoir pressure from 20 to 50 psi? Compare Latest Approved Pressure Survey Datum Pressure With the latest approved survey from previous Year?	4	PROD	PRODUCTIVITY	Y
Is there yearly increase in SBHP from 51 - 100 psi?	Is there yearly increase in reservoir pressure from 50 to 100 psi? Compare Latest Approved Pressure Survey Datum Pressure With the latest approved survey from previous Year?	10	PROD	PRODUCTIVITY	Y
Is there yearly increase in SBHP more than 100 psi?	Is there yearly increase in reservoir pressure more than 100 psi? Compare Latest Approved Pressure Survey Datum Pressure With the latest approved survey from previous Year?	30	PROD	PRODUCTIVITY	Y

Fig. 2C

ATTRIBUTE DESCRIPTION	DEFINITION	WEIGHT	CAT	CAT DESC	AUTO CALC
Is the well NOT meeting Production/Injection Targets / NOT Rate Complaint (Requires mandatory selection of another contributing attribute)?	Is the well NOT meeting production target? Not rate compliant? Requires another attribute to be selected that would define reason for non-compliance of rate	15	PROD	PRODUCTIVITY	Y
Does the well require frequent shut-ins to flow (Cyclic well)?	Is the well flowing intermittently for some period of time and then die and after a period of build up, the well start to flow again for a short period of time?	20	PROD	PRODUCTIVITY	
Is there no flow in the well and there is action plan in place?	Is the well not able to flow inspite of using ESP?	45	PROD	PRODUCTIVITY	
Is there no flow inspite of all revival attempts, by PE?	Is the well not able to flow inspite of all revival attempts using stimulation and ensuring ESP is functional?	501	PROD	PRODUCTIVITY	Y
Is the well ranked as Critical Well in WIRR?	Is the well ranked as Critical Well in WIRR?	501	INT	INTEGRITY	Y
Is the well under performing or closed due to ESP related issues?	Is the well under producing or closed due to ESP related issues?	45	PROD	PRODUCTIVITY	Y
Is fill accumulation impacting production?	Is well production impacted due to fill (for e.g. Debris, formation sand, proppant, etc.) accumulation in the wellbore?	45	WB	WELLBORE ISSUES	
Is there restriction in production due to surface flowline restrictions?	Is there restriction due to defective choke valve/smaller size pipeline?	20	SURF	SURFACE / FACILITIES	
Is production impacted due to Tubing / Flowing scale?	Is there restriction in production due to scale build up in the tubulars?	45	SURF	SURFACE / FACILITIES	
Is there Wellbore restriction (fish, SSSV issue)?	Is wellbore restriction due to fish in the tubulars or closed/partially closed SSSV, which is impacting production?	20	WB	WELLBORE ISSUES	

Fig. 2D

ATTRIBUTE DESCRIPTION	DEFINITION	WEIGHT	CAT	CAT DESC	AUTO CALC
Is the well ranked as Critical Well in WIRR?	Is the well ranked as Critical Well in WIRR?	501	INT	INTEGRITY	Y
Is fill accumulation impacting production?	Is well production impacted due to fill (for e.g. Debris, formation sand, proppant, etc.) accumulation in the wellbore?	45	WB	WELLBORE ISSUES	
Is performing surveys effected by Wellbore restriction (fish)	Is well monitoring restricted due to fish in the tubulars or closed/partially closed SSSV, etc.?	45	WB	WELLBORE ISSUES	
Is performing surveys effected by Wellbore accessibility issues like scale, corrosion, etc.	Is well monitoring restricted due to inability to perform pressure surveys because of issues like scale or corrosion?	45	WB	WELLBORE ISSUES	
Is PDHMS malfunctioning (if applicable)	Is data from PDHMS not available due to malfunction?	20			

Fig. 2E

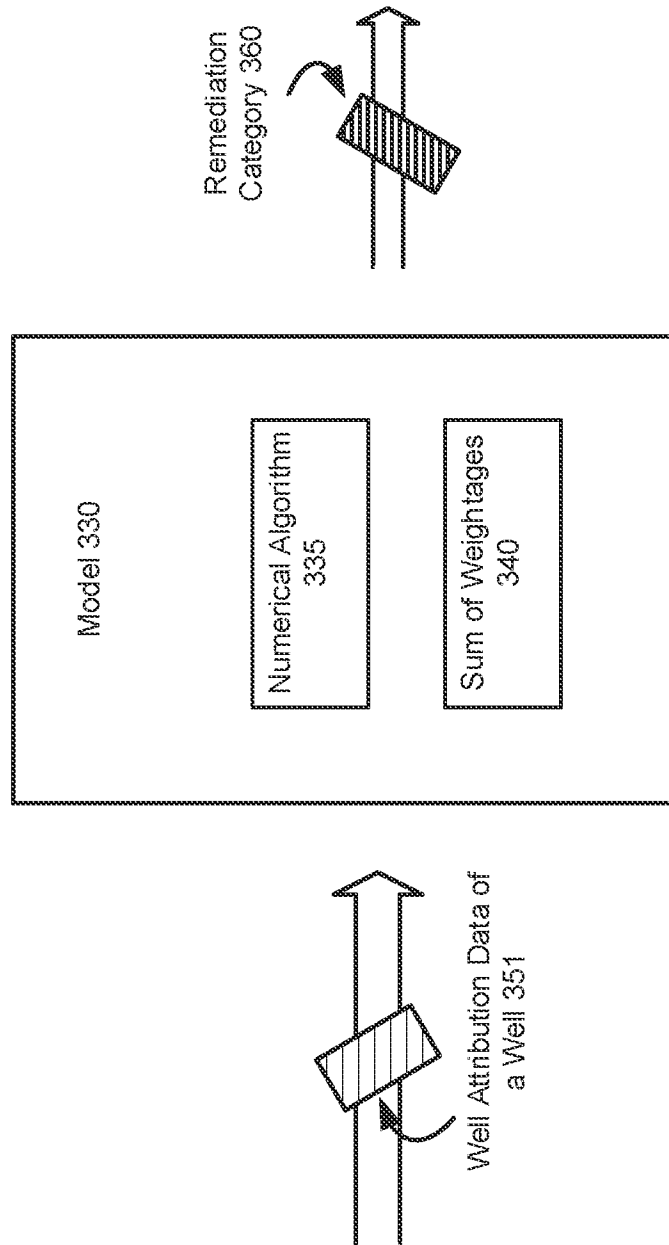


FIG. 3

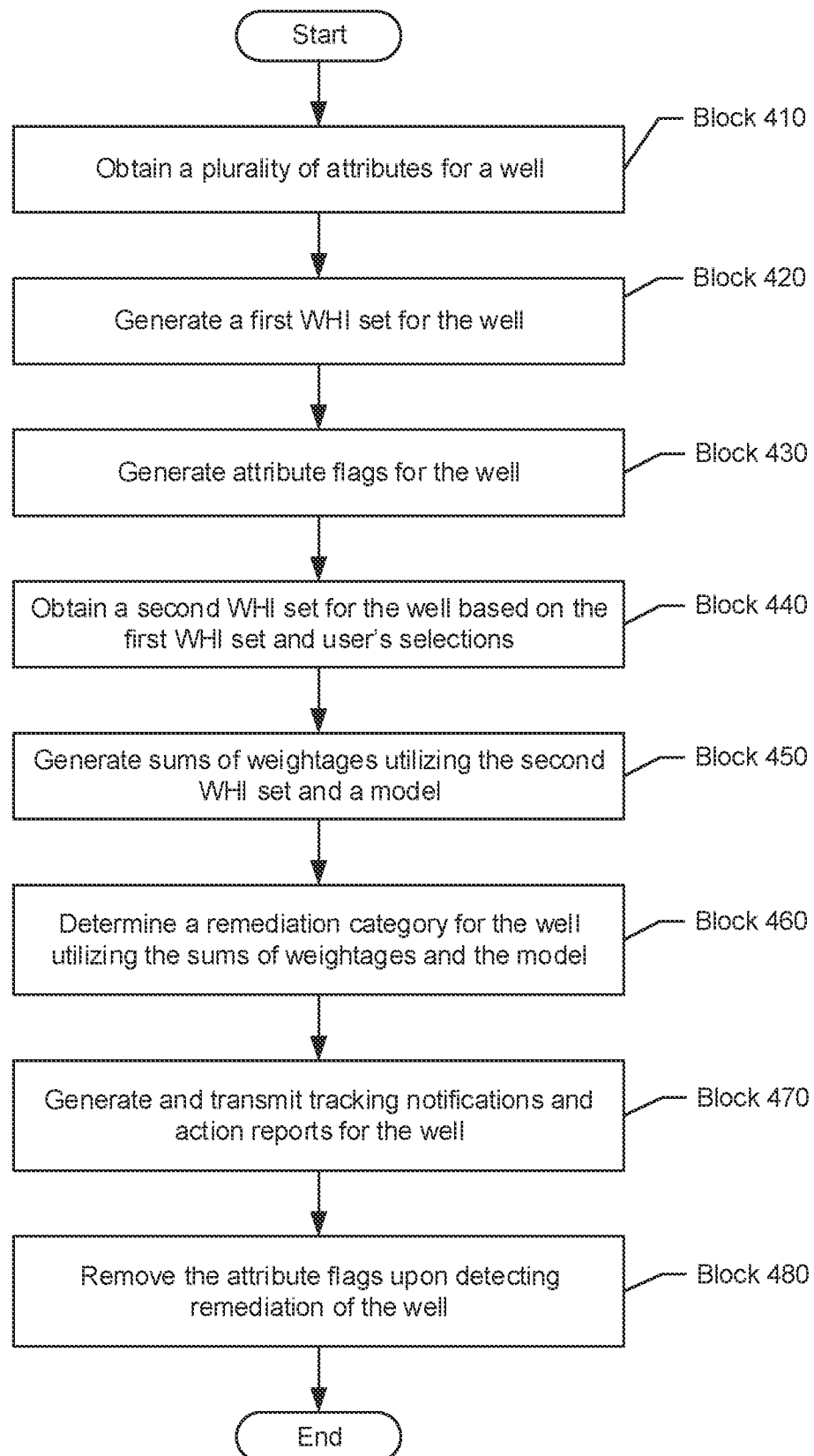


FIG. 4

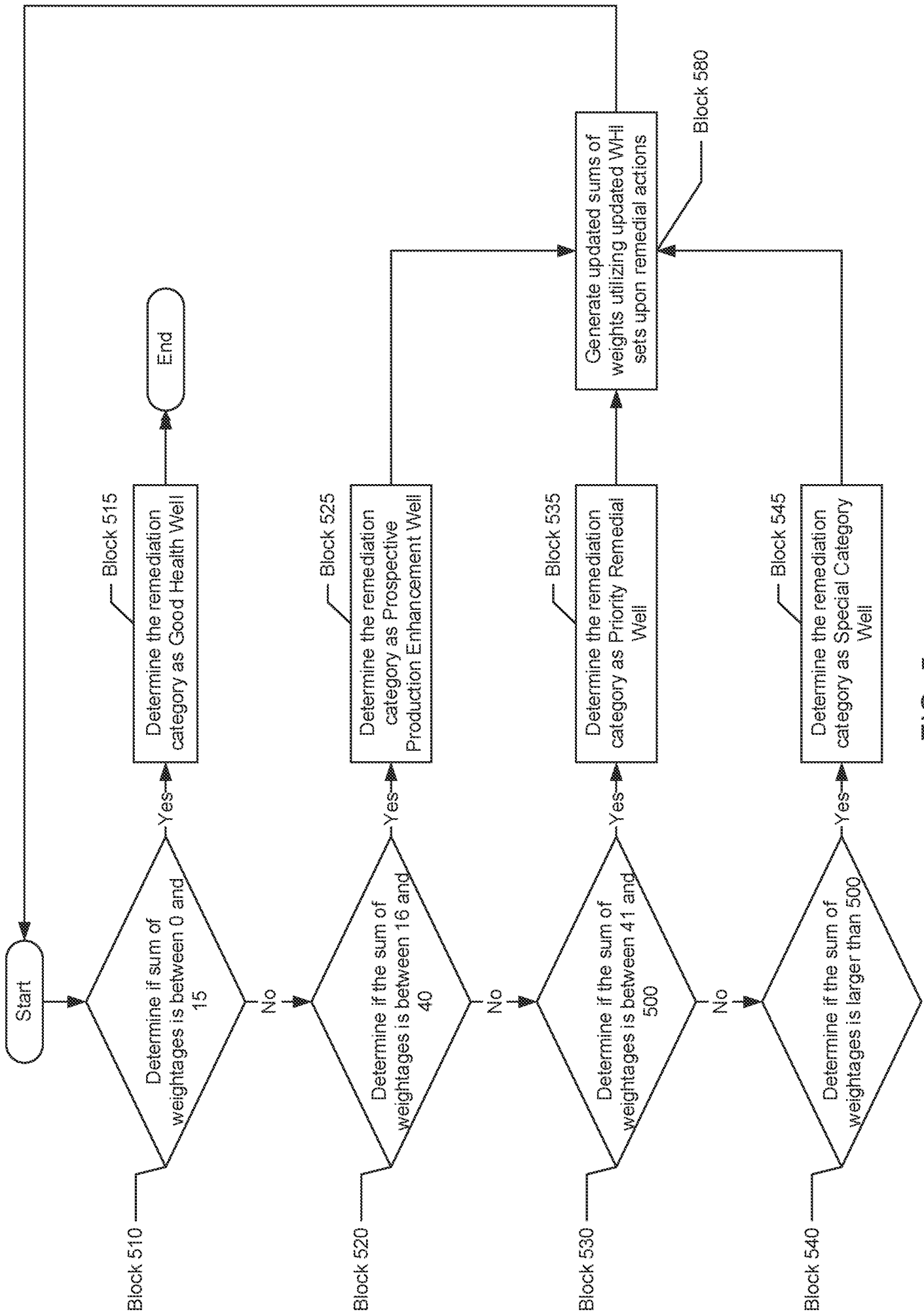


FIG. 5

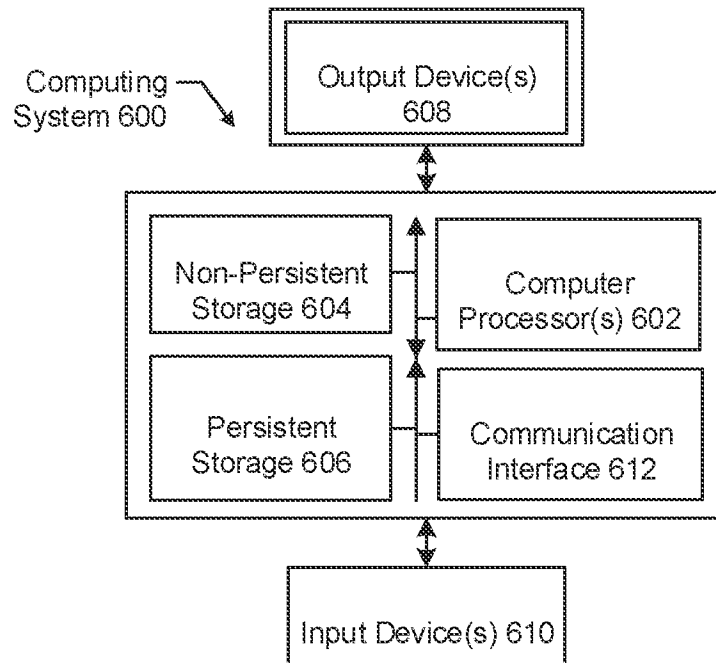


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2022/026335

A. CLASSIFICATION OF SUBJECT MATTER

INV. G06Q10/04 E21B44/00

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06Q E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2018/067131 A1 (SCHLUMBERGER TECHNOLOGY CORP [US]; SCHLUMBERGER CA LTD [CA] ET AL.) 12 April 2018 (2018-04-12) abstract figures 1,2 tables 1,2 paragraph [0017] paragraph [0040] - paragraph [0046] paragraph [0055] -----	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

27 June 2022

Date of mailing of the international search report

07/07/2022

Name and mailing address of the ISA/

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Authorized officer

Härdeman, David

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2022/026335

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2018067131 A1	12-04-2018	EP 3523502 A1	14-08-2019
		US 2020040719 A1	06-02-2020
		WO 2018067131 A1	12-04-2018
