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(54) **METHOD AND SYSTEM FOR CONTENT AWARE DYNAMIC IMAGE FRAMING**

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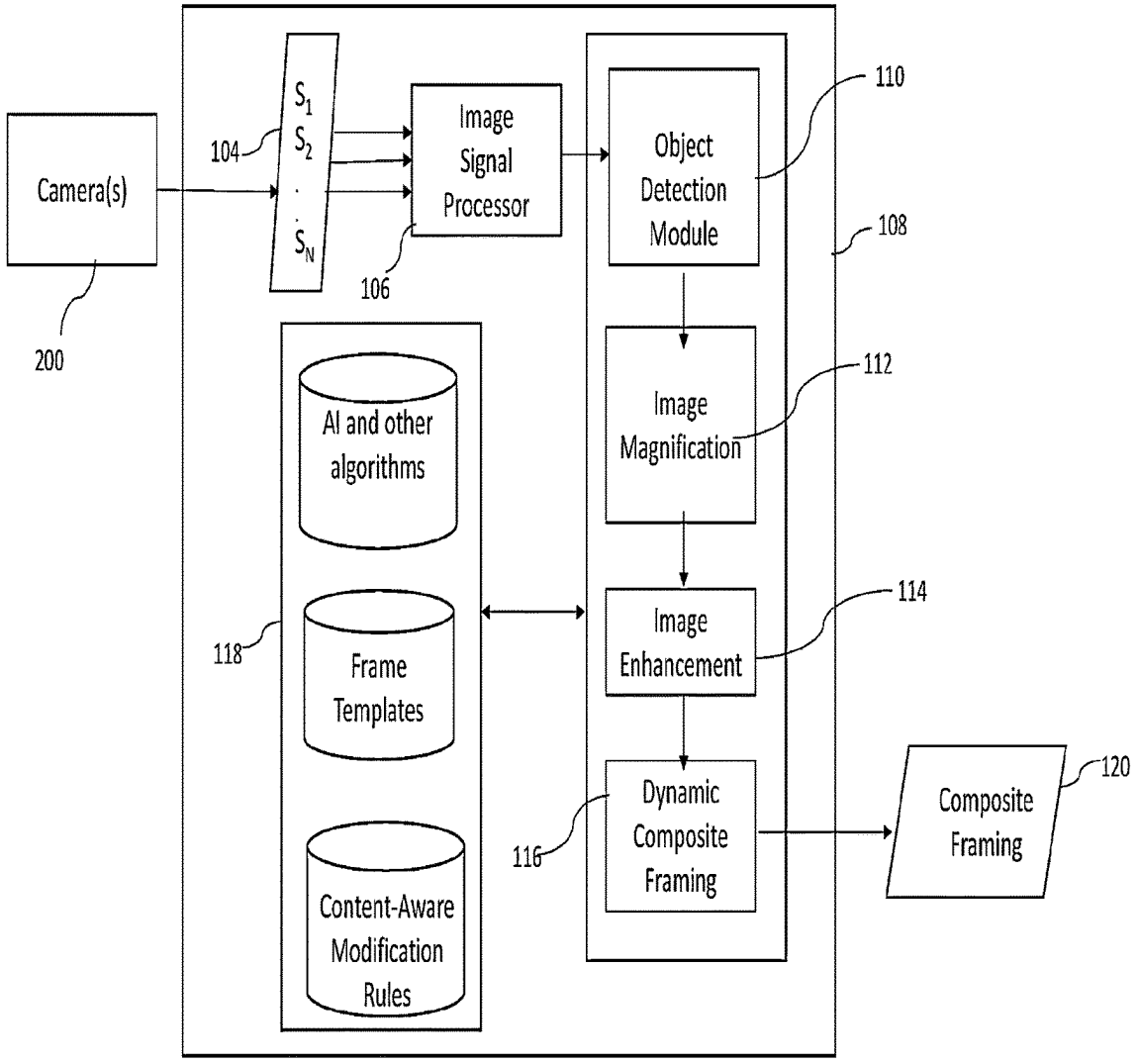
(57) **ABSTRACT**

Embodiments of the present invention disclose techniques for outputting content aware video based on at least one a video application use case. The technique recognizes objects associated with the use case and performs enhancement of the objects based on content-aware rules and composes at least some of the objects in an output frame based on content-aware frame composition templates. Embodiments of the present invention also disclose systems for implementing the above techniques.



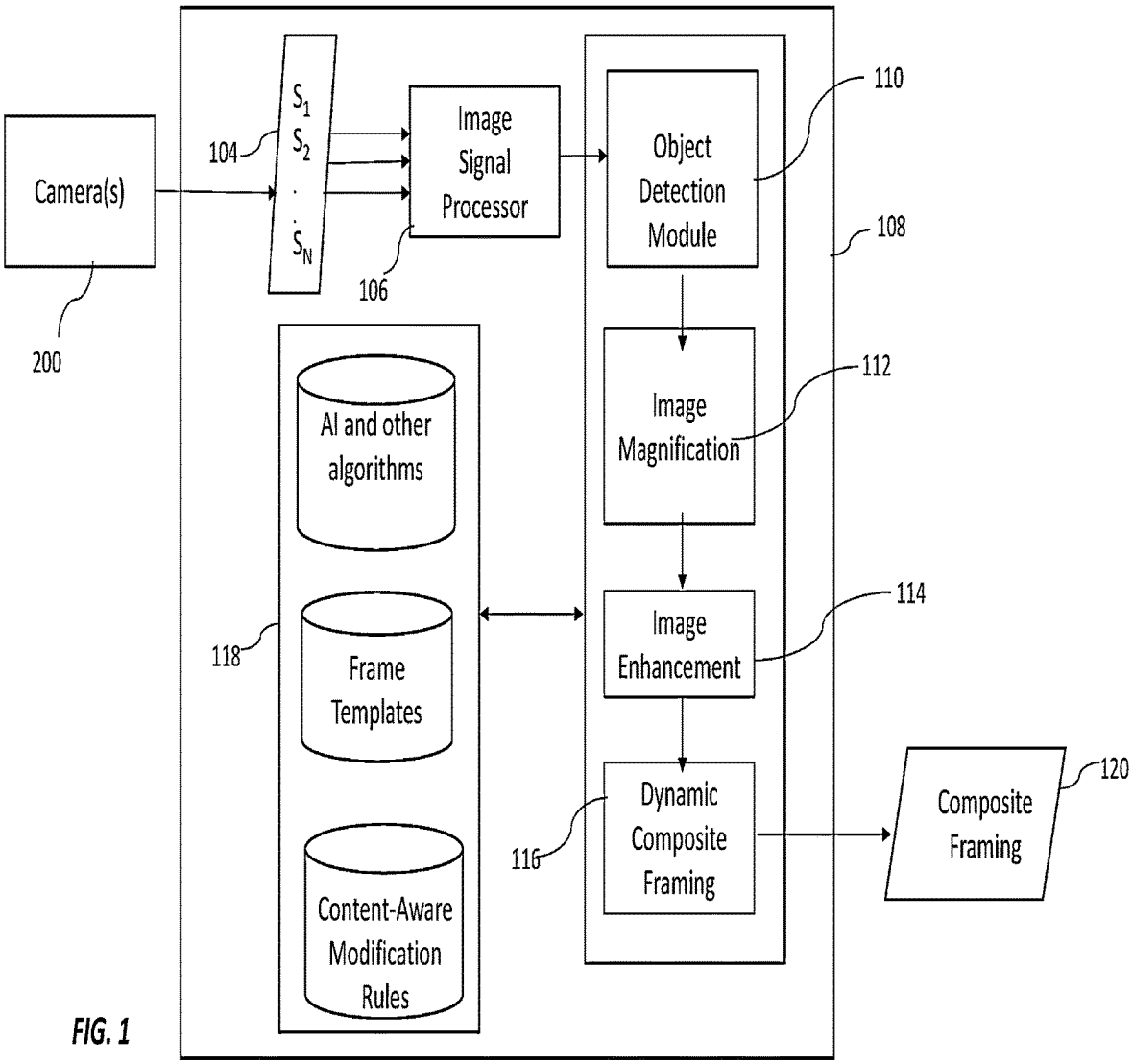

Camera(s)
200
104
S_1
S_2
.
.
S_N
Image Signal Processor
106
Object Detection Module
110
108
Image Magnification
112
Image Enhancement
114
Dynamic Composite Framing
116
Composite Framing
120
AI and other algorithms
Frame Templates
118
Content-Aware Modification Rules

FIG. 1

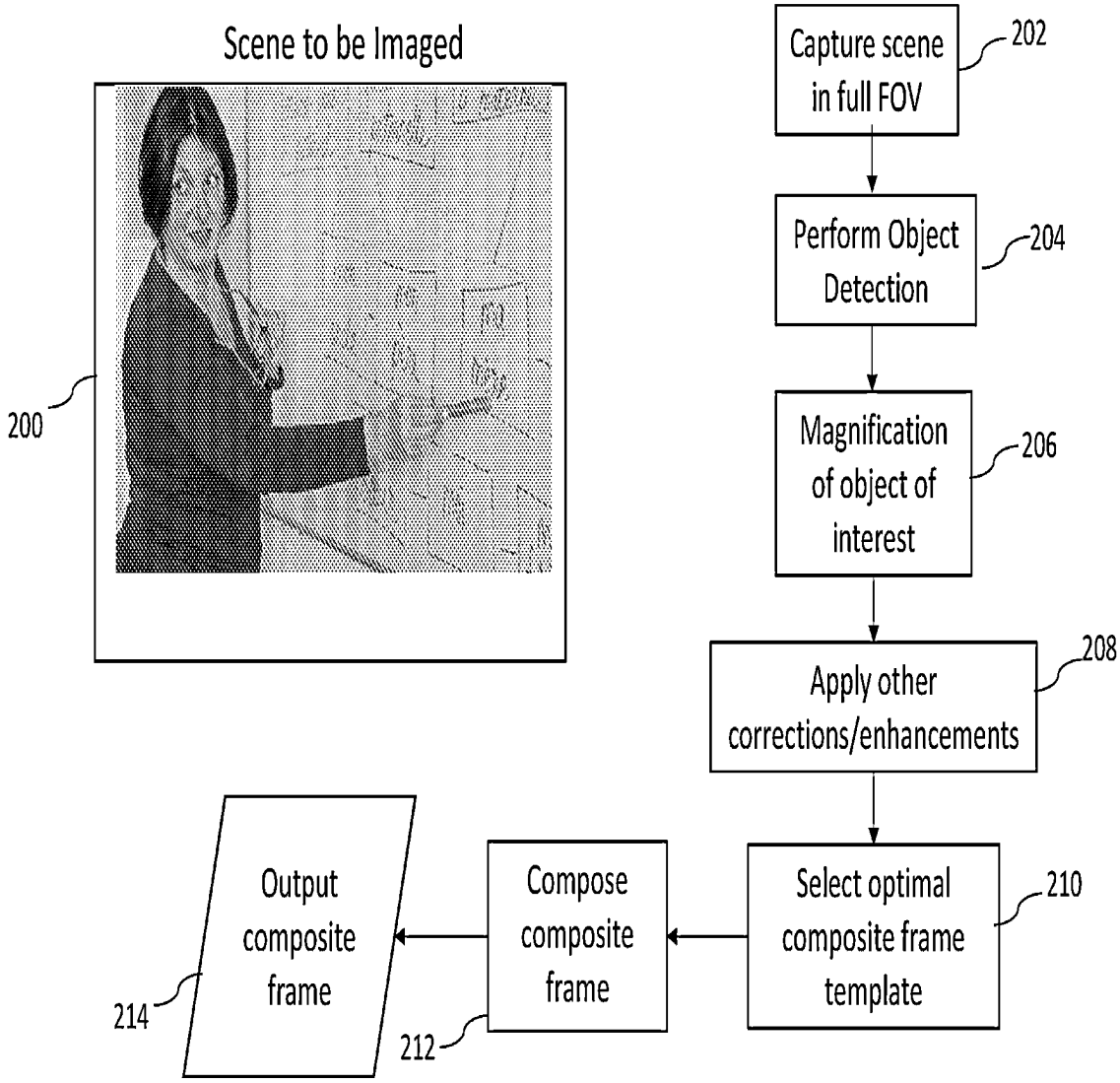

Scene to be Imaged
200
Capture scene in full FOV
202
Perform Object Detection
204
Magnification of object of interest
206
Apply other corrections/enhancements
208
Select optimal composite frame template
210
Compose composite frame
212
Output composite frame
214

FIG. 2

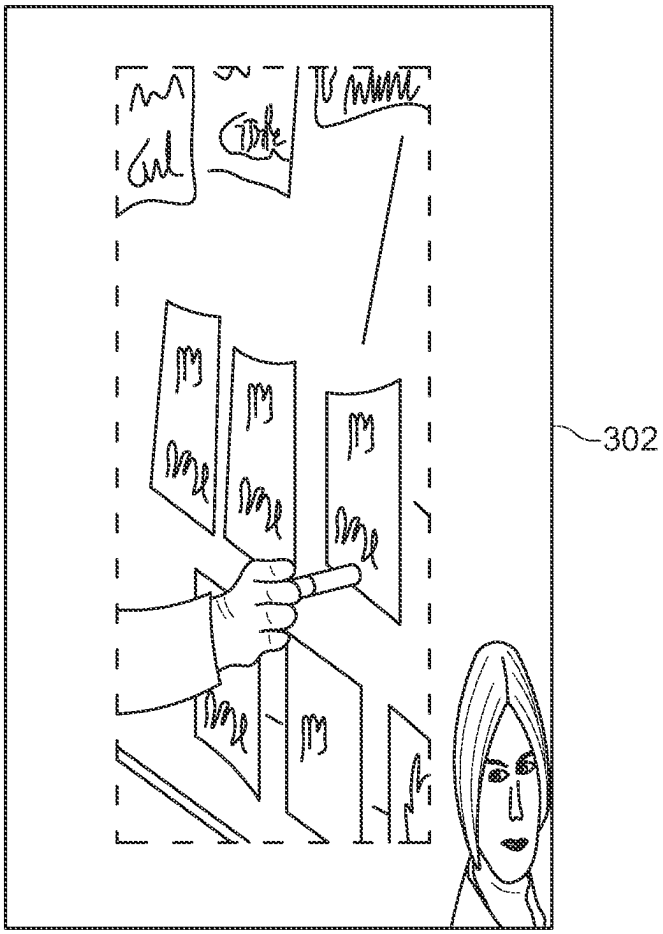


FIG. 3

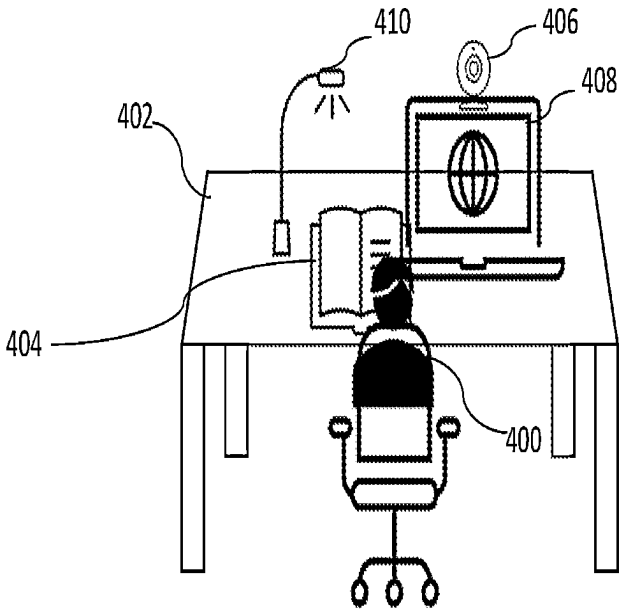
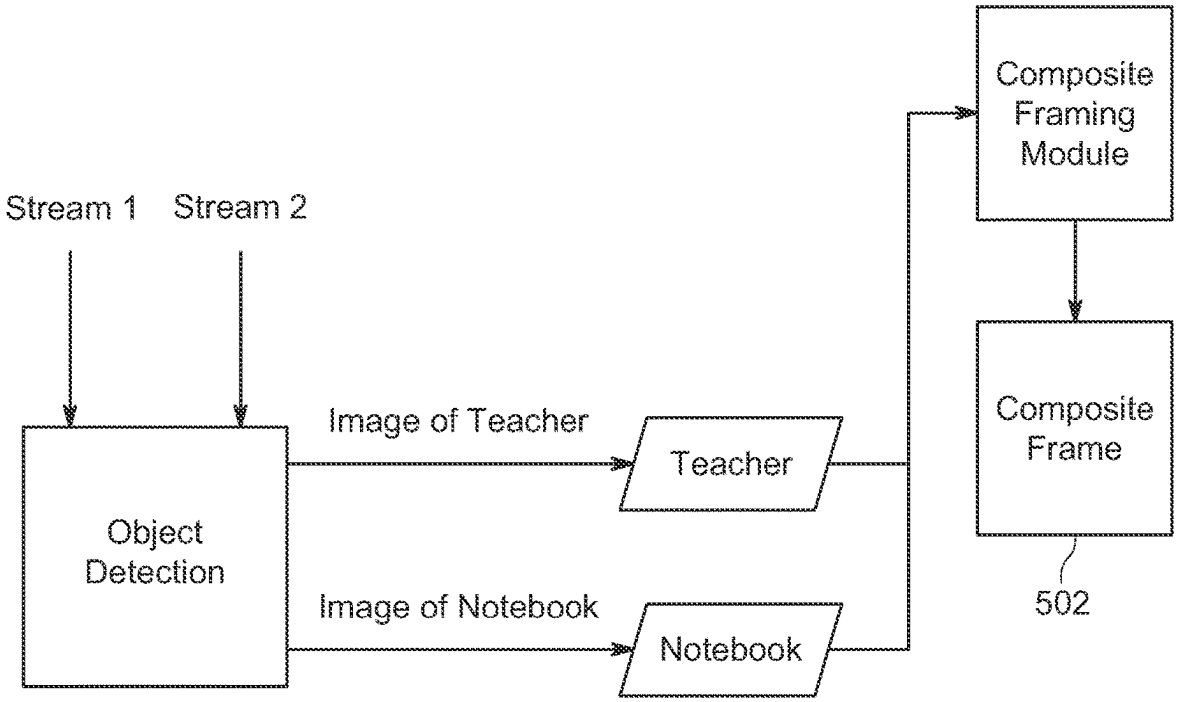


FIG. 4


Composite Framing Module
Stream 1
Stream 2
Composite Frame
Image of Teacher
Teacher
Object Detection
Image of Notebook
Notebook
502

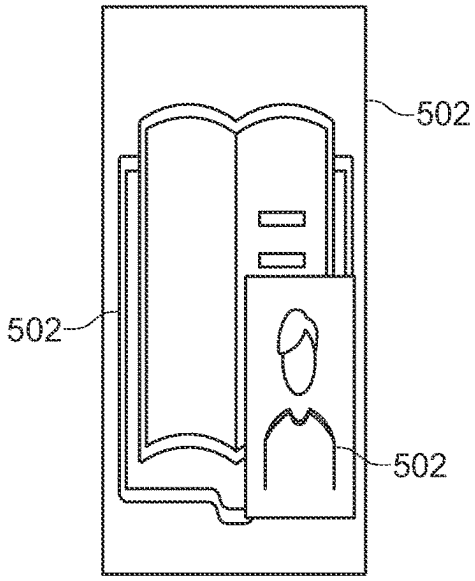

502
502
502

FIG. 5

METHOD AND SYSTEM FOR CONTENT AWARE DYNAMIC IMAGE FRAMING

FIELD

[0001] a. Embodiments of the present invention relate generally to video processing.

BACKGROUND

[0002] b. The use of video as a a medium to deliver content has grown tremendously over the past few years. Video application use cases range from the remote instructor-related training sessions, teacher-student classroom sessions, etc.

[0003] c. All of these applications video application use cases may benefit from content-aware framing of the video content.

SUMMARY

[0004] d. According to a first aspect of the invention, there is provided a method for framing video content, comprising: receiving at least one input video stream from at least one source; applying at least one image analysis technique to recognize objects in each input video stream; isolating at least one recognized object composing an output frame comprising at least some of the recognized objects; and outputting the output frame to video client device.

[0005] e. According to a second aspect of the invention, they provided a system for implementing the above method

[0006] f. Other aspects of the invention, will be apparent from the written description below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] g. FIG. **1** shows an exemplary content-aware video processing system for composing output video streams optimized for selected video application use cases.

[0008] h. FIG. **2** illustrates content-aware video composition for the use case of a remote instructor-related training session.

[0009] i. FIG. **3** illustrates an output frame generated based on content-aware rules for the remote instructor-led training session.

[0010] j. FIG. **4** illustrates content-aware video composition for the use case of a teacher-student remote classroom session.

[0011] k. FIG. **5** illustrates an output frame generated based on content-aware composition for the use case of a teacher-student remote classroom session.

DETAILED DESCRIPTION

[0012] l. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the invention. Reference in this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment, nor are separate or alternative embodiments mutually exclusive of other embodiments. Moreover, various features are described which may be exhibited by some embodiments and not by others. Similarly, various requirements are described which may be requirements for some embodiments but not others.

[0013] m. Moreover, although the following description contains many specifics for the purposes of illustration, anyone skilled in the art will appreciate that many variations and/or alterations to said details are within the scope of the present invention. Similarly, although many of the features of the present invention are described in terms of each other, or in conjunction with each other, one skilled in the art will appreciate that many of these features can be provided independently of other features. Accordingly, this description of the invention is set forth without any loss of generality to, and without imposing limitations upon, the invention.

[0014] n. FIG. **1** shows a high-level block diagram of exemplary content-aware video processing system **100** for composing output video streams optimized for selected video application use cases, in accordance with one embodiment of the invention.

[0015] o. Referring to FIG. **1**, one or more video cameras **102** may be configured to generate a plurality of input video streams indicated were reference numeral **104**. According to different embodiments, the cameras **102** may be configured in accordance with different geometries. For example, for some use cases, there may be two cameras **102** positioned in orthogonal fashion thereby to capture input video streams corresponding to different portions/aspects of the scene being imaged.

[0016] p. The input video streams **104** are fed into an image signal processor **106** which is configured to perform certain image processing operations, which will be well understood by one of ordinary skill in the art. For example, the signal processor **106** may implement techniques for image stitching thereby to produce a panoramic video from the various input video streams.

[0017] q. Output from the signal processor **106** is passed to an image processing pipeline **108**. According to one embodiment of the invention, the image processing pipeline comprises an object detection module **110**, and image magnification module **112**, an image enhancement module **114**, and a dynamic opposite flaming module **116**. The various functions and operations provided by these modules will be explained in greater detail later. To support the inventive content-aware processing performed in the imaging processing pipeline **108**, the system may be provisioned with various databases **118** including an artificial intelligence (AI) and other algorithms database, a flame templates database, and a content-aware modification rules database. Operation of the image processing pipeline **108** based on the databases **118** will be explained with reference to the following video application use cases.

Use case one: Remote Training Session by a Training Instructor

[0018] r. Referring to FIG. **2** of the drawings, an illustrative scene **200** to be imaged may comprise a training instructor providing some training on a white board to remote users. For this application, the scene **200** is captured field-of-view (FOV) at block **202**.

[0019] s. In accordance with one embodiment of the invention, a method for framing the video content in the scene **200** is performed, said method comprising:

[0020] i. receiving at least one input video stream from at least one source (camera(s) **200**), Each stream may

the generated by a camera configured to capture dedicated aspects of the video use case. A plurality of cameras may be used, each camera being orientated to capture a different aspect of the video application use case.

[0021] ii. applying at least one image analysis technique to recognize objects in each input video stream. The video analysis technique may be selected from the group consisting of artificial intelligence (AI), machine learning (ML), and deep learning. In one embodiment, the database **118** may be provisioned with suitable AI, ML, and deep learning algorithms tuned for object detection and extraction for with this use case. For example, the algorithms may be tuned to detect the instructor, the white board, writing under white board, etc. the steps executed by the object detection module **110**.

[0022] iii. isolating each recognized object, a step performed by the object detection module **110** as per block **204**. According to one embodiment, isolation may comprise extracting the object from its background so that it can be enhanced and framed independently of said background.

[0023] iv. composing an output frame comprising at least some of the recognized objects; and outputting the output frame to video client device. The step is performed by the module **116** in block **212**. In one embodiment, especially framing templates may be used. Each framing template may be optimized for the particular average application use case. Each template may be constructed to have dedicated zones within which particular objects may be placed based on the video use case application. The composing may include selecting a content-aware framing template that is matched to the recognized objects; and placing the extracted objects in the output frame based on the selected content-aware framing template.

[0024] v. applying at least one content-aware modification to at least some of the recognized objects, for example, objects may be magnified as indicated by about **206**. The modifications may be a selected from the group consisting of handwriting sharpening, object contrast enhancement, image straightening; image magnification; white board sharpening; and object extraction and placement in the output frame, independently of the instructor. For example for the present use case, the modification is selected from the group comprising extracting a notebook on the desk for presentation in the output frame independently of said desk; and at least one image enhancement technique to the notebook prior to presentation.

[0025] vi. outputting the composite frame as indicated in block **214**.

[0026] t. FIG. **3** of the drawings shows a composite frame **302**, wherein the presenter has been separated from the content of the white board so that uses can focus on the white board more effectively.

Use Case Two: Teacher-Student Remote Teaching Session with Notebook-based Teaching

[0027] u. This use cases is depicted in FIG. **4**. A student **400** sits at a desk **402** and take notes in a notebook **444** while a teacher uses a Web cam **404** of a computer **408**. A camera **410** captures video of the notebook. The processing for this usecase is as above. Handwriting on the notebook may be de-skewed and recognized as an optimization, in one embodiment. A composite output frame **500** is shown in FIG. **5** in which the notebook is magnified for viewing and discussion purposes.

[0028] v. As will be appreciated by one skilled in the art, the aspects of the present invention may be embodied as a system, method or computer program product. Accordingly, aspects of the present invention may take the form of an entirely hardware embodiment, an entirely software embodiment (including firmware, resident software, micro-code, etc.), or an embodiment combining software and hardware aspects that may all generally be referred to herein as a "circuit," "module," or "system." Furthermore, aspects of the present invention may take the form of a computer program product embodied in one or more computer readable medium(s) having computer readable program code embodied thereon.

[0029] w. The title, background, brief description of the drawings, abstract, and drawings are hereby incorporated into the disclosure and are provided as illustrative examples of the disclosure, not as restrictive descriptions. It is submitted with the understanding that they will not be used to limit the scope or meaning of the claims. In addition, in the detailed description, it can be seen that the description provides illustrative examples and the various features are grouped together in various implementations for the purpose of streamlining the disclosure. The method of disclosure is not to be interpreted as reflecting an intention that the claimed subject matter requires more features than are expressly recited in each claim. Rather, as the claims reflect, inventive subject matter lies in less than all features of a single disclosed configuration or operation. The claims are hereby incorporated into the detailed description, with each claim standing on its own as a separately claimed subject matter.

[0030] x. The claims are not intended to be limited to the aspects described herein but are to be accorded the full scope consistent with the language claims and to encompass all legal equivalents. Notwithstanding, none of the claims are intended to embrace subject matter that fails to satisfy the requirements of the applicable patent law, nor should they be interpreted in such a way.

What is claimed is:

1. A method, comprising:

receiving at least one input video stream from at least one source, wherein each input video stream corresponds to a video application use case;

applying at least one video analysis technique to recognize at least one object of interest in the input video stream;

composing an output frame comprising one or more of the at least one recognized object of interest, wherein composing the output frame comprises:

selecting a content-aware framing template that includes a plurality of dedicated zones to place the one or more of the at least one recognized object of interest, and

modifying, based on a content-aware rule, the one or more of the at least one recognized object of interest; and

outputting the composed output frame to a video client device.

2. The method of claim 1, wherein the at least one video analysis technique comprises at least one of artificial intelligence (AI), machine learning (ML), or deep learning.

3. The method of claim 1, further comprising retrieving the content-aware framing template from a database of framing templates.

4. The method of claim 1, wherein the modification comprising at least one of de-skewing handwriting, magnifying the object, contrast enhancement, sharpening, or extracting and repositioning the object in the output frame.

5. The method of claim 1, wherein the recognized object includes a notebook and the modifying step comprises enhancing handwriting content on the notebook.

6. The method of claim 1, further comprising isolating the one or more of the at least one recognized object of interest from its background prior to composing the output frame.

7. The method of claim 1, wherein the at least one input video stream is received from a plurality of video cameras arranged in different orientations to capture different aspects of a scene.

8. The method of claim 1, wherein the content-aware framing template is selected from a database of framing templates by matching, based on a predefined rule, the database of framing templates with a type of the one or more of the at least one recognized object of interest.

9. A system, comprising:

at least one video source configured to generate at least one input video stream corresponding to a video application use case; and

a processor configured to:

apply at least one video analysis technique to recognize at least one object of interest in the input video stream;

compose an output frame comprising one or more of the at least one recognized object of interest, wherein composing the output frame comprises:

selecting a content-aware framing template that includes a plurality of dedicated zones to place the one or more of the at least one recognized object of interest, and

modifying, based on a content-aware rule, the one or more of the at least one recognized object of interest; and

output the composed output frame to a video client device.

10. The system of claim 9, wherein the video analysis technique comprises at least one of artificial intelligence (AI), machine learning (ML), or deep learning.

11. The system of claim 9, wherein the processor is further configured to retrieve the content-aware framing template from a database of framing templates.

12. The system of claim 9, wherein the modification comprises at least one of de-skewing handwriting, magnifying the object, contrast enhancement, sharpening, or extracting and repositioning the object in the output frame.

13. The system of claim 9, wherein the recognized object includes a notebook and the processor is further configured to enhance handwriting content on the notebook.

14. The system of claim 9, wherein the processor is further configured to isolate the one or more of the at least one recognized object of interest from its background prior to composing the output frame.

15. The system of claim 9, wherein the input video stream is received from a plurality of video cameras arranged in different orientations to capture different aspects of a scene.

16. A non-transitory computer-readable medium storing instructions that, when executed by one or more processors, cause the one or more processors to perform operations comprising:

receiving at least one input video stream from at least one source, wherein each input video stream corresponds to a video application use case;

applying at least one video analysis technique to recognize at least one object of interest in the input video stream;

composing an output frame comprising one or more of the at least one recognized object of interest, wherein composing the output frame comprises:

selecting a content-aware framing template that includes a plurality of dedicated zones to place the one or more of the at least one recognized object of interest, and

modifying, based on a content-aware rule, the one or more of the at least one recognized object of interest; and

outputting the composed output frame to a video client device.

17. The non-transitory computer-readable medium of claim 16, wherein the video analysis technique comprises at least one of artificial intelligence (AI), machine learning (ML), or deep learning.

18. The non-transitory computer-readable medium of claim 16, wherein the operations further comprise retrieving the content-aware framing template from a database of framing templates.

19. The non-transitory computer-readable medium of claim 16, wherein the modification comprises at least one of de-skewing handwriting, magnifying the object, contrast enhancement, sharpening, or extracting and repositioning the object in the output frame.

20. The non-transitory computer-readable medium of claim 16, wherein the recognized object includes a notebook and the modifying comprises enhancing handwriting content on the notebook.

* * * * *