INTELLECTUAL PROPERTY
OFFICE OF SINGAPORE

Supplemental Guidance for the Examination of AI-related Patent Applications

This Guidance is based on IPOS' interpretation of the currently applicable law and practice of patents. It should not be used as a set of legal requirements, and should not be taken as a substitute for any legislation or case law or as a conclusive view of the law.

Any feedback from readers drawing attention to errors as well as suggestions for improvement will be greatly appreciated and this may be sent by e-mail to: operations@iposinternational.com.

A. Background and intent

1. Artificial intelligence (AI) applications are found in many fields of technology, from collision avoidance systems and detecting fraud in online payment transactions to predicting traffic flow patterns and drug discovery. There is no single, agreed-upon definition of AI and the term may refer to either rule-based or machine learning-based systems. Patent protection may be sought for many aspects of AI-related inventions, from generating training datasets and machine learning methods to AI-specific computer hardware such as processors and memory chips.

2. This guidance supplements the *Examination Guidelines for Patent Applications at IPOS*, Oct 2023 ("Guidelines") and provides a set of hypothetical examples pertaining to AI applications. Each example is accompanied by a brief background followed by a patent claim or a set of patent claims and a non-binding assessment on whether the claimed subject matter would be considered patentable or not patentable. In practice, AI-related patent applications would be examined for patentable subject matter on a case-by-case basis based on the information provided, which could include the consideration of other factors, bearing in mind that the claims still need to fulfil other requirements for patentability.

B. Supplemental guidance

i. Patentable subject matter

3. AI-related patent claims may encounter issues with patentable subject matter. Section 13(1) of the *Patents Act* states as follows:

> Subject to subsection (2), a patentable invention is one that satisfies the following conditions:
> (a) the invention is new;
> (b) it involves an inventive step; and
> (c) it is capable of industrial application.

In particular, the term "invention" in section 13(1) requires that a patent claim must, amongst other things, define an invention.

4. In some cases, an AI-related patent claim may not relate to an *invention* under Section 13(1) of the *Act* due to the subject matter. Categories of subject matter not considered to be patentable include: discoveries; scientific theories and mathematical methods; aesthetic creations; schemes, rules or methods for performing a mental act, playing a game or doing business; and presentation of information. It is worth noting that this list is not considered to be exhaustive. The preclusion of certain types of subject matter from patentability is in line with international patent norms and is the practice in major jurisdictions.

5. Determining if a patent claim defines an invention involves[1]:

(i) Properly construing the claim;
(ii) Identifying the actual contribution; and
(iii) Asking if the actual contribution falls *solely* within subject matter that is not patentable.

[1] Guidelines, chapter 8 paras 8.3-8.8

If the actual contribution is found to fall *solely* within non-patentable subject matter, the claim is not considered to define an invention.

6. The first step (i) involves construing the claim. A claim is construed following the guidance given in chapter 2 of the Guidelines. Potential issues of construction should be addressed at this stage before proceeding to the next step.

7. At the second step (ii), the actual contribution is identified[2] following the second step of the *Aerotel/Macrossan* test in *Aerotel Ltd v Telco Holdings Ltd & Ors Rev 1 [2007] RPC* 7 at [43]:

> "… [i]t *is an exercise in judgment probably involving the problem said to be solved, how the invention works, what its advantages are. What has the inventor really added to human knowledge perhaps best sums up the exercise. The formulation involves looking at substance not form – which is surely what the legislator intended.*"

8. On looking at the *substance* and not the form of a patent claim, AI-related patent claims typically involve a computer and may be claimed in various ways such as a computer program, a programmed computer and a computer-implemented method. In *Halliburton Energy Services Inc. v Comptroller-General of Patents* [2011] EWHC 2508 (Pat) Judge Birss QC (as he then was) found at [32]:

> *"Thus when confronted by an invention which is implemented in computer software, the mere fact that it works that way does not normally answer the question of patentability. The question is decided by considering what task it is that the program (or the programmed computer) actually performs. A computer programmed to perform a task which makes a contribution to the art which is technical in nature, is a patentable invention and may be claimed as such. Indeed (see* Astron Clinica *[2008] RPC 14) in those circumstances the patentee is perfectly entitled to claim the computer program itself."*

9. Thus, claims that are directed, for example, to a program, a programmed computer or a computer-implemented method but define the same task are expected to be the same in substance and so have the same actual contribution. A separate determination of the actual contribution of each type of claim is not normally expected to be necessary[3].

10. The third step (iii) involves asking whether the actual contribution falls *solely* within non-patentable subject matter. AI-related patent claims claiming computational models and algorithms are likely to engage or fall into the ambit of a mathematical method. If the actual contribution of an AI-related patent claim *solves* a *specific* (as opposed to a generic) problem, then it is likely not *solely* a mathematical method. Conversely, if the actual contribution of an AI-related patent claim is, for example, an AI algorithm which does not appear to solve a specific problem, it is likely to be *solely* a mathematical method and not an invention. The mere fact that the mathematical method *may* solve a specific problem is unlikely to be sufficient. The claimed method *solves* a specific problem if the claim is *functionally limited* to solve the problem, either explicitly or implicitly, for example, by establishing a sufficient link between the problem and the

[2] Guidelines, chapter 8 para 8.4
[3] see Examples 2 and 5

steps of the mathematical method by clearly specifying how the input and the output of the sequence of mathematical steps relate to the problem so that the mathematical method is causally linked to solve said problem[4].

11. It is worth noting the distinction between a *specific* and a *generic* problem. An AI-related patent claim where an AI algorithm is simply used "to control a system" or "to manage risk", without anything more, would be regarded as being directed to a generic rather than a specific problem since these terms may refer, without restriction, to controlling any kind of system or managing any type of risk in any technical field.

12. Artificial intelligence or machine learning methods may also be claimed with reference to their implementation on a computer or using computer hardware. However, where an AI-related patent claim merely involves the use of conventional computer hardware to implement a machine learning method based on a computation model, the underlying mathematical method would not be considered to interact with the computer hardware to a material extent. When there is no interaction to a material extent and no specific problem is apparent, the actual contribution is likely to be *solely* a mathematical method[5].

13. Further, on the third step, the mere determination that a specific, rather than a generic, problem is being solved is likely not enough since the specific problem could itself be, for example, a pure business method. As Mr Justice Kitchin (as he then was) found in *Raytheon Company v Comptroller General of Patents Designs and Trademarks* [2007] EWHC 1230 (Pat) at [40], the actual contribution can potentially fall wholly within two or more categories of subject matter that are not patentable:

> *"I must now consider whether the first aspect of the contribution falls within one of the other exclusions and, in particular, whether it is a method for doing business or the presentation of information as such. I will take them in turn. As the Court of Appeal made clear in* Macrossan*, it is not necessary for there to be something abstract about the method before the business method exclusion can apply. Nor is the exclusion limited to completed transactions. So is the idea of presenting inventory information in pictorial form a method of doing business? I think it is. It is a convenient way of displaying inventory information needed in the conduct of the business, just as it might be convenient on occasion to present it in numerical or text only form. For the same reason it seems to me to be no more than the presentation of information. …"*

14. For AI-related patent claims, an example might be a patent claim where the actual contribution is determined to be an AI algorithm for dynamically determining the level of compensation for members occupying each tier of a multi-level marketing scheme. In this example, while the AI algorithm is arguably directed to solving a specific problem, the specific problem being solved falls into the category of a pure business method. The actual contribution in this example is then no more than a mathematical method and a business method and either way, the patent claim would not define an invention.

[4] Guidelines, chapter 8 paras 8.22-8.25
[5] Guidelines, chapter 8 para 8.26

15. Machine learning AI algorithms may be trained using specific training datasets. Patent protection may be sought for datasets claimed in conjunction with AI algorithms or training methods that are directed to a specific problem. For example, the use of the features of a dataset may be explicitly or implicitly claimed as a constituent feature of a training method. Further, methods of generating or improving a dataset may also form the basis of an allowable claim. However, a claim for a dataset characterised only by the information content and/or the delivery of the dataset would likely be deemed a mere presentation of information and not patentable as would a patent claim characterised only by source code and not by any technical features[6].

ii. Inventive step, support and complete disclosure

16. The requirements for inventive step, support and complete disclosure, respectively, sections 15, 25(5)(c) and 25(4) of the *Patents Act*, for an AI-related invention are the same as they would be for any computer-implemented invention and follow the principles given in the Guidelines[7].

17. For an AI-related invention, the extent to which a training dataset should be disclosed is a matter to be decided by considering each case on its own merits. If the claimed subject matter is dependent on the particular characteristics of the training dataset used, those characteristics must be disclosed unless they are readily apparent, or the skilled person can determine them without undue burden using common general knowledge.

[6] Guidelines, chapter 8 para 8.34(f)

[7] Guidelines, chapter 4 (inventive step) and chapter 5 sections J (support) and K (disclosure of the invention)

C. Examples

1. A generative adversarial network for fraud detection and data augmentation

Background

An AI model can be used to determine if an identification document such as a passport, identity card or driving licence is fraudulent by using a landmarks detection algorithm to determine if a document is of a specified template and/or a face detection algorithm to determine if the face is properly present in the document. However, data for training the AI model may be limited due to data privacy regulations or when known instances of fraudulent data in a database is low. The applicant has developed a generative adversarial network (GAN) to synthesise identity data to augment an existing pool of identification documents to generate a suitable training dataset for training an AI model to verify identification documents.

Claim

An electronic system to augment documents in a training dataset comprising:

- *a generative adversarial network (GAN) comprising a generator model for generating at least one synthesised fake image and a discriminator model with input training data comprising the synthesised fake image and at least one ground truth identity data of one or more persons for classifying the input training data as either real or fake;*
- *wherein the GAN provides a trained generator model after training the generator model and a trained discriminator model after training the discriminator model; and*
- *a system comprising a data extraction model for extracting at least one text data from an input image used for fraud detection and a security model for determining whether the input image is real or fake identity data;*
- *wherein the trained generator model generates identification data for data augmentation and training of the data extraction model and the trained discriminator model is used as a binary classifier in the security model to determine whether an input identification data is real or fake.*

Analysis

i) *Construe the claim*

Although the claim is directed to an electronic system, physical hardware is not explicitly defined beyond the preamble of the claim. The plurality of "models" which are comprised in the system will be construed to be the equivalent of a computer program or a set of computer programs being executed on a computer. There appears to be no other issues construing the claim.

ii) *Identify the actual contribution*

The actual contribution is the use of a GAN to generate identification data for data augmentation and training of a system that is used to determine if an input identification data is real or fake.

iii) *Does the actual contribution fall solely within non-patentable subject matter?*

The actual contribution is an algorithm to augment a training dataset with identification data and thus falls into the ambit of a mathematical method. This addresses a specific problem and the steps in the claim are functionally limited to the problem as seen at least in the use of ground truth identity data of one or more persons and the generation of identification data for data augmentation. The actual contribution is thus not *solely* a mathematical method and therefore the claim defines an invention.

2. A reinforcement learning model for executing trades in the stock market

Background

If a large block of stocks is bought or sold in the stock market, the stock price may rise or fall sharply and increase the cost of the trade. Conventional algorithmic trading systems that execute a large block order in parts using predetermined rules may not respond appropriately to price changes caused by the trades. The applicant has developed a reinforcement learning-based (RL) model to derive a strategy for executing a large buy or sell order while minimising price fluctuations.

Claim 1

A server for stock trading, comprising:

a collection unit configured to collect historical trading data on at least one item;

a generation unit configured to:

generate a RL model including an actor which is a neural network that determines an action policy of a RL agent and a critic which is a neural network that estimates an action value of the RL agent; and

train the RL model to derive a strategy for executing an order for the at least one item based on the historical trading data; and

an execution unit configured to execute the order for the at least one item using the strategy.

Claim 2

A method for executing a stock trade comprising the server as defined in claim 1.

Claim 3

A computer program product comprising instructions for executing a stock trade using the server as defined in claim 1.

Analysis

i) *Construe the claim*

Although claim 1 is directed to a server, the collection, generation and execution units comprising it are not further defined in the claim as being physical hardware or software i.e. these units may be either computer programs or hardware modules performing their defined functions. The claim also does not actually define what the at least one "item" is. This will be construed to refer to the stock that is to be traded. There appears to be no other issues construing the claims.

ii) *Identify the actual contribution*

Although the server in claim 1 is also claimed as a method and a computer program product in claims 2 and 3 respectively, they perform the same task and thus the substance of these claims and consequently, the actual contribution, for all 3 claims would be the same. The actual contribution is a RL model that is trained on historical trading data collected for a stock to derive a strategy for executing an order for that stock.

iii) *Does the actual contribution fall solely within non-patentable subject matter?*

The actual contribution is an algorithm directed to the problem of deriving a strategy to execute a stock trade and therefore falls into the ambit of a mathematical method. This is a specific problem that is functionally limited to the steps of the method as seen at least in the collecting of historical trading data, the training of the RL model on the historical trading data and the derivation of a strategy to

execute an order for that stock. This specific problem, however, falls squarely into the category of a pure business method.

Further, the role of the server and its constituent units in the claim appears to be limited to collecting historical trading data, running a computer program or a set of computer programs and executing the order. These functions may be performed by a generic computer and thus the computer is not considered to interact with the method to a material extent and appears to add nothing more to the actual contribution. The actual contribution, therefore, falls wholly within both a mathematical method and a business method and therefore the claims do not define an invention.

3. Optimising the size of a trained neural network with respect to a processor

Background

Trained neural networks may not be optimised for the processors they run on resulting in longer than expected computation times. This may be a disadvantage in scenarios where timing is critical. For example, an autonomous vehicle using image recognition to detect potential road hazards must be able to do so in a timely manner so that an appropriate action, such as bringing the vehicle to a stop, may be taken to prevent an accident. The applicant has devised a method to speed up execution times by reducing the size of a trained neural network. This is done by selectively removing nodes from the neural network that are less heavily weighted so that the total computation time for the task may be minimised.

Claim

A server that reduces the number of arithmetic operations of a neural network performing a computation task on a processor, the server comprising:

a determination unit that determines the number of the arithmetic calculators in the processor;

a setting unit that sets the number of arithmetic operations required to be equal to the number of arithmetic calculators in the processor; and

a reduction unit that reduces the number of nodes of the neural network; and

wherein the number of arithmetic operations in the reduced neural network is equal to the number of arithmetic operations set by the setting unit and the neural network nodes are removed in order of their weight; and

executing the reduced neural network to perform the computational task on the processor.

Analysis

i) *Construe the claim*

The claim defines a server comprising several types of units with the specified functions. The claim does not further define if these units are in fact physical hardware or computer programs and so the server may simply be executing a computer program or a set of computer programs. A processor is also defined in the claim. However, the claim does not limit this processor to being part of the server i.e. the processor could be part of a different device or computer. The computational task to be executed by the reduced neural network on the processor is not further defined. There appears to be no other issues in construing the claim.

ii) *Identify the actual contribution*

The actual contribution is removing nodes of a neural network in order of their weight so that the number of arithmetic operations to be performed by the reduced neural network is equal to the number of arithmetic calculators in a processor.

iii) *Does the actual contribution fall solely within non-patentable subject matter?*

The actual contribution comprises an algorithm for removing nodes from a neural network to perform a computational task on a processor which is a specific problem. This specific problem is functionally limited to the steps of the method as seen at least in the determination of the number of arithmetic calculators in the processor and the execution of the reduced neural network on the processor. The actual contribution is thus not *solely* a mathematical method and therefore the claim defines an invention.

4. Method of extending a neural network

Background

As the size of a neural network increases, its performance may also increase, however, this is usually also accompanied by increasing complexity when training the neural network. The applicant has devised a method that progressively extends a trained neural network by adding nodes to hidden layers of the network and then trains the structure-extended neural network. The method allows the neural network to be progressively trained while carrying over the learning obtained before the neural network is extended.

Claim

A computer-implemented method of extending a trained neural network, the method comprising:

storing the trained neural network in a memory;

selecting, with a processor, a node in a hidden layer of the neural network;

adding a new node in the hidden layer that includes the selected node; and

connecting the new node to nodes included in a layer preceding and subsequent to the hidden layer;

setting weights of the new node; and

adjusting the weights of the new node by training the neural network extended to include the new node.

Analysis

i) *Construe the claim*

The claim defines physical components i.e. a memory and a processor that would be associated with an ordinary computer running a computer program. There appears to be no issues in construing the claim.

ii) *Identify the actual contribution*

The actual contribution is an algorithm to extend a trained neural network by adding a node and its weights to a hidden layer of the neural network.

iii) *Does the actual contribution fall solely within non-patentable subject matter?*

The actual contribution is an algorithm for extending a trained neural network and does not appear to be directed towards solving a specific problem. The claimed method may be applied to any field of technology that uses a neural network and thus the problem appears to be a generic one. Functionally, the tasks the computer in the claim performs, i.e. storing in memory and running a computer program appear to be generic in nature and so the computer in the claim is not considered to interact with the method to a material extent and adds nothing more to the actual contribution. The actual contribution is thus *solely* a mathematical method and therefore the claim does not define an invention.

5. Method for allocating memory to a neural network

Background

A device may execute a neural network comprising a series of layers. During the execution, each layer generates intermediate result data as well as scratch data which are temporarily stored in the volatile memory of the device. However, this temporary storage of data is generally not optimised. The applicant has devised a method to optimise volatile memory during the execution of a neural network by defining the placement of individual buffers in the volatile memory for storing intermediate result data and scratch data before executing the neural network on the device.

Claim 1

A computer-implemented method for optimising volatile memory in a device for executing a neural network, the method comprising, prior to executing the neural network:

determining an order of execution of layers of the neural network;

defining, in the volatile memory, a placement of an intermediate result buffer generated by each layer based on the order of execution of the layers;

determining a free area of the volatile memory for executing each layer; and

defining, in the free area, a placement of a temporary scratch buffer based on the order of execution of the layers.

Claim 2

A computer program product comprising instructions that, when executed by a computer comprising volatile memory, causes the computer to:

prior to executing a neural network;

determine an order of execution of layers of the neural network;

define, in the volatile memory, a placement of an intermediate result buffer generated by each layer based on the order of execution of the layers;

determine a free area of the volatile memory for executing each layer; and

define, in the free area, a placement of a temporary scratch buffer based on the order of execution of the layers.

Claim 3

A server comprising volatile memory and a processing unit, the processing unit configured to determine the placement of an intermediate result buffer and a temporary scratch buffer in the volatile memory for each layer of a neural network according to the method of claim 1.

Analysis

i) *Construe the claim*

The claim defines the placement of buffers in the volatile memory of a device prior to or before executing a neural network in the device. The neural network itself is not further defined beyond being characterised by order of execution of its layers. The volatile memory is construed to be physical memory capable of temporarily storing data. There appears to be no issues in construing the claim.

ii) *Identify the actual contribution*

While claims 1-3 define volatile memory comprised in different kinds of hardware, i.e. a device, a computer and a server, all three claims perform the same task and thus are the same in substance and would have the same actual contribution. For simplicity, the volatile memory will simply be referred to as being in a device. The actual contribution is the placement of an intermediate result buffer and

a temporary scratch buffer in the volatile memory of a device based on the order of execution of the layers of a neural network.

iii) *Does the actual contribution fall solely within non-patentable subject matter?*
The actual contribution is a method to place temporary buffers in the volatile memory. The method is not, in itself, a mathematical method although it is performed with reference to the order in which the layers of a neural network are executed. The actual contribution does not appear to fall into the ambit of a mathematical method or, for that matter, any of the other categories of non-patentable subject matter. The claims, therefore, define an invention.

6. A method for optimising a graphical user interface of a computer-aided design software

Background

Modern computer-aided design (CAD) software comprises a large collection of drawing tools that are accessed using specialised graphical controls in the graphical user interface (GUI) of the software. However, as the number of graphical controls that are reachable by the user in the GUI increase, the software becomes less intuitive making it difficult for beginners unfamiliar with the software to use it. The applicant has devised a GUI for a CAD software that uses machine learning to detect the level of qualification of the user who is interacting with it to predict a goal of the interaction in order to optimise the GUI to assist the user in completing the goal.

Claim

A method for optimising a graphical user interface (GUI) of a computer-aided design (CAD) software comprising:

determining a qualification level of a user;

determining a complexity level of one or more GUI controls; and

tracking, in real-time, user input data when the user interacts with the GUI; and

wherein a machine learning algorithm is used to:

determine an optimal GUI based on the qualification level of the user, the complexity level of the one or more GUI controls and the real-time user input data;

predict a goal of the user interaction based on the real-time user input data and recommend one or more actions to complete the predicted goal; and

select one or more pre-built 3D models from a database of models based on the predicted goal; and

displaying, to the user, the optimal GUI, the recommended one or more actions and the one or more selected pre-built 3D models.

Analysis

i) *Construe the claim*

Although the claim defines a machine learning algorithm, the algorithm itself is not further defined. There appears to be no issues construing the claim.

ii) *Identify the actual contribution*

The actual contribution is a method to use a machine learning algorithm to determine an optimal GUI, predict a goal of the user, recommend one or more actions to complete the predicted goal and select one or more pre-built 3D models to complete the predicted goal.

iii) *Does the actual contribution fall solely within non-patentable subject matter?*

The actual contribution comprises a machine learning algorithm directed to solving a specific problem of displaying an optimal GUI to a user to complete a predicted goal. The specific problem is functionally limited to the steps of the claimed method as seen in the estimation of the qualification level of the user, the complexity level of one or more GUI controls, the real-time tracking of user input and the displaying of the optimal GUI, recommended actions and selected pre-built 3D models. The actual contribution is thus not *solely* a mathematical method and therefore the claim defines an invention.

There is a residual issue of whether the actual contribution, which comprises displaying an optimal GUI, the recommended next actions and the selected pre-built 3D models, is potentially mere presentation of information. It is clear, however, that the GUI goes beyond merely displaying

information to the user because it allows the user to interact with the CAD software to perform a task or goal. The GUI is thus not characterised solely by its information content or the delivery of information and, therefore, is not a mere presentation of information.

7. Method of predicting the tensile strength of steel in a manufacturing process

Background

During the manufacture of steel sheets, molten metal that has been adjusted for material composition is first cast into slabs. The slabs are then heated and converted into hot-rolled steel sheets using a hot-rolling process. The hot-rolled steel sheets are then put through a cold-rolling process and an annealing process. There are many conditions required at each step to obtain steel sheets with the desired tensile strength. The applicant has devised a system to predict the tensile strength of steel sheets manufactured in this way by using a machine learning model and the conditions present at each step of the manufacturing process.

Claim

A system for predicting the tensile strength of a steel sheet manufactured using a hot-rolling, a cold-rolling and an annealing process, the system comprising:

a predictor configured to acquire:

line production factors comprising a roll diameter and a roll rotational speed used during the cold-rolling process and gas species fractions and a cooling gas injection volume used during the annealing process;

environmental factors comprising at least one of cooling water temperature and air temperature during the hot-rolling process; and

material component values comprising one or more of iron, carbon, chromium or molybdenum;

wherein the predictor comprises a machine learning model configured to use the line production factors, environmental factors and material component values as inputs and output production adjustment factors that define parameters that may be adjusted during the manufacturing process; and

a physicochemical metallurgical model configured to take the production adjustment factors as inputs and output the tensile strength of the steel sheet.

Analysis

i) *Construe the claim*

Although the preamble of the claim defines a system, the remainder of the claim does not explicitly define any physical components or hardware. A computer is implicit in the claim at least from the use of a machine learning model to process the data. There appears to be no other issues in construing the claim.

ii) *Identify the actual contribution*

The actual contribution is a method that uses a machine learning model to output production adjustment factors and a physicochemical metallurgical model that uses the output production adjustment factors to predict the tensile strength of a manufactured steel sheet.

iii) *Does the actual contribution fall solely within non-patentable subject matter?*

The actual contribution comprises two algorithms, a machine learning model and a physicochemical metallurgical model, which are mathematical methods. However, these algorithms are evidently directed to solve the specific problem of predicting the tensile strength of steel based on the manufacturing data. The steps of the method are functionally limited to the specific problem as seen in the use of the defined line production and environment factors, material component values, output production adjustment factors to predict the tensile strength of the steel sheet. The actual contribution is thus not *solely* a mathematical method. The claim therefore defines an invention.

8. Method of predicting an acute cardiopulmonary event using an artificial neural network

Background

Triage is the clinical process of rapidly screening large numbers of patients to assess severity and assign appropriate priority of treatment. Automatic analysis of a patient's risk of an acute cardiopulmonary (ACP) event, i.e. cardiac arrest, may be helpful when conducting triage, especially in disaster or mass casualty situations, where demand may potentially overwhelm emergency clinical resources. The applicant has devised an improved method to predict a patient's risk of an ACP event by using an artificial neural network (ANN) trained with heart rate variability data derived from patient electrocardiograms (ECGs) taken together with patient vital sign data.

Claim

A method of predicting an acute cardiopulmonary (ACP) event in a patient, the method comprising:

measuring a set of parameters relating to heart rate variability from an electrocardiogram (ECG) of the patient and vital sign data comprising at least one of systolic blood pressure, diastolic blood pressure, pulse oximetry, and respiratory rate;

training an artificial neural network (ANN) using an electronic database having a plurality of sets of data, each set of data having parameters relating to heart rate variability, vital sign data, and patient survivability;

processing the measured set of parameters to input into the ANN; and

wherein the ANN predicts whether an ACP event will occur within 48 hours of the measurement.

Analysis

i) *Construe the claim*

While a computer is not explicitly defined in the claim, it is implicit at least in the training and use of an ANN. Other than being trained on sets of data comprising heart rate variability, vital sign data and patient survivability, the ANN is not further defined. There appears to be no issues construing the claim.

ii) *Identify the actual contribution*

The actual contribution is the use of an ANN to predict whether an ACP event will occur within 48 hours based on the measured heart rate variability and vital sign data.

iii) *Does the actual contribution fall solely within non-patentable subject matter?*

The actual contribution comprises an ANN that is directed to a specific problem. Each step of the method is functionally limited to the problem as seen at least in the specific measured data used to predict whether an ACP event will occur. The actual contribution is thus not *solely* a mathematical method and therefore the claim defines an invention.

9. Method for computing nozzle blockage of a liquid metal 3D printer

Background

A liquid metal jet printing device can lay down tiny droplets of liquid metal, such as molten aluminium, to create metal objects gradually, layer by layer. Liquid metal droplets may oxidise as they leave the nozzle and are exposed to air causing blockage at the nozzle. Removing blockage at the printer nozzle requires the 3D printer to be taken offline, reducing the throughput of the printer. Human inspectors rely on their experience to assess when a blockage has exceeded an acceptable level. This assessment can be subjective and lead to suboptimal downtime. The applicant has devised a method for detecting blockage in a 3D printer nozzle by image analysis using a machine-learning model.

Claim

A computer-executed method for computing blockage in a liquid metal 3D printer nozzle, the method comprising:

capturing, using a camera, an image of the nozzle while the nozzle is operating;

performing an image analysis on the captured image to identify blocked regions in the nozzle by:

training a machine-learning model using labelled images of the nozzle;

applying the trained machine-learning model on the captured image to identify the blocked regions; and

computing a blockage fraction of the nozzle based on the identified blocked regions.

Analysis

i) *Construe the claim*

The method is "executed" or implemented using a computer. There appears to be no issues of construction in the claim.

ii) *Identify the actual contribution*

The actual contribution is a method to compute the blockage fraction of a liquid metal 3D printer nozzle by training a machine learning model to identify blocked regions in a captured image of the nozzle while it is operating.

iii) *Does the actual contribution fall solely within non-patentable subject matter?*

The actual contribution is a machine learning algorithm directed to the problem of detecting the blockage fraction of a 3D printer nozzle. This is clearly a specific problem that is functionally limited to the steps of the method, as seen at least in the use of a captured image of the nozzle in operation, in identifying blocked regions in the image and in computing the blockage fraction of the nozzle. The actual contribution is thus not *solely* a mathematical method and therefore the claim defines an invention.