Colorectal polyp image recognition method, apparatus, and storage medium

CROSS-REFERENCE

[0001] This application claims the priority of a Chinese patent application entitled "RECOGNITION METHOD AND APPARATUS FOR COLORECTAL POLYP IMAGE AND STORAGE MEDIUM" submitted to the China Patent Office on Friday, July 23, 2021, with application No. 202110833639.8, and the entire content of which is incorporated in this application by reference.

TECHNICAL FIELD

[0002] This application relates to the field of medical technologies, and in particular to a recognition method and an apparatus for a colorectal polyp image and a storage medium.

BACKGROUND

Colorectal polyps refer to protrusion lesions protruding in enteric cavities, and are one of common intestinal diseases, including adenomatous polyps and non-adenomatous polyps (such as hamartomatous polyps, metaplastic polyps and inflammatory polyps), where the adenomatous polyps belong to a kind of precancerous lesions. The incidence and the mortality of colorectal cancers in China are increasing year by year; the colorectal cancers have been in middle and advanced stage for many patients when being found; and the five-year survival rate of the patients is smaller than 50%. A colonoscope is a most intuitive and effective method of finding lesions, which may increase a finding rate of intestinal cancers in the early stage and thus lowers the mortality. Electronic staining endoscopy is an important advance in the digestive endoscopy field in recent years, for example, narrow band imaging (NBI), Fuji intelligent chromo endoscopy (FICE), I-scan and the like have been widely used for improving the detectability of colorectal adenomas. Researches show that in the aspect

of identifying neoplastic and non-neoplastic colorectal polyp-like lesions, the electronic staining light technology has similar and high sensitivity, specificity and accuracy, and electron staining typing has a good application value in the aspect of diagnosing and treating colorectal lesions. However, determination on a type result still relies on experiences and visual inspection from doctors, and there are subjective differences.

SUMMARY

[0003] In order to solve the above technical problems or at least partially solve the above technical problems, this application provides a recognition method and an apparatus for a colorectal polyp image and a storage medium.

[0004] In one aspect, this application provides a recognition method for the colorectal polyp image, where the recognition method includes:

[0005] conducting color equalization processing and edge feature image fusion on a colorectum site image to obtain a gradient feature fusion image for the colorectum site image; and

[0006] calling a pre-constructed classification model for a type of colorectal polyps based on an attention splitting module ResNeSt Block, and recognizing the gradient feature fusion image for the colorectum site image.

[0007] Further, in order to predict or determine the type of the colorectal polyps, after the above steps, the recognition method may further includes: evaluating, according to a recognition result, the type of the colorectal polyps at a colorectum site.

[0008] Optionally, the recognition method for the colorectal polyp image further includes:

[0009] conducting color equalization processing and edge feature image fusion on a pre-acquired colorectal polyp sample image to obtain the gradient feature fusion image for the colorectal polyp sample image;

[0010] training, by using the gradient feature fusion image for the colorectal polyp sample image and a pre-constructed feature extraction network based on the ResNeSt Block, the classification model, and optimizing, according to a loss function, the classification model during training of the classification model; and

[0011] after training of the classification model, obtaining the classification model for the type of the colorectal polyps based on the ResNeSt Block.

[0012] Optionally, the training, by using the gradient feature fusion image for the

colorectal polyp sample image and the pre-constructed feature extraction network based on the ResNeSt Block, the classification model includes:

[0013] training, in the constructed feature extraction network based on the ResNeSt Block, the gradient feature fusion image for the colorectal polyp sample image; and

[0014] activating, through a Mish function, an output of the ResNeSt Block.

[0015] Optionally, the Mish function is as follows:

[0016] $f(x)=x*\tanh(\ln(1+e^{x}))$;

[0017] in the formula, x is each pixel value of an output feature image of the ResNeSt Block.

[0018] Optionally, training, in the pre-constructed feature extraction network based on the ResNeSt Block, the gradient feature fusion image for the colorectal polyp sample image includes:

[0019] splitting the gradient feature fusion image for the colorectal polyp sample image to obtain k group convolutions;

[0020] splitting each group convolution into r first feature images;

[0021] conducting 1*1 convolution operation and 3*3 convolution operation on the k * r first feature images first, then re-obtaining and fusing r second feature images in each group convolution, inputting a fused image into a Split Attention layer, and reinforcing features through an attention mechanism to obtain k results; and

[0022] continuously fusing the k results, then inputting a fused result into a 1*1 convolutional layer for convolution operation to obtain an output of the ResNeSt Block, where k and r are both hyper-parameters.

[0023] Optionally, the optimizing the classification model through the loss function during training of the classification model includes:

[0024] weighting, according to a number ratio of positive samples and negative samples of the colorectal polyp sample image, the positive samples; and calculating the loss value.

[0025] Optionally, the color equalization processing includes:

[0026] determining, according to a color mean of the image, an RGB channel weight value of the image; and

[0027] conducting, according to the RGB channel weight value of the image, RGB channel weighting on the image, where the image is the colorectum site image or the colorectal polyp sample image.

[0028] Optionally, the edge feature image fusion includes:

[0029] scaling the image subjected to RGB channel weighting to obtain a scaled image;

[0030] conducting edge extraction on the scaled image to obtain an edge feature image; and

[0031] fusing the scaled image with the edge feature image to obtain the gradient feature fusion image.

[0032] In the second aspect, this application provides a result prediction apparatus for a type of colorectal polyps, where the result prediction apparatus includes a memory, a processor and computer programs storing on the memory and running on the processor; and

[0033] the computer programs, when being executed by the processor, implements the steps of the recognition method for the colorectal polyp image according to any one of the above items.

[0034] In the third aspect, this application provides a computer-readable storage medium, storing a result prediction program for a type of colorectal polyps thereon; and the result prediction program for the NICE type of the colorectal polyps, when being executed by the processor, implements the steps of the recognition method for the colorectal polyp image according to any one of the above items.

[0035] In the fourth aspect, this application provides a method of examining a subject with colonoscopy, where the method includes: predicting or determining, by using the recognition method for the colorectal polyp image according to any one of the above items or the result prediction apparatus for the type of the colorectal polyps according to any one of the above items, the type of the colorectal polyps of the subject under a colonoscope in real time.

[0036] In this specification, the type of the colorectal polyps refers to a morphological type such as non-neoplastic polyps, neoplastic polyps or glandular cancers.

[0037] A type standard may be a type standard under a traditional endoscope or a type standard under a magnification endoscopy-narrow band imaging (ME-NBI) endoscope. The type standard under the ME-NBI endoscope includes, for example, an NICE type standard, a Sano type standard, a Pit type standard, a Hiroshima type standard, a Showa type standard, a Jikei type standard, and a JNET type standard, preferably, the NICE type standard.

[0038] The colorectal polyp image may be an image acquired under the endoscope in real time and may further be a stored image.

[0039] Compared with the prior art, the technical solutions provided by the embodiments of this application have the following advantages:

[0040] In various embodiments of this application, by conducting color equalization processing and edge feature image fusion on the colorectum site image to construct a recognition sample, image features may be effectively unified and strengthened; and by extracting features with the ResNeSt Block, a result for the type of the colorectal polyps can be more accurately predicted, to assist a doctor to infer the pathological nature of the colorectal polyps.

BRIEF DESCRIPTION OF DRAWINGS

[0041] The accompanying drawings herein are incorporated into the specification and constitute a part of the specification, show examples consistent with the present invention, and are used to explain the principle of the present invention together with the specification.

[0042] In order to describe the technical solutions in the embodiments of the present invention or the prior art more clearly, the following briefly introduces the accompanying drawings required for describing the embodiments or the prior art. Apparently, those of ordinary skill in the art may still derive other drawings from these drawings without any creative efforts.

[0043] FIG. 1 is a flowchart of a result prediction method for an NICE type of colorectal polyps provided by various embodiments of this application;

[0044] FIG. 2 is a schematic diagram of a feature extraction network based on a ResNeSt Block provided by various embodiment of the present application; and

[0045] FIG. 3 is a plot of an improved Mish function provided by various embodiment of the present application.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0046] It should be understood that the specific embodiments described herein are only used for explaining the present invention, and are not used for defining the present invention.

[0047] In the subsequent description, suffixes, such as “module”, “component” or “unit”, for representing the elements are used for facilitating the description of the

present invention merely without particular meanings self. Therefore, “module”, “component” and “unit” may be used in combination.

[0048] In this specification, the term “type of the colorectal polyps” refers to a morphological type such as non-neoplastic polyps, neoplastic polyps or glandular cancers. A type standard may be, for example, an NICE type standard, a Sano type standard, a Pit type standard, a Hiroshima type standard, a Showa type standard, a Jikei type standard and a JNET type standard.

[0049] Embodiment 1

[0050] The embodiments of the present invention provide a result prediction method for an NICE type of colorectal polyps. As shown in FIG. 1, the result prediction method for the NICE type of the colorectal polyps includes:

[0051] S101, color equalization processing and edge feature image fusion are conducted on a colorectum site image to obtain a gradient feature fusion image for the colorectum site image; and

[0052] S102, a pre-constructed NICE type classification model based on an attention splitting module ResNeSt Block is called, and the gradient feature fusion image for the colorectum site image is recognized; and

[0053] S103, the NICE type of the colorectal polyps at a colorectum site is evaluated according to a recognition result.

[0054] In the embodiments of the present invention, by conducting color equalization processing and edge feature image fusion on the colorectum site image to construct a recognition sample, image features may be effectively unified and strengthened; and by extracting features with the ResNeSt Block to construct a computer-assistant NICE type system based on deep learning, a result for the NICE type of the colorectal polyps can be more accurately predicted, to assist a doctor to infer the pathological nature of the colorectal polyps.

[0055] In the specific implementation process, the colorectal polyp image is obtained in a mode of white light, NBI, FICE, BLI, LCI, I-SCAN or the like. The NICE type result includes type I, type II, type III and normal intestinal tracts.

[0056] In some embodiments, before the pre-constructed NICE type classification model based on the attention splitting module ResNeSt Block is called, the result prediction method includes:

[0057] conducting color equalization processing and edge feature image fusion on a pre-acquired colorectal polyp sample image to obtain the gradient feature fusion image

for the colorectal polyp sample image;

[0058] the classification model is trained according to the gradient feature fusion image for the colorectal polyp sample image and a pre-constructed feature extraction network based on the ResNeSt Block, and the classification model is optimized according to a loss function during training of the classification model, where a loss function formula is as follows:

$$L = w(i) * (-t[i] + (\sum_{n} \exp(t[n])))$$

[0059] and after training of the classification model, the classification model for the NICE type based on the ResNeSt Block is obtained. In the formula, L represents a loss value; n represents the number of general classes; i represents a real class of current data; t represents a 1D tensor, obtained through the feature extraction network, for class possibility distribution; t[i] represents a predicted probability value from the classification model under the class i; w(i) represents a weighting coefficient for the predicted probability loss value under the class i; and $\sum_{n} \exp(t[n])$ represents that all numerical values of t are processed with exp and then summation.

[0060] In the embodiments of the present invention, by conducting color equalization processing and edge feature image fusion on the colorectum site image to construct a training sample, image features may be effectively unified and strengthened, so as to improve the prediction accuracy of the NICE type result of the colorectal polyps; and by optimizing the classification model according to the loss function, the training speed of the model is effectively increased.

[0061] In some embodiments, that the classification model is trained by using the gradient feature fusion image for the colorectal polyp sample image and the pre-constructed feature extraction network based on the ResNeSt Block includes:

[0062] the gradient feature fusion image for the colorectal polyp sample image is trained in the feature extraction network based on the ResNeSt Block; and

[0063] an output of the ResNeSt Block is added with the gradient feature fusion image for the colorectal polyp sample image, and a fused image is activated with the improved Mish function.

[0064] Optionally, the improved Mish function is as follows:

[0065] $f(x)=x*\tanh(\ln(1+e^{x}))$;

[0066] in the formula, x is a pixel value of an output feature image of the ResNeSt Block.

[0067] The embodiments of the present invention effectively improve the feature fitting ability of the network based on the improved Mish function.

[0068] Optionally, training, in the pre-constructed feature extraction network based on the ResNeSt Block, the gradient feature fusion image for the colorectal polyp sample image includes:

[0069] splitting the gradient feature fusion image for the colorectal polyp sample image to obtain k group convolutions;

[0070] splitting each group convolution into r first feature images;

[0071] conducting 1*1 convolution operation and 3*3 convolution operation on the k * r first feature images first, then re-obtaining and fusing r second feature images in each group convolution, inputting a fused image into a Split Attention layer, and reinforcing features through an attention mechanism to obtain k results; and

[0072] continuously fusing the k results, then inputting a fused result into a 1*1 convolutional layer for convolution operation to obtain an output of the ResNeSt Block, where k and r are both hyper-parameters.

[0073] In detail, as shown in FIG. 2, a processing flow of the ResNeSt Block includes:

[0074] a) an input (an input of the gradient feature fusion image) is split to obtain Cardinal 1- Cardinal k, i.e. k group convolutions in total;

[0075] b) the image is split continuously in each group convolution to obtain Split 1 – Split r, i.e. r first feature images in total;

[0076] c) 1*1 convolution operation and then 3*3 convolution operation are conducted on the k * r first feature images; after the two convolution operations, r feature images in each group convolution are re-obtained and fused; a fused image is inputted into a Split Attention layer; and features are reinforced through an attention mechanism to obtain k results finally;

[0077] d) the k results are continuously fused, then a fused result is inputted into a 1*1 convolutional layer for convolution operation to obtain an output; and

[0078] e) the output of the ResNeSt Block is added with the input for activation with an activation function, to obtain a final feature image.

[0079] The activation function is selected a smoother Mish function, which improves the feature fitting ability of the network. A plot is shown in FIG. 3.

[0080] In the ResNeSt Block feature extraction network, 16 groups of ResNeSt Blocks are provided in total; and each group of Blocks is formed by three convolutional layers, so its network connecting structure is as follows:

[0081] Input → Conv*1 → ResNeSt Block (Conv * 2 + Attention + Conv*1) * 16 → fully connected layer.

[0082] A most effective portion in the ResNet is a residual module. In the embodiments of the present invention, an original residual structure is modified into the ResNeSt Block (attention splitting module); the feature extraction network may be formed by any number of the ResNeSt Blocks; however, the number of the Blocks is inversely proportional to a training/prediction speed and in direct proportion to the prediction accuracy; however, too many Blocks may cause the situations of the network of degradation in the fitting ability and weakening in the accuracy. In the embodiments of the present invention, 16 groups of ResNeSt Blocks are employed, so that the prediction accuracy is improved, and the training speed is also ensured.

[0083] Optionally, that the classification model is optimized through the loss function during training of the classification model includes:

[0084] weighting, according to a number ratio of positive samples and negative samples of the colorectal polyp sample image, the positive samples; and calculating the loss value.

[0085] Further, during training of the classification model, a data set on ImageNet is used for model pre-training, so as to ensure that initial parameters have excellent feature extraction ability and generalization ability. The initial learning rate of model training is 0.0001; and the learning rate is reduced in a mode of fixed-step attenuation. Based on this, the loss function is used for, based on the number ratio of positive samples and negative samples at the same time, weighting the positive samples for calculating a loss value. Its specific formula is as follows:

$$L = w(i) * (-t[i] + (\sum_{n} \exp(t[n])))$$

[0086] (in the formula, L represents a loss value; n represents the number of general classes; i represents a real class of current data; t represents a 1D tensor, obtained through the feature extraction network, for class possibility distribution; t[i] represents a predicted probability value from the classification model under the class i; w(i) represents a weighting coefficient for the predicted probability value under the class i;

and $\sum_{n} \exp(t[n])$ represents that all numerical values of t are processed with exp and then summation.)

[0087] An optimizer employs an AdamW optimizer algorithm, and has weight attenuation and L2 regularization functions, which may effectively increase the training speed and the model accuracy. The model yields an optimal solution after about 300 iterations.

[0088] In some embodiments, the color equalization processing includes:

[0089] determining, according to a color mean of the image, an RGB channel weight value of the image; and

[0090] conducting, according to the RGB channel weight value of the image, RGB channel weighting on the image, where the image is the colorectum site image or the colorectal polyp sample image.

[0091] The edge feature image fusion includes:

[0092] scaling the image subjected to RGB channel weighting to obtain a scaled image;

[0093] conducting edge extraction on the scaled image to obtain an edge feature image; and

[0094] fusing the scaled image with the edge feature image to obtain the gradient feature fusion image.

[0095] In the embodiments of the present invention, on the basis of original image sample data, a training sample is constructed in a mode of superimposing use of color equalization processing and gradient feature image fusion, and the image features may be effectively unified and reinforced in the above two modes.

[0096] Color equalization includes:

[0097] 1. Values of R, G and B channels of all pixels of the image are added; and a sum is divided by the number of pixel points to obtain means of the R, G and B channels, i,e, v (r), v (g) and v (b).

[0098] 2. A total mean K is solved, K=(v (r)+ v (g)+v (b))/3.

[0099] 3. Weight values of various channels are calculated, i.e. Kb=K/v (b), Kg = K/v (g) and Kr=K/v (r).

[00100] 4. Values of the R, G and B channels of the image are subjected to weighting multiplying with Kr, Kg and Kb respectively, for example, an addWeighted function of

python-opencv is used.

[00101] Use of the color equalization processing may reduce a color difference in an intestinal tract due to lights and a patient self, more unify tones of the data set and improve the learning and detection efficiency of the feature extraction network.

[00102] Gradient feature image fusion includes:

[00103] 1. The data set is uniformly scaled into m pixel *n pixel to obtain a scaled image H, for example, 430 pixel *368 pixel.

[00104] 2. The scaled image is converted to a grayscale image, and the grayscale image is subjected to edge extraction with an edge extraction operator (for example, Scharr, Canny, Sobel, Laplace and the like) to obtain an edge feature image J.

[00105] 3. The scaled image H and the edge feature image J are fused into 4-channel data, i.e. the gradient feature fusion image.

[00106] In various embodiments of the present invention, a computer-assistant NICE type system based on deep learning may be constructed, and a result for the NICE type of the colorectal polyps can be more accurately predicted, to assists a doctor to infer the pathological nature of the colorectal polyps.

[00107] Embodiment 2:

[00108] The embodiments of the present invention provide a result prediction apparatus for an NICE type of colorectal polyps, where the result prediction apparatus includes a memory, a processor and computer programs storing on the memory and running on the processor; and

[00109] the computer programs, when being executed by the processor, implements the steps of the result prediction method for the NICE type of the colorectal polyps according to any one of the above items in embodiment 1.

[00110] The result prediction apparatus for the NICE type of the colorectal polyps may be a endoscopy device; and the memory may be a cloud memory.

[00111] Embodiment 3:

[00112] The embodiments of the present invention provide a computer-readable storage medium, storing therein a result prediction program for an NICE type of colorectal polyps; and the result prediction program for the NICE type of the colorectal polyps, when being executed by the processor, implements the steps of the result prediction method for the NICE type of the colorectal polyps according to any one of the above items in embodiment 1.

[00113] Example 4:

[00114] The embodiments of the present invention provide a method of examining a subject with colonoscopy, where the method includes: the NICE type of the colorectal polyps of the subject under a colonoscope is predicted or determined by using the result prediction method for the NICE type of the colorectal polyps in embodiment 1 and the result prediction apparatus for the NICE type of the colorectal polyps in embodiment 2 in real time.

[00115] Specific implementations of embodiment 2, embodiment 3 and embodiment 4 may refer to embodiment 1 and have the corresponding technical effects.

[00116] It should be noted that the terms “include”, “comprise”, or any variants thereof herein are intended to cover a non-exclusive inclusion, so that a process, method, article, or apparatus that includes a series of elements not only includes those elements, but also includes other elements not listed explicitly, or includes inherent elements of the process, method, article, or apparatus. In the absence of more limitations, an element defined by “include a...” does not exclude other same elements existing in the process, method, article, or apparatus including the element.

[00117] The serial numbers of the embodiments of the invention are only for description, and do not represent the advantages and disadvantages of the embodiments.

[00118] From the description of the above embodiments, it will be apparent to those skilled in the art that the methods of the above examples may be implemented by means of software plus a necessary general-purpose hardware platform, and of course may also be implemented by means of hardware, but in many cases the former is a better embodiment. On the basis of the understanding, the technical solution of the present invention may be embodied in a form of a software product in essence or a part contributing to the prior art, and the computer software product is stored in the storage medium (for example, a read only memory (ROM)/random access memory (RAM), a magnetic disk and an optical disk) as above, and includes several instructions for enabling a terminal (like a mobile phone, a computer, a server, an air conditioner, or a network device) to execute the method of each embodiment of the present invention.

[00119] The embodiments of the present invention are described above in combination with the accompanying drawings. However, the present invention is not limited to the above specific implementations; and the above specific implementations are merely meant to be illustrative and not limiting. Those of ordinary skill in the art may, under the inspiration of the present disclosure, further make various forms, which all fall within protection of the present invention, without departing from the spirit of the present

invention and the protection scope defined by the appended claims.

What is claimed is:

1. A recognition method for the colorectal polyp image, the recognition method comprising:

conducting color equalization processing and edge feature image fusion on a colorectum site image to obtain a gradient feature fusion image for the colorectum site image; and

calling a pre-constructed classification model for a type of colorectal polyps based on an attention splitting module ResNeSt Block, and recognizing the gradient feature fusion image for the colorectum site image~~.~~;

wherein the edge feature image fusion comprises:

scaling the image subjected to color equalization processing~~RGB channel weighting~~ to obtain a scaled image;

conducting edge extraction on the scaled image to obtain an edge feature image; and

fusing the scaled image with the edge feature image to obtain the gradient feature fusion image.

2. The recognition method for the colorectal polyp image according to claim 1, the recognition method further comprising:

conducting color equalization processing and edge feature image fusion on a pre-acquired colorectal polyp sample image to obtain the gradient feature fusion image for the colorectal polyp sample image;

training, by using the gradient feature fusion image for the colorectal polyp sample image and a pre-constructed feature extraction network based on the ResNeSt Block, the classification model, and optimizing the classification model through a loss function during training of the classification model, a loss function formula being as follows:

$$L = w(i) * (-t[i] + (\sum_{n} \exp(t[n])))$$

and after training of the classification model, obtaining the classification model for the type of the colorectal polyps based on the ResNeSt Block; in the formula, *L* represents a loss value; *n* represents the number of general classes; *i* represents a real class of current data; t represents a 1D tensor, for class possibility distribution, obtained through the feature extraction network,; *t[i]* represents a predicted probability value from the classification model under the class *i*; *w(i)* represents a weighting coefficient

for the predicted loss value under the class *i*; and $\sum_{n} \exp(t[n])$ represents that all numerical values of t are processed with exp and then summation.

3. The recognition method for the colorectal polyp image according to claim 2, wherein the training, by using the gradient feature fusion image for the colorectal polyp sample image and the pre-constructed feature extraction network based on the ResNeSt Block, the classification model comprises:

training, in the pre-constructed feature extraction network based on the ResNeSt Block, the gradient feature fusion image for the colorectal polyp sample image; and

activating, through a Mish function, an output of the ResNeSt Block.

4. The recognition method for the colorectal polyp image according to claim 3, wherein the Mish function is as follows:

$f(x)=x*\tanh(\ln(1+e^{x}))$;

in the formula, x is a pixel value of an output feature image of the ResNeSt Block.

5. The recognition method for the colorectal polyp image according to claim 3, wherein the training, in the pre-constructed feature extraction network based on the ResNeSt Block, the gradient feature fusion image for the colorectal polyp sample image comprises:

splitting the gradient feature fusion image for the colorectal polyp sample image to obtain k group convolutions;

splitting each group convolution into r first feature images;

conducting 1*1 convolution operation and 3*3 convolution operation on the k * r first feature images first, then re-obtaining and fusing r second feature images in each group convolution, inputting a fused image into a Split Attention layer, and reinforcing features through an attention mechanism to obtain k results; and

continuously fusing the k results, then inputting a fused result into a 1*1 convolutional layer for convolution operation to obtain an output of the ResNeSt Block, wherein k and r are both hyper-parameters.

6. The recognition method for the colorectal polyp image according to claim 2, wherein the optimizing the classification model through the loss function during training of the classification model comprises:

weighting, according to a number ratio of positive samples and negative samples of the colorectal polyp sample image, the positive samples; and calculating the loss value.

7. The recognition method for the colorectal polyp image according to any one of claims 1 to 6, wherein the color equalization processing comprises:

determining, according to a color mean of the image, an RGB channel weight value of the image; and

conducting, according to the RGB channel weight value of the image, RGB channel weighting on the image, wherein the image is the colorectum site image or the colorectal polyp sample image.

~~8. The recognition method for the colorectal polyp image according to claim 7, wherein the edge feature image fusion comprises:~~

~~scaling the image subjected to RGB channel weighting to obtain a scaled image;~~

~~conducting edge extraction on the scaled image to obtain an edge feature image; and~~

~~fusing the scaled image with the edge feature image to obtain the gradient feature fusion image.~~

~~9~~8. The recognition method for the colorectal polyp image according to claim 1, wherein a standard for the type of the colorectal polyps is an NICE type standard, a Sano type standard, a Pit type standard, Hiroshima type standard, a Showa type standard, a Jikei type standard, or a JNET type standard.

~~10~~9. The recognition method for the colorectal polyp image according to claim ~~9~~8, wherein the standard for the type of the colorectal polyps is the NICE type standard.

~~11~~10. A result prediction apparatus for a type of colorectal polyps, comprising a memory, a processor and computer programs storing on the memory and running on the processor,

the computer programs, when being executed by the processor, implementing the steps of the recognition method for the colorectal polyp image according to any one of claim 1 to 9~~claim 1~~.

~~12~~11. A computer-readable storage medium storing therein a result prediction program for a type of colorectal polyps, the result prediction program for the type of the colorectal polyps, when being executed by the processor, implementing the steps of the recognition method for the colorectal polyp image according to any one of claim 1 to 9.

~~13~~12. A method of examining a subject with colonoscopy, the method comprising: predicting or determining, by using the recognition method for the colorectal polyp image according to any one of claim 1 to 9~~claim 1~~ or the result prediction apparatus for the type of the colorectal polyps according to claim ~~11~~10, the type of the colorectal

polyps of the subject under a colonoscope in real time.