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CERTIFICATE OF GRANT

INNOVATION PATENT

Patent number: 2021102880

The Commissioner of Patents has granted the above patent on 22 September 2021, and certifies that the below particulars have been registered in the Register of Patents.

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Title of invention:

A NOVEL SYSTEM FOR COVID-19 PREDICTION IN CHEST RADIOGRAPHY IMAGES USING HYBRID QUANTUM MASK R-CNN MODEL

Name of inventor(s):

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Term of Patent:

Eight years from 27 May 2021

NOTE: This Innovation Patent cannot be enforced unless and until it has been examined by the Commissioner of Patents and a Certificate of Examination has been issued. See sections 120(1A) and 129A of the Patents Act 1990, set out on the reverse of this document.

COMMONWEALTH OF AUSTRALIA AUSTRALIA PATENT OFFICE

Dated this 22nd day of September 2021

Commissioner of Patents

Extracts from the Patents Act, 1990

Sect 120(1A) Infringement proceedings in respect of an innovation patent cannot be started unless the patent has been certified.

Sec 128 **Application for relief from unjustified threats**

(1) Where a person, by means of circulars, advertisements or otherwise, threatens a person with infringement proceedings or other similar proceedings a person aggrieved may apply to a prescribed court, or to another court having jurisdiction to hear and determine the application, for:

(a) a declaration that the threats are unjustifiable; and

(b) an injunction against the continuance of the threats; and

(c) the recovery of any damages sustained by the applicant as a result of the threats.

(2) Subsection (1) applies whether or not the person who made the threats is entitled to, or interested in, the patent or a patent application.

Sec 129A **Threats related to an innovation patent application or innovation patent and courts power to grant relief.**

Certain threats of infringement proceedings are always unjustifiable.

(1) If:

(a) a person:

(i) has applied for an innovation patent, but the application has not been determined; or

(ii) has an innovation patent that has not been certified; and

(b) the person, by means of circulars, advertisements or otherwise, threatens a person with infringement proceedings or other similar proceedings in respect of the patent applied for, or the patent, as the case may be;

then, for the purposes of an application for relief under section 128 by the person threatened, the threats are unjustifiable.

Courts power to grant relief in respect of threats made by the applicant for an innovation patent or the patentee of an uncertified innovation patent

(2) If an application under section 128 for relief relates to threats made in respect of an innovation patent that has not been certified or an application for an innovation patent, the court may grant the application the relief applied for.

Courts power to grant relief in respect of threats made by the patentee of certified innovation patent

(3) If an application under section 128 for relief relates to threats made in respect of a certified innovation patent, the court may grant the applicant the relief applied for unless the respondent satisfies the court that the acts about which the threats were made infringed, or would infringe, a claim that is not shown by the applicant to be invalid.

Schedule 1 **Dictionary**

certified, in respect of an innovation patent other than in section 19, means a certificate of examination issued by the Commissioner under paragraph 101E(e) in respect of the patent

A NOVEL SYSTEM FOR COVID-19 PREDICTION IN CHEST RADIOGRAPHY IMAGES USING HYBRID QUANTUM MASK R-CNN MODEL

ABSTRACT

Developing a precise model to anticipate COVID-19 via Chest Radiography Images is required to help in preliminary diagnosis. In Pattern Recognition and Image Classification, Convolutional Neural Networks is one of the most widely used and efficient deep learning models. The Mask R-CNN (Regional-Convolutional Neural Networks), a segment-based image classification algorithm, achieves superior results in detecting a variety of diseases, including heart disease, dental disease, brain tumor, and pneumonia disease. Entanglement in quantum computing enables qubits that behave randomly to be perfectly correlated with one another. Specific complex problems can be solved more efficiently on quantum computers by utilizing quantum algorithms. The present invention disclosed herein is a Novel System for Covid-19 Prediction in Chest Radiography Images using Hybrid Quantum Mask R-CNN Model comprising of Random Quantum Circuits, Quantum Convolutional Neural Networks, and Modified Mask R-CNN; used to detect lung disease and identify COVID-19 or Pneumonia patients. The present invention disclosed here contains ten layers, including an input and reshape image layer, four quantum convolutional layers with varying features, fully connected layer, fragmental output layer, classifier layer, Modified Mask R-CNN layer, and an output layer. The image classification is accomplished using two layered quantum convolutional layers that incorporate variable features and Max pooling. Further, Two classifiers are used in the classifier layer to aid in disease detection. The Hybrid Quantum Mask R-CNN (HQMRCNN) uses a modified Mask R-CNN to improve the accuracy. The proposed invention is tested with three datasets of Chest Radiography with 4044 COVID-19, 5500 Normal, and 5427 Pneumonia Images. The present invention disclosed herein outperformed other existing models with an accuracy of 98.4% on COVID-19 Chest X-ray Dataset, 95.1% on Normal Chest X-ray Dataset, and 89.1% on Pneumonia Chest X-ray Dataset. With regard to the accuracy, and cost the present invention HQMRCNN model excelled other models.

A NOVEL SYSTEM FOR COVID-19 PREDICTION IN CHEST RADIOGRAPHY IMAGES USING HYBRID QUANTUM MASK R-CNN MODEL

CLAIMS

We claim:

1. A Novel System for Covid-19 Prediction in Chest Radiography Images using Hybrid Quantum Mask R-CNN Model comprising of Random Quantum Circuits, Quantum Convolutional Neural Networks, and Modified Mask RCNN; used to detect the lung disease and identify COVID-19 or Pneumonia patients. The present invention disclosed here contains ten layers, including an input and reshape image layer, four quantum convolutional layers with varying features, fully connected layer, fragmental output layer, classifier layer, Modified Mask R-CNN layer, and an output layer.

2. A Novel System for Covid-19 Prediction in Chest Radiography Images using Hybrid Quantum Mask R-CNN Model as claimed in claim 1, wherein the performance of the model is enhanced by combining random quantum circuits with CNN and Modified Mask R-CNN, to generate convolutional filters on a quantum device, the model used quantum circuits as a quantum convolutional layer.

3. A Novel System for Covid-19 Prediction in Chest Radiography Images using Hybrid Quantum Mask R-CNN Model as claimed in claim 1, wherein a modified Mask R-CNN is used to improve image classification, the image classification is accomplished using two layered quantum convolutional layers that incorporate variable features and Max pooling.

4. A Novel System for Covid-19 Prediction in Chest Radiography Images using Hybrid Quantum Mask R-CNN Model as claimed in claim 1, wherein by applying weights to the predicted classes, the fully connected layer performs the initial classification; two classifiers comprise the classifier layer.

5. A Novel System for Covid-19 Prediction in Chest Radiography Images using Hybrid Quantum Mask R-CNN Model as claimed in claim 1, wherein present invention disclosed herein outperformed than other existing models with an accuracy of 98.4% on COVID-19 Chest X-ray Dataset, 95.1% on Normal Chest X-ray Dataset, and 89.1% on Pneumonia Chest X-ray Dataset.

A NOVEL SYSTEM FOR COVID-19 PREDICTION IN CHEST RADIOGRAPHY IMAGES USING HYBRID QUANTUM MASK R-CNN MODEL

FIELD OF INVENTION

[0001] The present and proposed invention relates to the technical field of Artificial Intelligence.

[0002] Particularly, the present and proposed invention is related to a Novel System for Covid-19 Prediction in Chest Radiography Images using Hybrid Quantum Mask RCNN Model of the broader field of Machine Learning of Artificial Intelligence.

[0003] More particularly, the present invention relates to a Novel System for Covid-19 Prediction in Chest Radiography Images using Hybrid Quantum Mask R-CNN Model comprising of Random Quantum Circuits, Quantum Convolutional Neural Networks, and Modified Mask R-CNN; used to detect the lung disease and identify COVID-19 or Pneumonia patients. The proposed Hybrid Quantum Mask R-CNN Model comprising of various layers together to predict Covid-19 Prediction in Chest Radiography Images and the classification accuracy of the model is improved with modified Mask R-CNN.

BACKGROUND OF INVENTION

[0004] The COVID-19 has been virulent in many countries affecting human infection with Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV-2). The COVID-19 pandemic continues to devastate human health, causing respiratory disease and acute kidney injury. The COVID-19's genetic structure is near identical to RaTG13, SARS and MERS viruses. Despite its low empathy during the early stages, real-time "Reverse Transcription-Polymerase Chain Reaction" (RT-PCR) is the most commonly used diagnostic method for COVID-19 prediction. Alternative imaging techniques such as chest X-ray (CXR) and computed tomography (CT) are important in COVID-19 prediction. COVID-19 infection has been diagnosed using CXRs. As a result, Artificial Neural Networks must now be used to detect COVID-19 in CXR. Artificial Neural

Networks (ANN) has made important progress in medical image classification. One of the best image classification and recognition algorithms is Convolutional Neural Networks (CNN).

[0005] Quantum Computing (QC) has demonstrated its strength in solving complex problems. Additionally, QC has demonstrated a strong influence on machine learning (ML) in the context of near-term quantum computers. This invention is focused on quantum-neural hybrid networks. Within CNN, the quantum convolutional layer is based on quantum circuits to estimate the kernel in n-dimensionality. This model will result in accurate COVID-19 detection and also saving money and time in saving lives. The Convolutional Neural Networks (CNN) is one of the best image classification and recognition algorithms. For COVID-19 like infection, a more powerful algorithm is needed and one such algorithm is Mask R-CNN. Mask R-CNN is an object recognition algorithm and has been extensively used in image classification and segmentation. Processing huge training data requires high computational power and cost.

[0006] Developing a precise model to anticipate COVID-19 via Chest Radiography Images are required to help in preliminary diagnosis. In Pattern Recognition and Image Classification, Convolutional Neural Networks is one of the most widely used and efficient Deep Learning models. The Mask R-CNN (Regional-Convolutional Neural Networks), a segment-based image classification algorithm, achieves superior results in detecting a variety of diseases, including heart disease, dental disease, brain tumor, and pneumonia disease. Entanglement in quantum computing enables qubits that behave randomly to be perfectly correlated with one another. Specific complex problems can be solved more efficiently on quantum computers by utilizing quantum algorithms. For COVID-19 like infection, a more powerful algorithm is needed and one such algorithm is Mask R-CNN. The Modified Mask R-CNN is also an object recognition algorithm and has been extensively used in image classification and segmentation. Processing huge training data requires moderate computational power and cost in the case of Modified Mask R-CNN.

[0007] The present invention disclosed herein is having the applications such as Health Care Hospitals in detecting the Covid-19 from the X-Ray Images, Lung disease Detection, Pattern Recognition, Segmentation, and Object Detection.

SUMMARY OF INVENTION

[0008] The principle embodiment of the present disclosure is about a Novel System for Covid-19 Prediction in Chest Radiography Images using Hybrid Quantum Mask R-CNN Model comprising of Random Quantum Circuits, Quantum Convolutional Neural Networks, and Modified Mask R-CNN; used to detect the lung disease and identify COVID-19 or Pneumonia patients. The proposed Hybrid Quantum Mask R-CNN Model comprising of various layers together to predict Covid-19 symptoms in Chest Radiography Images and further the classification accuracy of the model is improved with modified Mask R-CNN. The Hybrid Quantum Mask R-CNN Model comprising of different layers such as Quantum Convolutional Layer-1(103), Quantum Convolutional Layer-2(104), Quantum Convolutional Layer-3(105), Quantum Convolutional Layer-4(106), Fully Connected Layer (107), Classifier Layer (108), Intermediate Output Layer (109), Modified Mask R-CNN (110), Final Output Layer (111); to predict Covid-19 Symptoms in Chest Radiography Images and further the classification accuracy of the model is improved with modified Mask-RCNN. The layers and the classifiers present in the proposed model can able to classify the images into two categories as 'COVID-19/Pneumonia' and 'Normal'. Further these two categories will be classified and Covid-19 symptoms present in the Chest X-Ray images are determined. The proposed Hybrid Quantum Mask R-CNN (HQMRCNN) model employs four layers of Quantum Convolution, each of which operates on different dimensions and features. Each Quantum Convolution is composed of three stages: encoding, quantum circuit construction, and decoding. The proposed model employs angular rotation gate encoding methods to access data into the quantum circuit. A quantum circuit is made up of quantum unitary operations (gates) and measurements that are connected together via wires (Qubits). Quantum circuit composes of a matrix quantum kernel, used for the classification of images. Additionally, HQMRCNN gives higher accuracy due to modified Mask R-CNN. The proposed invention is tested with three datasets of Chest Radiography with 4044 COVID-19, 5500 Normal, and 5427 Pneumonia Images. The present invention disclosed herein outperformed other existing models with an accuracy of 98.4% on COVID-19 Chest X-ray Dataset, 95.1% on Normal Chest X-ray Dataset, and 89.1% on Pneumonia Chest X-ray Dataset. With regard to the accuracy, and cost the present invention HQMRCNN model exceled other models.

[0009] The Summary of the Invention, as well as the attached sketches and the Detailed Description of the Invention, describe the present invention in various levels of detail, and the inclusion or omission of components, sections, or the extent of the present disclosure is not meant to be limited by anything else in this Summary of the Invention. For a clearer understanding of the current disclosure, read the summary of the invention alongside the thorough explanation.

BRIEF DESCRIPTION OF DRAWINGS

[0010] The accompanying illustrations are incorporated into and constitute part of this specification to help you understand the innovation. When read in connection with the description, the drawing displays exemplary embodiments of the current disclosure and aids in understanding the disclosure's principles. The drawings are for illustrative purposes only and do not restrict the extent of the present disclosure. The elements are similar but not identical, as shown by the use of the same reference numerals. Different reference numerals, on the other hand, may be used to classify related components. Some embodiments might lack such elements and/or components, whereas others may use elements or components not depicted in the sketches.

[0011] Referring to Figure 1, illustrates the present invention of the disclosure that shows Data Flow in Hybrid Quantum Mask R-CNN Model with different steps and layers comprising of Start (101), Load, Reshape Images with (28*28*1)(102), Quantum Convolutional Layer-1(103), Quantum Convolutional Layer-2(104), Quantum Convolutional Layer-3(105), Quantum Convolutional Layer-4(106), Fully Connected Layer (107), Classifier Layer (108), Intermediate Output Layer (109), Apply Modified Mask R-CNN (110), Final Output Layer (111), and Stop (112), in accordance with the main exemplary embodiment of the present disclosure, accompanied by drawing. This drawing is considered to understand the present disclosure, some elements and/or components may not be present in embodiments, and others may be used in different ways than those depicted in the sketches, so this example is provided to assist comprehension of the disclosure. The use of singular terminology to describe a component or element may encompass a plural number of such components or elements, depending on the context, and vice versa.

[0012] Referring to Figure 2, illustrates the Framework for Quantum Convolutional Layer-1 used in the main embodiment of the disclosure comprising of Define Quantum Layers (201), Create Quantum Circuit of 2*2* Blocks, Returns 4D (202), Convolve Image with 4-channels (203), Preprocess Train Images (204), and Preprocess Test Images (205), in accordance with another exemplary embodiment of the present disclosure to understand Quantum Convolutional Layer-1 of the Hybrid Quantum Mask R-CNN Model. This drawing is considered to understand the Quantum Convolutional Layer-1, the invention is not limited to this drawing, and this illustration is provided to assist comprehension of the disclosure and should not be construed as restricting the depth, nature, or applicability of the disclosure.

[0013] Referring to Figure 3, illustrates the Framework for Quantum Convolutional Layer-2 used in the main embodiment of the disclosure comprising of Define Quantum Layers (301), Create Quantum Circuit of 2*2* Blocks, Returns 4D (302), Convolve Image with 16-channels (303), Preprocess Train Images (304), and Preprocess Test Images (305), in accordance with another exemplary embodiment of the present disclosure to understand Quantum Convolutional Layer-2 of the Hybrid Quantum Mask R-CNN Model. This drawing is considered to understand the Quantum Convolutional Layer-2, the invention is not limited to this drawing, and this illustration is provided to assist comprehension of the disclosure and should not be construed as restricting the depth, nature, or applicability of the disclosure.

[0014] Referring to Figure 4, illustrates the Framework for Quantum Convolutional Layer-3 used in the main embodiment of the disclosure comprising of Define Quantum Layers (401), Create Quantum Circuit of 2*2* Blocks, Returns 4D (402), Convolve Image with 64-channels (403), Preprocess Train Images (404), and Preprocess Test Images (405), in accordance with another exemplary embodiment of the present disclosure to understand Quantum Convolutional Layer-3 of the Hybrid Quantum Mask R-CNN Model. This drawing is considered to understand the Quantum Convolutional Layer-3, the invention is not limited to this drawing, and this illustration is provided to assist comprehension of the disclosure and should not be construed as restricting the depth, nature, or applicability of the disclosure.

[0015] Referring to Figure 5, illustrates the Framework for Quantum Convolutional Layer-4 used in the main embodiment of the disclosure comprising of Define Quantum Layers (501), Create Quantum Circuit of 2*2* Blocks, Returns 4D (502), Convolve Image with 256-channels (503), Preprocess Train Images (504), and Preprocess Test Images (505), in accordance with another exemplary embodiment of the present disclosure to understand Quantum Convolutional Layer-4 of the Hybrid Quantum Mask R-CNN Model. This drawing is considered to understand the Quantum Convolutional Layer-4, the invention is not limited to this drawing, and this illustration is provided to assist comprehension of the disclosure and should not be construed as restricting the depth, nature, or applicability of the disclosure.

[0016] Referring to Figure 6, illustrates Data Flow in Modified Mask R-CNN used in the main embodiment of the disclosure for predicting Covid-19 symptoms and improves the Classification Accuracy in prediction of the present invention and the steps in its data flow are comprising of Start (601), Input Image (602), Identify and generate object proposal (603), Detection of Mask Head (604), Feature Pyramid Network with ROI Mapping (605), ROI Aligned by Channels and Pool Resolution (606), Padding (607), Binary Mask (608), Classification (609) and Stop (610), in accordance with another exemplary embodiment of the present disclosure to understand Modified Mask R-CNN of the Hybrid Quantum Mask R-CNN Model. This drawing is considered to understand the Modified Mask R-CNN, the invention is not limited to this drawing, and this illustration is provided to assist comprehension of the disclosure and should not be construed as restricting the depth, nature, or applicability of the disclosure.

[0017] Referring to Figure 7, illustrated with images showing Predicted Covid-19 Symptom with Hybrid Quantum Mask R-CNN Model in Chest X-Ray Image, in accordance with another exemplary embodiment of the present disclosure to understand performance of the Hybrid Quantum Mask R-CNN Model. This drawing is considered to understand the Hybrid Quantum Mask R-CNN Model, the invention is not limited only to this drawing, and this illustration is provided to assist comprehension of the disclosure and should not be construed as restricting the depth, nature, or applicability of the disclosure.

[0018] Referring to Figure 8, illustrates Qubits Rotations with respect to X, Y and Z axes, the matrices of each axes are shown in this figure are another exemplary embodiment of the present disclosure.

DETAIL DESCRIPTION OF INVENTION

[0019] When considering the following full description of the invention, the invention will become more well-known, and objects other than those listed below will become clear. This description makes use of the appended drawings**.** When considering the following thorough description of the invention, the invention will become more well-known, and objects other than those listed above will become clear. This description refers to the invention's accompanying drawings. The Embodiments of the current disclosure will now be identified utilizing the accompanying drawings as a guide. Embodiments are provided in order for a person versed in the art to fully appreciate the current disclosure. To offer a thorough understanding of embodiments of the current disclosure, several specifics relating to various components and processes are set out. As those versed in the art would recognize, the information provided in the embodiments should not be considered to limit the scope of the current disclosure. The order of stages revealed in this disclosure's procedure and the process should not be interpreted as mandating that they be carried out in the order described or represented. It's also worth noting that additional or alternative steps should be done.

[0020] Referring to Figure 1, illustrates the present invention of the disclosure that shows Data Flow in Hybrid Quantum Mask R-CNN Model with different steps and layers comprising of Start (101), Load, Reshape Images with (28*28*1)(102), Quantum Convolutional Layer-1(103), Quantum Convolutional Layer-2(104), Quantum Convolutional Layer-3(105), Quantum Convolutional Layer-4(106), Fully Connected Layer (107), Classifier Layer (108), Intermediate Output Layer (109), Apply Modified Mask R-CNN (110), Final Output Layer (111), and Stop (112), in accordance with the main exemplary embodiment of the present disclosure, accompanied by drawing for the present proposed invention. The proposed Hybrid Quantum Mask R-CNN (HQMRCNN) Model as shown in Figure 1, comprising of various layers together to predict Covid-19 symptoms in Chest Radiography Images and further the classification accuracy of the model is improved with modified Mask R-CNN.

[0021] The images in the dataset are real Chest X-Rays that have not been altered in any way. The images are of variable size. A consistent dimension is required for image processing. The images have been resized to 28x28x1 in accordance with the present model. The model's first layer, input, converts all images to 28x28x1 dimensions. The representation of the images in the entire disclosure is either 'x' or '*' symbols can be considered. Every image is represented by the number of elements in row* number of elements in column. The symbols in the description such as 'x' or '*' represented or can be replaced with 'by'. The proposed and present invention, HQMRCNN model employs four layers of Quantum Convolution, each of which operates on different dimensions and features. Each Quantum Convolution is composed of three stages: encoding, quantum circuit construction, and decoding. The proposed model employs angular rotation gate encoding methods to access data into the quantum circuit. The Rotation gates Rx, Ry, and Rz are used to rotate a single quantum bit with an angle for the X, Y, and Z axes. The rotation gates with axes and angles are visualized in matrices given in Figure 8. A quantum circuit is made up of quantum unitary operations (gates) and measurements that are connected together via wires (Qubits). The Quantum circuit composes of a matrix quantum kernel, used for the classification of images. Referring to Figure 8, shows the qubits rotations with respect to X, Y and Z axes respectively, where ϕ is the angle of rotation.

[0022] The Quantum Convolutional Layer-1(103) takes (28*28*1) image data and converts it to image data with a dimension of (14*14*4). The quantum circuit is constructed using 1000 shots and four wires. A quantum kernel with a size of 2*2 is used, and a four-dimensional (4D) output is obtained, image is processed using 4-Channels further. The Quantum Convolutional Layer-2(104) receives (14*14*4) image data and converts it to image data with a dimension of (7*7*16). The quantum circuit is constructed using 1000 shots and four wires. A quantum kernel with a size of 2*2 is used, and a four-dimensional (4D) output is obtained, image is processed using 16-Channels. The Quantum Convolutional Layer-3(105) receives (7*7*16) image data and converts it to image data with a dimension of (3*3*64). The quantum circuit is constructed using 1000 shots and four wires. A quantum kernel with a size of 3*3 is used, and a four-dimensional (4D) output is obtained, image is processed using 64-Channels. The Quantum Convolutional Layer-4(106) takes (3*3*64) image data and converts it to image

data with a dimension of (1*1*256). The quantum circuit is constructed using 1000 shots and four wires. A quantum kernel with a size of 3*3 is used, and a four-dimensional (4D) output is obtained, image is processed using 256-Channels.

[0023] By applying weights to the predicted classes, the Fully Connected Layer (107) performs the initial classification. Two classifiers comprise the Classifier Layer (108). This model's testing and training datasets is divided into three categories: Images of COVID-19, Pneumonia, and a Normal Chest X-Ray. The first classifier divides the data into two categories: 'COVID-19/Pneumonia' and 'Normal'. On the classifier 1, a quantum bit Y & Z rotation with axes is applied. The second classifier takes the output of classifier 1 and further categorizes the data as 'COVID-19' or 'Pneumonia'. The Intermediate Output Layer (109) layer receives the data from the classifier layer and sends both the classifiers data to modified Mask R-CNN layer (110) for further prediction. The Modified Mask R-CNN (110) algorithm segments each and every object pixel by pixel and also extracts each object separately from its background. The Final Output Layer (111) produces the predicted Covid-19 Image from the Chest X-Ray Image. The algorithm runs at 5fps speed, further the Accuracy is improved with Modified Mask R-CNN.

[0024] Referring to Figure 6, illustrates Data Flow in Modified Mask-RCNN used in the main embodiment of the disclosure to improve the Classification Accuracy of the present invention. The Modified Mask R-CNN model ignored the default dataset bounding boxes and generated as required; Optimized hyperparameters for detecting lung disease in images; appropriately reduced anchor sizes; increased maximum predicted object count in an image for improved accuracy. This layer communicates classification information to the HQMRCNN model's final layer.

[0025] The computation of Accuracy, precision and F1 score is done using the formulations. The HQMRCNN model computes the accuracy, precision and F1 score for all three classes of the datasets (COVID-19, Pneumonia, and Normal) individually. The proposed model provides the accuracy of 98.4 % on cases from the first dataset, 95.1% on cases from the second dataset, and 89.1 % on cases from the third dataset. The experiments were performed on the proposed HQMRCNN model using COVID 19 patient’s data set. The framework is evaluated with CNN and learning model algorithm.

According to the results presented in the below Table 1, it can be concluded that the performance of the proposed model is better than the other algorithms.

TABLE 1

Comparison of Performance Accuracy of HQMRCNN Model with other Models

Model	CNN Model	Learning Model	HQMRCNN Model (Present Invention)
Dataset-1 (4044 Records)	**96.7% Accuracy**	**94.2% Accuracy**	**98.4% Accuracy**
Dataset-2 (5500 Records)	91.1% Accuracy	91.9% Accuracy	95.1% Accuracy
Dataset-3 (5427 Records)	87.7% Accuracy	78.8% Accuracy	89.1% Accuracy

[0026] Referring to Figure 2, the Quantum Convolutional Layer-1(103) takes (28*28*1) image data and converts it to image data with a dimension of (14*14*4), it defines Quantum Layers (201), the quantum circuit is constructed using 1000 shots and four wires. A quantum kernel with a size of 2*2 is used, and a four-dimensional (4D) output is obtained (202), image is processed using 4-Channels further by convolving (203). From the dataset images, training is processed (204) and Testing is also processed (205). Referring to Figure 3, the Quantum Convolutional Layer-2(104) receives (14*14*4) image data and converts it to image data with a dimension of (7*7*16), it defines Quantum Layers (301), the quantum circuit is constructed using 1000 shots and four wires. A quantum kernel with a size of 2*2 is used, and a four-dimensional (4D) output (302) is obtained, image is processed using 16-Channels by convolution (303). From the dataset images, training is processed (304) and Testing is also processed (305). Referring to Figure 4, the Quantum Convolutional Layer-3(105) receives (7*7*16) image data and converts it to image data with a dimension of (3*3*64), it defines Quantum Layers (401), and the quantum circuit is constructed using 1000 shots and four wires. A quantum kernel with a size of 3*3 is used, and a four-dimensional (4D) output (402) is obtained, image is processed using 64-Channels using convolution (403). From the dataset images, training is processed (404) and Testing is also

processed (405). Referring to Figure 5, the Quantum Convolutional Layer-4(106) takes (3*3*64) image data and converts it to image data with a dimension of (1*1*256), it defines Quantum Layers (501), the quantum circuit is constructed using 1000 shots and four wires. A quantum kernel with a size of 3*3 is used, and a four-dimensional (4D) output (502) is obtained, image is processed using 256-Channels using convolution (503). From the dataset images, training is processed (504) and Testing also is processed (505).

[0027] Referring to Figure 6, illustrates Data Flow in Modified Mask R-CNN used in the main embodiment of the disclosure for predicting Covid-19 symptoms and improves the Classification Accuracy in prediction of the present invention and the steps in its data flow are comprising of Start (601), Input Image (602), Identify and generate object proposal (603), Detection of Mask Head (604), Feature Pyramid Network with ROI Mapping (605), ROI Aligned by Channels and Pool Resolution (606), Padding (607), Binary Mask (608), Classification (609) and Stop (610). This data flow is for improving the classification accuracy of the present invention. Identify and generate object proposal (603) in the Input Image (602) after starting (601) classification. The Mask Head (604) is detected after identifying the object. The Feature Pyramid Network with ROI Mapping (605) is created, The Region of Interest (ROI) Aligned by Channels and Pool Resolution (606). The padding (607) is performed to generate Binary Mask (608) for Classification (609). Referring to Figure 7, illustrates the Predicted Covid-19 Symptom with Hybrid Quantum Mask R-CNN Model. These out of the present invention can be understood with these visualized images shown in the Figure 7. The present invention disclosed herein outperformed other models with an accuracy of 98.4 % on COVID-19 Chest X-ray Dataset, 95.1% on Normal Chest X-ray Dataset, and 89.1 %on Pneumonia Chest X-ray Dataset. With regard to the accuracy, and cost the present invention HQMRCNN model exceled other models.

[0028] Several specific details are set out in the following exemplary explanation in order to provide a more detailed understanding of embodiments of the invention. An artisan of ordinary skill, on the other hand, might notice that the existing innovation can be practiced without integrating any of the specific information mentioned herein. The main embodiments of the present disclosure are considered with the HQMRCNN model for predicting the Covid-19 symptoms from the Chest X-Ray Images. The subsequent

description gives the details about the accuracy improvement with the modified Mask R-CNN. To predict the Covid-19 Symptoms from the Chest X-Ray, the method and the way of the present embodiment is provided in the following layout and it shall not limit the scope of the present disclosure. The present invention is described with the limited number of the embodiments and accordingly, the present disclosure should be limited to the claims specified in the claims of the invention.

A NOVEL SYSTEM FOR COVID-19 PREDICTION IN CHEST RADIOGRAPHY IMAGES USING HYBRID QUANTUM MASK R-CNN MODEL

DRAWINGS

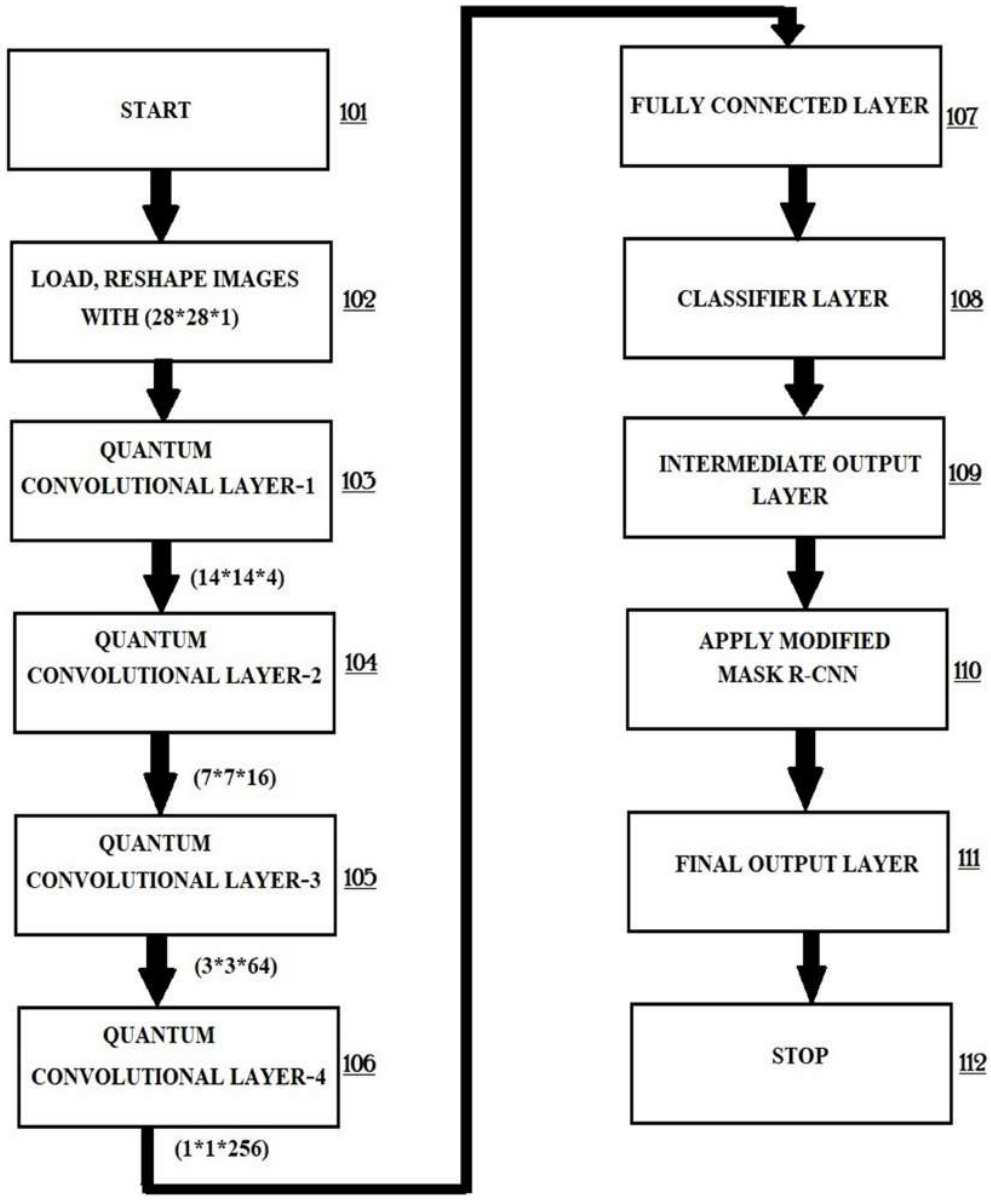

Figure 1: Data Flow in Hybrid Quantum Mask R-CNN Model

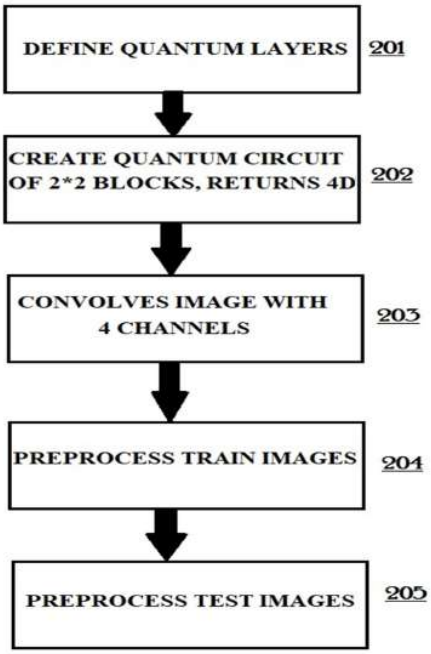

Figure 2: Framework for Quantum Convolutional Layer-1

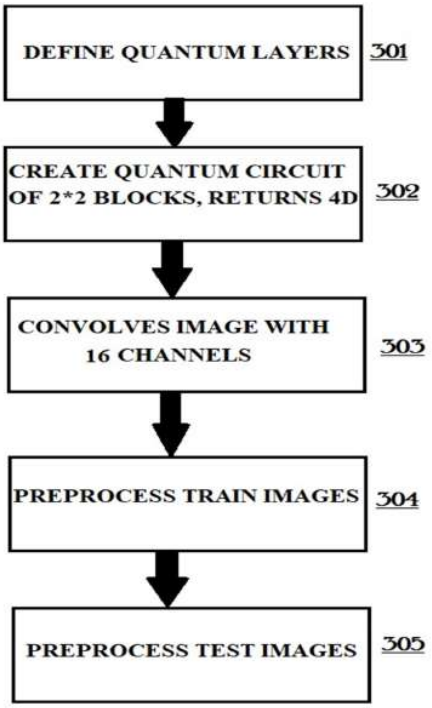

Figure 3: Framework for Quantum Convolutional Layer-2

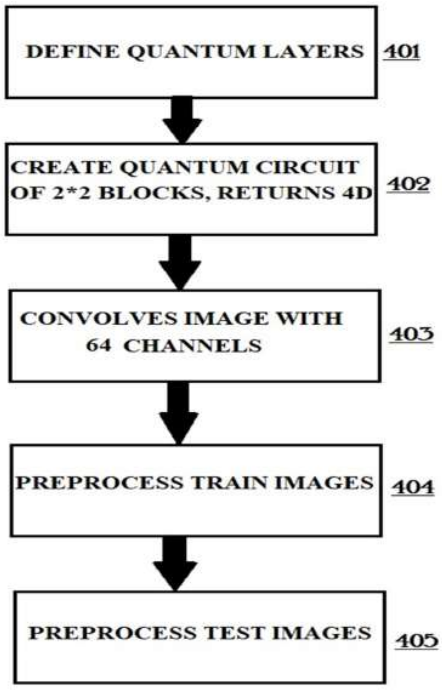

Figure 4: Framework for Quantum Convolutional Layer-3

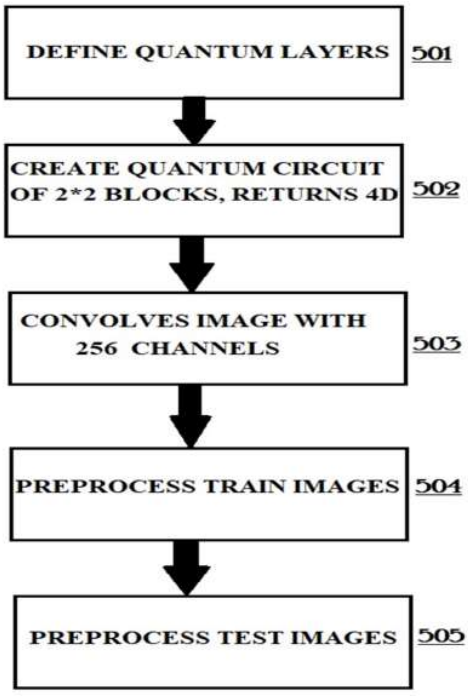

Figure 5: Framework for Quantum Convolutional Layer-4

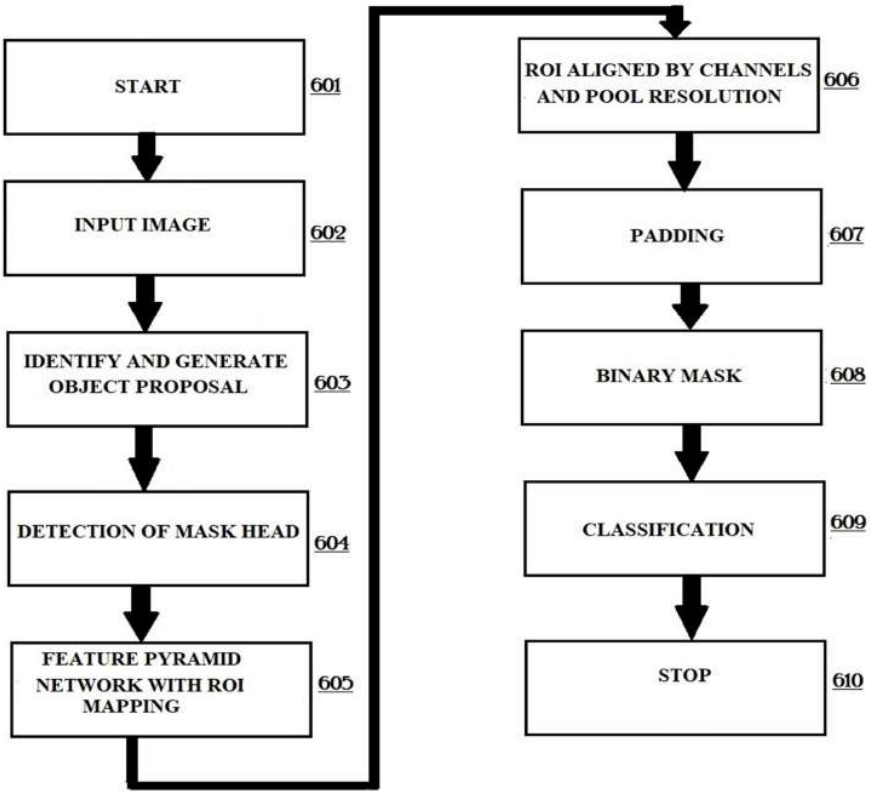

Figure 6: Data Flow in Modified Mask R-CNN

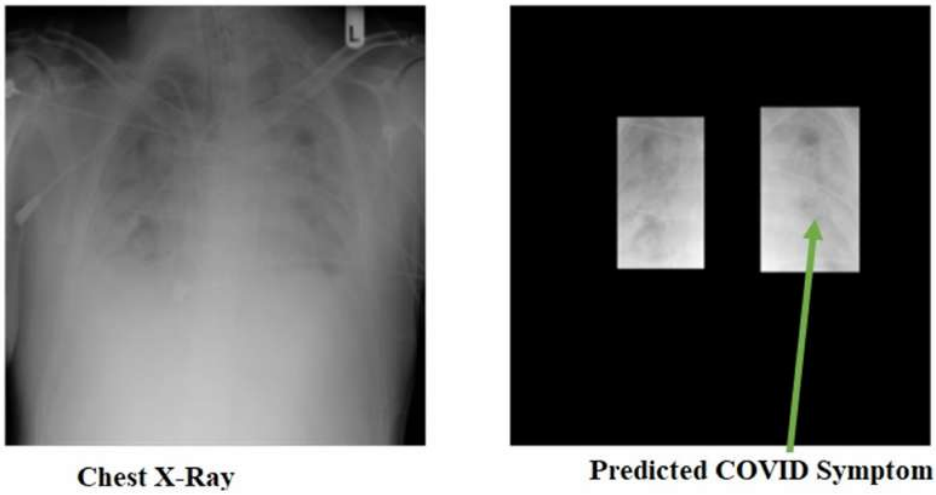

Figure 7: Predicted Covid-19 Symptom with Hybrid Quantum Mask R-CNN Model

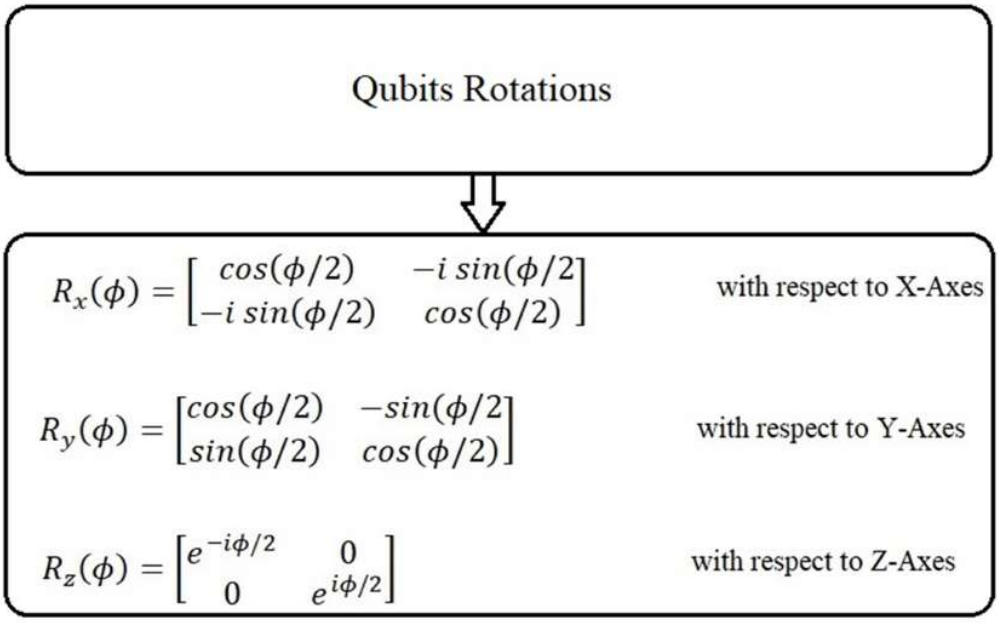

Figure 8: Qubits Rotations with respect to X, Y and Z axes