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(54) Titre : SYSTEME ET PROCEDE D'EVALUATION D'UNE PERFUSION DANS UNE STRUCTURE ANATOMIQUE
(54) Title: SYSTEM AND METHOD FOR ASSESSING PERFUSION IN AN ANATOMICAL STRUCTURE

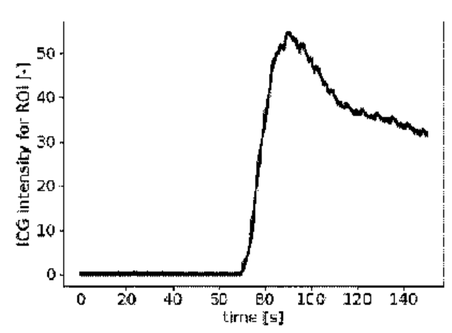


Fig. 1A

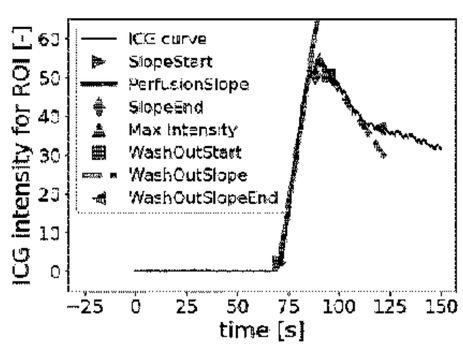


Fig. 1B

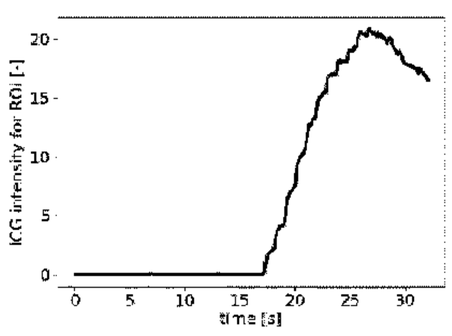


Fig. 1C

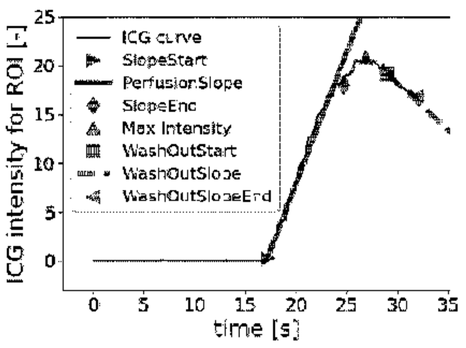


Fig. 1D

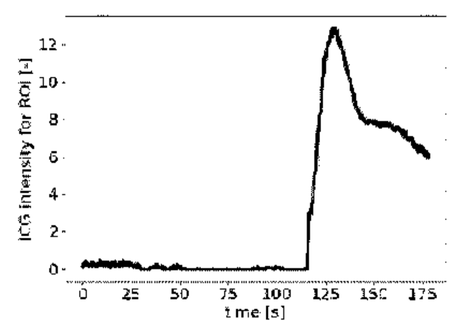


Fig. 1E

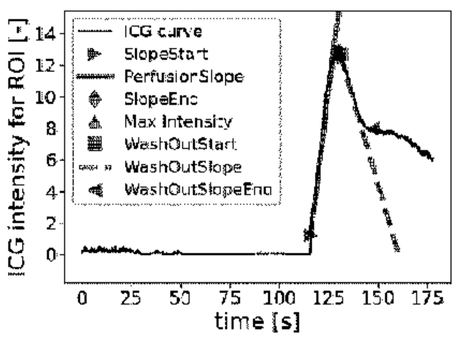


Fig. 1F

(57) Abrégé/Abstract:
The present disclosure relates to a system for measuring and assessing hemodynamics in an anatomical structure of a subject, and a method for image processing hemodynamics in at least a part of an anatomical structure in video images acquired from a subject. In particular the present disclosure relates to measuring and assessing hemodynamics in, around and near the surface, in particular the gastrointestinal wall, of the gastrointestinal tract of a subject. One embodiment discloses a method for image processing hemodynamics in at least a part of an anatomical structure in video images acquired from a subject, comprising the steps of: performing image analysis of at least one video sequence acquired after a fluorescent contrast agent has been supplied to the subject, calculating intensity values in one or more regions of interest based on the image analysis, and determining the perfusion slope of the flow of the fluorescent contrast agent through at least one of said regions of interest.

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**(54) Title:** SYSTEM AND METHOD FOR ASSESSING PERFUSION IN AN ANATOMICAL STRUCTURE

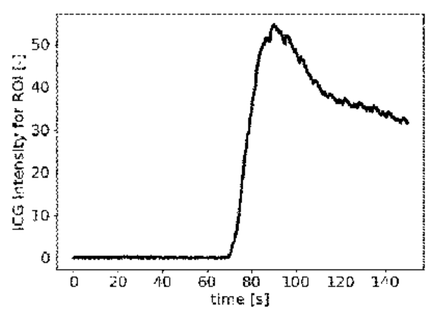


Fig. 1A

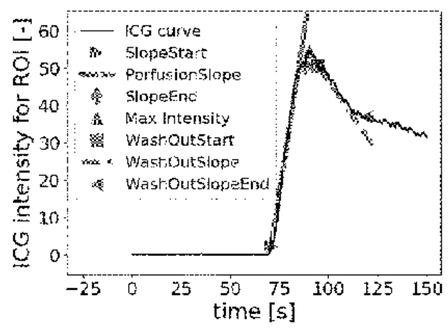


Fig. 1B

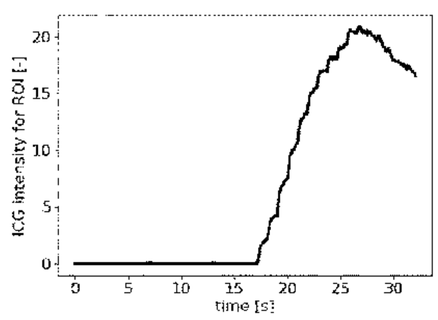


Fig. 1C

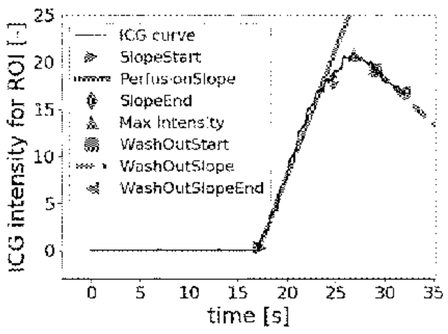


Fig. 1D

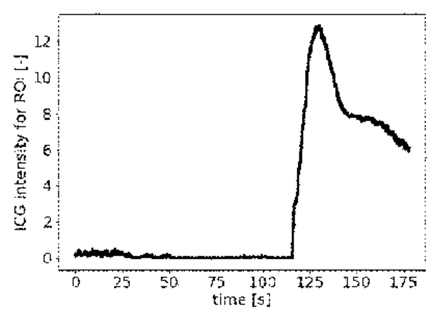


Fig. 1E

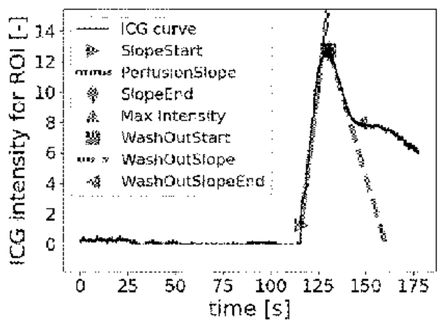


Fig. 1F

**(57) Abstract:** The present disclosure relates to a system for measuring and assessing hemodynamics in an anatomical structure of a subject, and a method for image processing hemodynamics in at least a part of an anatomical structure in video images acquired from a subject. In particular the present disclosure relates to measuring and assessing hemodynamics in, around and near the surface, in particular the gastrointestinal wall, of the gastrointestinal tract of a subject. One embodiment discloses a method for image processing hemodynamics in at least a part of an anatomical structure in video images acquired from a subject, comprising the steps of: performing image analysis of at least one video sequence acquired after a fluorescent contrast agent has been supplied to the subject, calculating intensity values in one or more regions of interest based on the image analysis, and determining the perfusion slope of the flow of the fluorescent contrast agent through at least one of said regions of interest.

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## Claims

1. A computer implemented method for image processing hemodynamics in at least a part of the gastrointestinal tract in video images acquired from a subject, comprising the steps of:
   - performing image analysis of at least one video sequence acquired after a fluorescent contrast agent has been supplied to the subject,
   - calculating intensity values in one or more regions of interest based on the image analysis, and
   - determining at least a first perfusion slope of the flow of the fluorescent contrast agent through at least a first of said regions of interest.

2. The method according to any claim 1, wherein the perfusion slope is defined by the slope of said intensity values from slope start to slope end, wherein slope start is defined as the point in time where the slope exceeds a predefined first threshold.

3. The method according to any of preceding claims 2, wherein the first threshold is determined by a predefined factor k and the mean and standard deviation (std) of intensity values prior to slope start and wherein slope start is defined as the time point where the slope exceeds the mean by k * std.

4. The method according to any of preceding claims 2-3, wherein the perfusion slope is determined from a histogram in a parameter space binning all slope values calculated after slope start and where the perfusion slope is determined as the most frequent value of the histogram.

5. The method according to any of preceding claims 2-4, wherein the slope values calculated immediately after slope start is assigned more weight in the histogram than later slope values.

6. The method according to any of preceding claims, further comprising the step of determining the washout slope of the extinctive flow of the fluorescent contrast agent through at least one of said regions of interest, wherein the washout slope is defined by the slope of said intensity values from washout start to washout end, wherein washout start is after perfusion slope end and wherein

the washout slope is determined from a histogram in a parameter space binning all calculated slope values after washout start and where the washout slope is determined as the most frequent value of the histogram.

7. The method according to any of preceding claims, further comprising the step of determining the max slope intensity, defined as the intensity value at the time point where the distance to the perfusion slope exceeds a predefined limit, for example a limit based on a constant ($k_2$) times the standard deviation of the perfusion slope.

8. The method according to any of preceding claims, further comprising the step of 1) determining the slope rise time, defined as the difference between the time point of the max slope intensity and slope start, and 2) determining the relative perfusion slope, defined as the inverse of the slope rise time.

9. The method according to any of preceding claims, further comprising the step of determining the subject specific relative perfusion slope, defined as the relative perfusion slope times an extrema intensity of a separate, preferably subject specific, region of interest.

10. The method according to any of preceding claims, further comprising the step of determining at least a second of the following parameters: the perfusion slope, the washout slope, the max slope intensity, the relative perfusion slope and the subject specific relative perfusion slope of the flow of the fluorescent contrast agent through at least a second of said regions of interest, wherein the first and second regions of interest represent different parts of the gastrointestinal tract.

11. The method according to claim 10, wherein said different parts are the colon and the small intestine, respectively.

12. The method according to any of claims 10-11, wherein the perfusion of one of said different parts of the gastrointestinal tract is evaluated by comparing with the perfusion of at least one other of said different parts.

13. The method according to any of preceding claims, further comprising the steps of

- performing image analysis of two or more of the following video sequences, each video sequence acquired after a fluorescent contrast agent has been supplied to the subject:
    - video images representing at least a part of the gastrointestinal tract acquired before resection,
    - video images representing at least a part of the gastrointestinal tract acquired after resection but before anastomosis, and
    - video images representing at least a part of the gastrointestinal tract acquired after anastomosis
- calculating intensity values in one or more regions of interest based on the image analysis, wherein at least a first of said regions of interest is the same region in said two or more video sequences, and
- determining the perfusion slopes of the flow of the fluorescent contrast agent through at least the first region of interest based on said two or more video sequences.

14. The method according to any of preceding claims 13, further comprising the steps of 1) determining one or more of the following parameters based on said two or more video sequences: the washout slopes, the max slope intensities, the relative perfusion slopes and the subject specific relative perfusion slopes, and 2) calculating quantitative data for the perfusion in at least one of said regions of interest based on slope parameters determined from said at least two video sequences.

15. The method according to any of preceding claims, further comprising the step of tracking movements of at least a part of the gastrointestinal tract in said video images, and correlating said movements such that at least said first region of interest corresponds to the same subsection of the gastrointestinal tract in said video images.

16. The method according to any of preceding claims 15, wherein movement tracking is provided by free image tracking in the form of classifier based tracking comprising the step of determining classifiers of one more recognizable features in the video images, preferably in an area adjacent or surrounding at least one of the regions of interest.

17. The method according to any of preceding claims 15, wherein movement tracking is provided by free image tracking in the form of colour based tracking based on 1) colour tracking of one or more colour markers which have been applied on to the gastrointestinal tract, or 2) colour filtering and thresholding to obtain a Boolean map of pixels in the video images.

18. The method according to any of preceding claims 15, wherein movement tracking is provided by object based tracking based in tracking the movement of one or more predefined objects attached to the gastrointestinal tract.

19. The method according to any of the preceding claims, wherein said part of the gastrointestinal tract is selected from the group of: buccal cavity; pharynx; the small intestine including duodenum, jejunum, and ileum; the stomach, including esophagus, cardia, and pylorus; the large intestine including cecum, colon, rectum and the anal canal.

20. The method according to any of preceding claims, wherein the video sequences are acquired using natural light or infrared light or a combination thereof.

21. A system for measuring and/or assessing hemodynamics in at least a part of the gastrointestinal tract of a subject,
- an imaging device for acquiring video images of the exterior portion of said part of the gastrointestinal tract, and
- an image processing device configured for carrying out the method of any of the preceding claims 1-20.

22. A system for measuring and/or assessing hemodynamics in at least a part of the gastrointestinal tract of a subject, comprising a non-transitive, computer-readable storage device for storing instructions that, when executed by a processor, performs a method according to any of claims 1-20.

23. An electronic medical device comprising a processor and a memory and being adapted to perform the method for measuring and/or assessing hemodynamics in at least a part of the gastrointestinal tract of a subject according to any of claims 1-20.

24. A computer program having instructions which when executed by a computing device or system causes the computing device or system to measure and/or assess hemodynamics in at least a part of the gastrointestinal tract of a subject according to any of claims 1-20.