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Rule Generation System

Abstract

A rule generation system for a switchgear includes a deterministic rule generator; an input unit; and an output unit; wherein the input unit is configured to receive a request from an operator for a rule relating to operation of a switchgear; wherein the input unit is configured to provide the request to the deterministic rule generator; wherein the deterministic rule generator is configured to implement a large language model; wherein the deterministic rule generator is configured to generate a switchgear operation rule, and wherein the generation of the switchgear operation rule comprises processing of the request by the large language model; and wherein the output unit is configured to output the switchgear operation rule.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The instant application claims priority to European Patent Application No. 24157509.1, filed Feb. 14, 2024, which is incorporated herein in its entirety by reference.

FIELD OF THE DISCLOSURE

[0002] The present disclosure generally relates to a rule generation system for a low, medium or high voltage switchgear, a rule utilization system for a low, medium or high voltage switchgear, a rule explanation system for a low, medium or high voltage switchgear, a rule generation method for a low, medium or high voltage switchgear, a rule utilization method for a low, medium or high voltage switchgear, a rule explanation method for a low, medium or high voltage switchgear, as well as a computer program element.

BACKGROUND OF THE INVENTION

[0003] While the level of required knowledge for service personnel increases, a wave of new, young and inexperienced people arrive and need tools to support them. This applies to many technical fields, one example being (medium voltage) switchgears. Text and video can capture a lot of knowledge but are less helpful than a more interactive system.

[0004] Deterministic rules engine serves as a support tool for the service personnel that can guide them, based on the state of the machine (e.g., Switchgears) on what actions need to be performed to maintain a machine. This can be a series of instruction on smartphone or something deployed on the machine to be serviced. Deterministic rules engines depend on a collection of facts presented as rules (e.g., using Ontologies). However, building the knowledge base is quite time intensive. Thus, all possible solutions have their own drawbacks.

BRIEF SUMMARY OF THE INVENTION

[0005] Therefore, it would be advantageous to have an improved support tool for service personnel working on low, medium and high voltage switchgear. In a first aspect, there is provided a rule generation system for a low, medium or high voltage switchgear, comprising a deterministic rule generator; an input unit; and an output unit. The input unit is configured to receive a request from an operator for a rule relating to operation of a switchgear. The input unit is configured to provide the request to the deterministic rule generator. The deterministic rule generator is configured to implement a large language model. The deterministic rule generator is configured to generate a switchgear operation rule, and the generation of the switchgear operation rule comprises processing of the request by the large language model. The output unit is configured to output the switchgear operation rule.

[0006] Thus, a new technique is provided that makes use of a Large Language Model (LLM) such as ChatGPT to determine switchgear operation rules that can then be used, for example in a deterministic rule engine, to support service personnel to guide them when working on a switchgear.

Description

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

[0007] FIG. 1 is a block diagram of an exemplar rule generation system in accordance with the disclosure.

[0008] FIG. 2 is a block diagram of an exemplar rule utilization system in accordance with the

disclosure.

[0009] FIG. **3** is a block diagram of an exemplar rule explanation system, where the rule generation system can operate as the rule explanation system, in accordance with the disclosure.

[0010] FIG. **4** is a block flow diagram of a rule generation system in accordance with the disclosure.

[0011] FIG. **5** is an exemplary interaction of a developer with a rule generation system, which is also termed a Rules Co-Pilot, in accordance with the disclosure.

[0012] FIG. **6** is an exemplary interaction of a developer with a rule generation system that is operating as a rule explanation system, in accordance with the disclosure.

DETAILED DESCRIPTION OF THE INVENTION

[0013] FIG. **1** shows an example rule generation system **100** for a low, medium or high voltage switchgear, comprising: a deterministic rule generator **10**; an input unit **20**; and an output unit **30**. The input unit is configured to receive a request from an operator for a rule relating to operation of a switchgear. The input unit is configured to provide the request to the deterministic rule generator. The deterministic rule generator is configured to implement a large language model. The deterministic rule generator is configured to generate a switchgear operation rule, and the generation of the switchgear operation rule comprises processing of the request by the large language model. The output unit is configured to output the switchgear operation rule.

[0014] Thus, a new technique is provided that makes use of a Large Language Model (LLM) such as ChatGPT to determine switchgear operation rules that can then be used, for example in a deterministic rule engine, to support service personnel to guide them when working on a switchgear.

[0015] It is to be noted that when reference is made to a rule generation system for a low, medium or high voltage switchgear, this relates to a system to generate switchgear operations rules that relate to multiple different parts of the switchgear, such as: circuit breakers; earthing switches; disconnecter switches; racking system; wiring circuits. In other words, rules that relate to a multitude of different service and operation requirements that are performed on switchgears.

[0016] In an example, the request is in a natural language. In an example, the switchgear operation rule comprises computational code. In an example, the switchgear operation rule comprises natural language.

[0017] In an example, the processing of the request by the large language model comprises generation of a preliminary switchgear operation rule. The output unit is configured to output the preliminary switchgear operation rule. The input unit is configured to receive an edit request from the operator for an edit to the preliminary switchgear operation rule. The generation of the switchgear operation rule comprises processing of the edit request by the large language model. In this manner, human feedback is provided to fine tune the output of the LLM, thereby in effect validating the output of the LLM and mitigating the situation that can arise where LLMs generate incorrect or unreliable facts.

[0018] To put this another way, the LLM assists/guides an operator in the generation of rules that can be saved in a database, which can then be used to answer queries from the operator or other operator when working on the switchgear.

[0019] In an example, the preliminary switchgear operation rule comprises computational code. In an example, the preliminary switchgear operation rule comprises natural language. In an example, the edit request is in a natural language. In an example, the large language model has been trained on a plurality of example rules relating to operation of the switchgear and associated domain information.

[0020] To put this another way, the LLM is fine-tuned/trained through the provision of contextual information in the form of examples and domain information, that could be in the form of vector embeddings, in order that desired results are generated.

[0021] FIG. **2** shows an example rule utilization system **200** for a low, medium or high voltage

switchgear, comprising: a rule generation system **100** as described with respect to FIG. **1**; a deterministic rule engine **40**; an input unit **50**; and an output unit **60**.

[0022] The rule generation system is configured to generate a plurality of rules relating to operation of a switchgear. The rule generation system is configured to provide the plurality of rules to the deterministic rule engine. The input unit is configured to receive a request from an operator relating to operation of a switchgear. The input unit is configured to provide the request to the deterministic rule engine. The deterministic rule engine is configured to generate an operation action for the switchgear, and the generation of the operator action comprises utilization of the plurality of rules and the request. The output unit is configured to output the operation action.

[0023] Thus, the rule utilization system that can be considered to be a deterministic rule engine, can be used by service personnel in order to gain guidance on how to service a switchgear can make use of rules generated by a rule generation system. In other words, a knowledge base used by the rule utilization system (the deterministic rule engine) is artificially generated, whereas normally the generation of this knowledge base is very difficult and very time consuming.

[0024] It is to be noted that when reference is made to a rule utilization system for a low, medium or high voltage switchgear, this relates to a system to utilize switchgear operations rules that relate to multiple different parts of the switchgear, such as: circuit breakers; earthing switches; disconnecter switches; racking system; wiring circuits. In other words, rules that relate to a multitude of different service and operation requirements that are performed on switchgears.

[0025] In an example, the request is in a natural language. In an example, the operation action is in a natural language.

[0026] FIG. **3** shows an example rule explanation system **300** for a low, medium or high voltage switchgear, comprising a deterministic rule explainer **70**; an input unit **80**; and an output unit **90**. The input unit is configured to receive a request from an operator for a rule relating to operation of a switchgear. The input unit is configured to provide the request to the deterministic rule explainer. The deterministic rule explainer is configured to implement a large language model. The deterministic rule explainer is configured to determine a switchgear operation rule and generate an explanation of the switchgear operation rule, and the determination and generation comprises processing of the request by the large language model. The output unit is configured to output the explanation of the switchgear operation rule.

[0027] It is to be noted that the rule generation system **100** can be configured to operate as the rule explanation system **300**.

[0028] In this manner, the rule explanation system is able to explain existing rule in a natural language, and a developer doesn't have to read and understand the code associated with a rule in order to determine what the rule does.

[0029] It is to be noted that when reference is made to a rule explanation system for a low, medium or high voltage switchgear, this relates to a system to explain switchgear operations rules that relate to multiple different parts of the switchgear, such as: circuit breakers; earthing switches; disconnecter switches; racking system; wiring circuits. In other words, rules that relate to a multitude of different service and operation requirements that are performed on switchgears.

[0030] In an example, the request comprises natural language. In an example, the request comprises computational code. In an example, the explanation comprises natural language. In an example, the explanation comprises computational code.

[0031] In an example, the processing of the request by the large language model comprises generation of a preliminary explanation of the switchgear operation rule. The output unit is configured to output the preliminary explanation of the switchgear operation rule. The input unit is configured to receive an edit request from the operator for an edit to the preliminary explanation of the switchgear operation rule. The generation of the explanation of the switchgear operation rule comprises processing of the edit request by the large language model.

[0032] In an example, the preliminary explanation of the switchgear operation rule comprises

computational code. In an example, the preliminary explanation of the switchgear operation rule comprises natural language. In an example, the edit request is in a natural language. In an example, the large language model has been trained on a plurality of example rules relating to operation of the switchgear and associated domain information.

[0033] In an example, a rule generation method for a low, medium or high voltage switchgear, is in effect associated with the rule generation system **100**. The rule generation method comprises receiving by an input unit a request from an operator for a rule relating to operation of a switchgear; providing the request to a deterministic rule generator, and wherein the deterministic rule generator is configured to implement a large language model, generating by the deterministic rule generator a switchgear operation rule, and wherein the generating the switchgear operation rule comprises processing the request by the large language model; and outputting by an output unit the switchgear operation rule.

[0034] In an example, the request is in a natural language. In an example, the switchgear operation rule comprises computational code. In an example, the switchgear operation rule comprises natural language.

[0035] In an example, the method comprises generating a preliminary switchgear operation rule, and outputting by the output unit the preliminary switchgear operation rule, and receiving by the input unit an edit request from the operator for an edit to the preliminary switchgear operation rule, and wherein the generating the switchgear operation rule comprises processing the edit request by the large language model.

[0036] In an example, the preliminary switchgear operation rule comprises computational code. In an example, the preliminary switchgear operation rule comprises natural language. In an example, the edit request is in a natural language. In an example, the large language model has been trained on a plurality of example rules relating to operation of the switchgear and associated domain information.

[0037] In an example, a rule utilization method for a low, medium or high voltage switchgear, is in effect associated with the rule utilization system **200**. The rule utilization method comprises generating by a rule generating system **100** as described with respect to FIG. **1** according to the associated rule generation method a plurality of rules relating to operation of a switchgear; providing by the rule generating system the plurality of rules to a deterministic rule engine; receiving by an input unit a request from an operator relating to operation of a switchgear; providing by the input unit the request to the deterministic rule engine; generating by the deterministic rule engine an operation action for the switchgear, and wherein the generating the operator action comprises utilizing the plurality of rules and the request; and outputting by an output unit the operation action.

[0038] In an example, the request is in a natural language. In an example, the operation action is in a natural language. In an example, a rule explanation method for a low, medium or high voltage switchgear, is in effect associated with the rule explanation system **300**. The rule explanation method comprises receiving by an input unit a request from an operator for a rule relating to operation of a switchgear; providing by the input unit the request to a deterministic rule explainer, and wherein the deterministic rule explainer is configured to implement a large language model, determining by the deterministic rule explainer a switchgear operation rule and generating by the deterministic rule explainer an explanation of the switchgear operation rule, and wherein the determination and generation comprises processing the request by the large language model; and outputting by an output unit the explanation of the switchgear operation rule.

[0039] In an example, the request comprises natural language. In an example, the request comprises computational code. In an example, the explanation comprises natural language. In an example, the explanation comprises computational code.

[0040] In an example, the method comprises generating a preliminary explanation of the switchgear operation rule, and outputting by the output unit the preliminary explanation of the

switchgear operation rule, and receiving by the input unit an edit request from the operator for an edit to the preliminary explanation of the switchgear operation rule, and wherein the generation the explanation of the switchgear operation rule comprises processing the edit request by the large language model.

[0041] In an example, the preliminary explanation of the switchgear operation rule comprises computational code. In an example, the preliminary explanation of the switchgear operation rule comprises natural language. In an example, the edit request is in a natural language. In an example, the large language model has been trained on a plurality of example rules relating to operation of the switchgear and associated domain information.

[0042] Large Language Models (LLMs) like ChatGPT are a quick way to get answers for questions on any kind of topic. However, LLMs are known to fabricate facts and are thus not fully reliable and act as a black box, so no “debugging” is possible. Deterministic rules engines, as used by service personnel for help and guidance in servicing switchgears, depend on a collection of facts presented as rules (e.g., using Ontologies). However, building the knowledge base for such deterministic rules engines is quite time intensive. Thus, the inventors developed a new technique to leverage the ease of use of LLMs with the precision of deterministic tools by using the LLMs to support the creation of the rules.

[0043] The rule generation system for a low, medium or high voltage switchgear, the rule utilization system for a low, medium or high voltage switchgear, the rule explanation system for a low, medium or high voltage switchgear, the rule generation method for a low, medium or high voltage switchgear, the rule utilization method for a low, medium or high voltage switchgear, and the rule explanation method for a low, medium or high voltage switchgear are now described in further detail, where reference is made to FIGS. 4-6.

[0044] FIG. 4 shows a detailed example of a rule generation system. Today, LLMs can be used to write code snippets that can be used by human programmers to write their own software more quickly. The inventors combined domain information and example rules, and then use the LLM to create preliminary rules suggestions for certain situations related to the domain-servicing of a switchgear.

[0045] Thus, as shown in shown in FIG. 4 and expanded upon in more detail in FIG. 5, a human expert will ask the LLM to provide the rules based on his or her idea about what is needed to be in the system. The human can look at the rules and fix them, create variants not covered, and even provide new rules that are still missing. The LLM can be used to generate preliminary rules. This LLM can be a pre-trained LLM, but does not need to be, trained on rule generation data set which is then fine-tuned on more prompt and corresponding generated rule pairs. The fine-tuned LLMs is provided with additional contextual information in the form of example rules and domain information in the terms of vector embeddings to generate the desired results.

[0046] Thus, Large Language Models (LLMs) like ChatGPT are a quick way to get answers for questions on any kind of topic, however LLMs are known to fabricate facts and are thus not fully reliable. Also, they are black boxes, so one cannot double check easily how they came to their conclusions.

[0047] The above described feedback mechanism, involving the generation of preliminary rules and feedback on those rules, addresses this negative aspect of LLMs. Thus, a deterministic rules engine that serves as a support tool for the service personnel that can guide them, based on the state of the machine (e.g., Switchgears) on what actions need to be performed to maintain a machine, can be utilized with newly generated rule.

[0048] The deterministic rules engine can for example be a series of instructions on smartphone or something deployed on the machine to be serviced. Deterministic rules engines depend on a collection of facts presented as rules (e.g., using Ontologies). However, previously building the knowledge base was quite time intensive. Now, the rules used by the deterministic rules engine can be generated in a new way, as described above.

[0049] The new development can be part of an integrated development environment for deterministic rules. FIG. 5 shows a very simple example of how this tool could work. The developer writes, for example, a request for a rule that gives advice on when to exchange the bearings on the main shaft of a circuit breaker. The system proposes a rule that matches the chosen syntax (in this example a rather simple XML document). The developer who is also an expert in the domain decides to add a safety margin to the rule, decreasing the number of allowed operations.

[0050] There can be variants to the new development: The rules can also be ontologies or similar data formats; The system can write the full set of rules and then let the expert fix them; The system can look at existing rules and suggest changes including explanations and references to documents that suggest the changes.

[0051] The system can explain existing rules, as shown in FIG. 6. Regarding FIG. 6, a rule generation system **100**—also called a CoPilot—can execute in effect an opposite scenario to rule generation and act as a rule explanation system **300**. The CoPilot is able to explain existing rules in a natural language so that the developer doesn't have to “read” the code. This can be part of a conversation to change or extend rules. An example conversation is shown in FIG. 6

[0052] In another exemplary embodiment, a computer program or computer program element is provided that is characterized by being configured to execute the method steps of the method according to one of the preceding embodiments, on an appropriate processor or system.

[0053] The computer program element might therefore be stored on a computer unit, which might also be part of an embodiment. This computing unit may be configured to perform or induce performing of the steps of the method described above. Moreover, it may be configured to operate the components of the above described system. The computing unit can be configured to operate automatically and/or to execute the orders of a user. A computer program may be loaded into a working memory of a data processor. The data processor may thus be equipped to carry out the method according to one of the preceding embodiments.

[0054] This exemplary embodiment of the invention covers both, a computer program that right from the beginning uses the invention and computer program that by means of an update turns an existing program into a program that uses the invention.

[0055] Further on, the computer program element might be able to provide all necessary steps to fulfill the procedure of an exemplary embodiment of the method as described above.

[0056] According to a further exemplary embodiment of the present invention, a computer readable medium, such as a CD-ROM, USB stick or the like, is presented wherein the computer readable medium has a computer program element stored on it which computer program element is described by the preceding section.

[0057] A computer program may be stored and/or distributed on a suitable medium, such as an optical storage medium or a solid state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the internet or other wired or wireless telecommunication systems.

[0058] However, the computer program may also be presented over a network like the World Wide Web and can be downloaded into the working memory of a data processor from such a network. According to a further exemplary embodiment of the present invention, a medium for making a computer program element available for downloading is provided, which computer program element is arranged to perform a method according to one of the previously described embodiments of the invention.

[0059] It is to be noted that when reference is made to a rule generation system for a low, medium or high voltage switchgear, this relates to a system to generate switchgear operations rules that relate to multiple different parts of the switchgear, such as: circuit breakers; earthing switches; disconnecter switches; racking system; wiring circuits. In other words, rules that relate to a multitude of different service and operation requirements that are performed on switchgears.

[0060] In an example, the request is in a natural language. In an example, the switchgear operation

rule comprises computational code. In an example, the switchgear operation rule comprises natural language. In an example, the processing of the request by the large language model comprises generation of a preliminary switchgear operation rule. The output unit is configured to output the preliminary switchgear operation rule. The input unit is configured to receive an edit request from the operator for an edit to the preliminary switchgear operation rule. The generation of the switchgear operation rule comprises processing of the edit request by the large language model.

[0061] In this manner, human feedback is provided to fine tune the output of the LLM, thereby in effect validating the output of the LLM and mitigating the situation that can arise where LLMs generate incorrect or unreliable facts. To put this another way, the LLM assists/guides an operator in the generation of rules that can be saved in a database, which can then be used to answer queries from the operator or other operator when working on the switchgear.

[0062] In an example, the preliminary switchgear operation rule comprises computational code. In an example, the preliminary switchgear operation rule comprises natural language. In an example, the edit request is in a natural language. In an example, the large language model has been trained on a plurality of example rules relating to operation of the switchgear and associated domain information.

[0063] To put this another way, the LLM is fine-tuned/trained through the provision of contextual information in the form of examples and domain information, which could be in the form of vector embeddings, in order that desired results are generated.

[0064] In a second aspect, there is provided a rule utilization system for a low, medium or high voltage switchgear, comprising a rule generation system according to the first aspect; a deterministic rule engine; an input unit; and an output unit. The rule generation system is configured to generate a plurality of rules relating to operation of a switchgear. The rule generation system is configured to provide the plurality of rules to the deterministic rule engine. The input unit is configured to receive a request from an operator relating to operation of a switchgear. The input unit is configured to provide the request to the deterministic rule engine. The deterministic rule engine is configured to generate an operation action for the switchgear, and the generation of the operator action comprises utilization of the plurality of rules and the request. The output unit is configured to output the operation action.

[0065] Thus, the rule utilization system that can be considered to be a deterministic rule engine, can be used by service personnel in order to gain guidance on how to service a switchgear can make use of rules generated by a rule generation system. In other words, a knowledge base used by the rule utilization system (the deterministic rule engine) is artificially generated, whereas normally the generation of this knowledge base is very difficult and very time consuming.

[0066] It is to be noted that when reference is made to a rule utilization system for a low, medium or high voltage switchgear, this relates to a system to utilize switchgear operations rules that relate to multiple different parts of the switchgear, such as: circuit breakers; earthing switches; disconnecter switches; racking system; wiring circuits. In other words, rules that relate to a multitude of different service and operation requirements that are performed on switchgears.

[0067] In an example, the request is in a natural language. In an example, the operation action is in a natural language.

[0068] In a third aspect, there is provided a rule explanation system for a low, medium or high voltage switchgear, comprising a deterministic rule explainer; an input unit; and an output unit. The input unit is configured to receive a request from an operator for a rule relating to operation of a switchgear. The input unit is configured to provide the request to the deterministic rule explainer. The deterministic rule explainer is configured to implement a large language model. The deterministic rule explainer is configured to determine a switchgear operation rule and generate an explanation of the switchgear operation rule, and the determination and generation comprises processing of the request by the large language model. The output unit is configured to output the explanation of the switchgear operation rule.

[0069] In this manner, the rule explanation system is able to explain existing rule in a natural language, and a developer doesn't have to read and understand the code associated q with a rule in order to determine what the rule does.

[0070] It is to be noted that when reference is made to a rule explanation system for a low, medium or high voltage switchgear, this relates to a system to explain switchgear operations rules that relate to multiple different parts of the switchgear, such as: circuit breakers; earthing switches; disconnecter switches; racking system; wiring circuits. In other words, rules that relate to a multitude of different service and operation requirements that are performed on switchgears.

[0071] In an example, the request comprises natural language. In an example, the request comprises computational code. In an example, the explanation comprises natural language. In an example, the explanation comprises computational code. In an example, the processing of the request by the large language model comprises generation of a preliminary explanation of the switchgear operation rule. The output unit is configured to output the preliminary explanation of the switchgear operation rule. The input unit is configured to receive an edit request from the operator for an edit to the preliminary explanation of the switchgear operation rule. The generation of the explanation of the switchgear operation rule comprises processing of the edit request by the large language model.

[0072] In an example, the preliminary explanation of the switchgear operation rule comprises computational code. In an example, the preliminary explanation of the switchgear operation rule comprises natural language. In an example, the edit request is in a natural language. In an example, the large language model has been trained on a plurality of example rules relating to operation of the switchgear and associated domain information.

[0073] In a fourth aspect, there is provided a rule generation method for a low, medium or high voltage switchgear, comprising receiving by an input unit a request from an operator for a rule relating to operation of a switchgear; providing the request to a deterministic rule generator, and wherein the deterministic rule generator is configured to implement a large language model, generating by the deterministic rule generator a switchgear operation rule, and wherein the generating the switchgear operation rule comprises processing the request by the large language model; and outputting by an output unit the switchgear operation rule.

[0074] In an example, the request is in a natural language. In an example, the switchgear operation rule comprises computational code. In an example, the switchgear operation rule comprises natural language. In an example, the method comprises generating a preliminary switchgear operation rule, and outputting by the output unit the preliminary switchgear operation rule, and receiving by the input unit an edit request from the operator for an edit to the preliminary switchgear operation rule, and wherein the generating the switchgear operation rule comprises processing the edit request by the large language model.

[0075] In an example, the preliminary switchgear operation rule comprises computational code. In an example, the preliminary switchgear operation rule comprises natural language. In an example, the edit request is in a natural language. In an example, the large language model has been trained on a plurality of example rules relating to operation of the switchgear and associated domain information.

[0076] In a fifth aspect, there is provided a rule utilization method for a low, medium or high voltage switchgear, comprising generating by a rule generating system according to the rule generation method of the fourth aspect a plurality of rules relating to operation of a switchgear; providing by the rule generating system the plurality of rules to a deterministic rule engine; receiving by an input unit a request from an operator relating to operation of a switchgear; providing by the input unit the request to the deterministic rule engine; generating by the deterministic rule engine an operation action for the switchgear, and wherein the generating the operator action comprises utilizing the plurality of rules and the request; and outputting by an output unit the operation action.

[0077] In an example, the request is in a natural language. In an example, the operation action is in a natural language.

[0078] In a sixth aspect, there is provided a rule explanation method for a low, medium or high voltage switchgear, comprising receiving by an input unit a request from an operator for a rule relating to operation of a switchgear; providing by the input unit the request to a deterministic rule explainer, and wherein the deterministic rule explainer is configured to implement a large language model, determining by the deterministic rule explainer a switchgear operation rule and generating by the deterministic rule explainer an explanation of the switchgear operation rule, and wherein the determination and generation comprises processing the request by the large language model; and outputting by an output unit the explanation of the switchgear operation rule.

[0079] In an example, the request comprises natural language. In an example, the request comprises computational code. In an example, the explanation comprises natural language. In an example, the explanation comprises computational code.

[0080] In an example, the method comprises generating a preliminary explanation of the switchgear operation rule, and outputting by the output unit the preliminary explanation of the switchgear operation rule, and receiving by the input unit an edit request from the operator for an edit to the preliminary explanation of the switchgear operation rule, and wherein the generation the explanation of the switchgear operation rule comprises processing the edit request by the large language model.

[0081] In an example, the preliminary explanation of the switchgear operation rule comprises computational code. In an example, the preliminary explanation of the switchgear operation rule comprises natural language. In an example, the edit request is in a natural language. In an example, the large language model has been trained on a plurality of example rules relating to operation of the switchgear and associated domain information.

[0082] In a seventh aspect, there is provided a computer program element for controlling a processor to carry out the method according to the fourth aspect. In an example, there is provided a computer readable medium having stored the computer element of the seventh aspect.

[0083] In an eighth aspect, there is provided a computer program element for controlling a processor to carry out the method according to the fifth aspect. In an example, there is provided a computer readable medium having stored the computer element of the seventh aspect.

[0084] In a ninth aspect, there is provided a computer program element for controlling a processor to carry out the method according to the sixth aspect. In an example, there is provided a computer readable medium having stored the computer element of the seventh aspect. The computer program elements can for example be a software program but can also be a FPGA, a PLD or any other appropriate digital means.

[0085] All references, including publications, patent applications, and patents, cited herein are hereby incorporated by reference to the same extent as if each reference were individually and specifically indicated to be incorporated by reference and were set forth in its entirety herein.

[0086] The use of the terms “a” and “an” and “the” and “at least one” and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The use of the term “at least one” followed by a list of one or more items (for example, “at least one of A and B”) is to be construed to mean one item selected from the listed items (A or B) or any combination of two or more of the listed items (A and B), unless otherwise indicated herein or clearly contradicted by context. The terms “comprising,” “having,” “including,” and “containing” are to be construed as open-ended terms (i.e., meaning “including, but not limited to,”) unless otherwise noted. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable

order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., “such as”) provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

[0087] Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. Variations of those preferred embodiments may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced otherwise than as specifically described herein.

Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

REFERENCE NUMERALS

[0088] **10** Deterministic Rule Generator [0089] **20** Input Unit [0090] **30** Output Unit [0091] **40** Deterministic Rule Engine [0092] **50** Input Unit [0093] **60** Output Unit [0094] **70** Deterministic Rule Explainer [0095] **80** Input Unit [0096] **90** Output Unit [0097] **100** Rule Generation System [0098] **200** Rule Utilization System [0099] **300** Rule Explanation System

Claims

1. A rule generation system for a low, medium or high voltage switchgear, comprising: a deterministic rule generator; an input unit; and an output unit; wherein the input unit is configured to receive a request from an operator for a rule relating to operation of a switchgear; wherein the input unit is configured to provide the request to the deterministic rule generator; wherein the deterministic rule generator is configured to implement a large language model; wherein the deterministic rule generator is configured to generate a switchgear operation rule, and wherein the generation of the switchgear operation rule comprises processing of the request by the large language model; and wherein the output unit is configured to output the switchgear operation rule.
2. The system according to claim 1, wherein the request is in a natural language.
3. The system according to claim 1, wherein the switchgear operation rule comprises computational code.
4. The system according to claim 1, wherein the switchgear operation rule comprises natural language.
5. The system according to claim 1, wherein the processing of the request by the large language model comprises generation of a preliminary switchgear operation rule, wherein the output unit is configured to output the preliminary switchgear operation rule, wherein the input unit is configured to receive an edit request from the operator for an edit to the preliminary switchgear operation rule, and wherein the generation of the switchgear operation rule comprises processing of the edit request by the large language model.
6. The system according to claim 5, wherein the preliminary switchgear operation rule comprises computational code.
7. The system according to claim 5, wherein the preliminary switchgear operation rule comprises natural language.
8. The system according to claim 5, wherein the edit request is in a natural language.
9. The system according to claim 1, wherein the large language model has been trained on a plurality of example rules relating to operation of the switchgear and associated domain information.
10. A rule utilization system for a low, medium or high voltage switchgear, comprising: a rule

generation system; a deterministic rule engine; an input unit; and an output unit; wherein the rule generation system is configured to generate a plurality of rules relating to operation of a switchgear; wherein the rule generation system is configured to provide the plurality of rules to the deterministic rule engine; wherein the input unit is configured to receive a request from an operator relating to operation of a switchgear; wherein the input unit is configured to provide the request to the deterministic rule engine; wherein the deterministic rule engine is configured to generate an operation action for the switchgear, and wherein the generation of the operator action comprises utilization of the plurality of rules and the request; and wherein the output unit is configured to output the operation action.

11. The rule utilization system of claim 10, wherein the rule generation system comprises a deterministic rule generator; a rule generator input unit; and a rule generator output unit; wherein the rule generator input unit is configured to receive a request from an operator for a rule relating to operation of a switchgear; wherein the rule generator input unit is configured to provide the request to the deterministic rule generator; wherein the deterministic rule generator is configured to implement a large language model; wherein the deterministic rule generator is configured to generate a switchgear operation rule, and wherein the generation of the switchgear operation rule comprises processing of the request by the large language model; and wherein the rule generator output unit is configured to output the switchgear operation rule.

12. A rule explanation system for a low, medium or high voltage switchgear, comprising: a deterministic rule explainer; an input unit; and an output unit; wherein the input unit is configured to receive a request from an operator for a rule relating to operation of a switchgear; wherein the input unit is configured to provide the request to the deterministic rule explainer; wherein the deterministic rule explainer is configured to implement a large language model, wherein the deterministic rule explainer is configured to determine a switchgear operation rule and generate an explanation of the switchgear operation rule, and wherein the determination and generation comprises processing of the request by the large language model; and wherein the output unit is configured to output the explanation of the switchgear operation rule.

13. A rule generation method for a low, medium or high voltage switchgear, comprising: receiving by an input unit a request from an operator for a rule relating to operation of a switchgear; providing the request to a deterministic rule generator, and wherein the deterministic rule generator is configured to implement a large language model, generating by the deterministic rule generator a switchgear operation rule, and wherein the generating the switchgear operation rule comprises processing the request by the large language model; and outputting by an output unit the switchgear operation rule.

14. A rule utilization method for a low, medium or high voltage switchgear, comprising: generating by a rule generating system a plurality of rules relating to operation of a switchgear; providing by the rule generating system the plurality of rules to a deterministic rule engine; receiving by an input unit a request from an operator relating to operation of a switchgear; providing by the input unit the request to the deterministic rule engine; generating by the deterministic rule engine an operation action for the switchgear, and wherein the generating the operator action comprises utilizing the plurality of rules and the request; and outputting by an output unit the operation action.

15. A rule explanation method for a low, medium or high voltage switchgear, comprising: receiving by an input unit a request from an operator for a rule relating to operation of a switchgear; providing by the input unit the request to a deterministic rule explainer, and wherein the deterministic rule explainer is configured to implement a large language model, determining by the deterministic rule explainer a switchgear operation rule and generating by the deterministic rule explainer an explanation of the switchgear operation rule, and wherein the determination and generation comprises processing the request by the large language model; and outputting by an output unit the explanation of the switchgear operation rule.
