(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 May 2024 (23.05.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/105702 A1

(51) International Patent Classification:
G06F 30/13 (2020.01) *G06T 15/10* (2011.01)
G06T 7/60 (2017.01)

(21) International Application Number:
PCT/IN2023/051068

(22) International Filing Date:
18 November 2023 (18.11.2023)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
202221066499 19 November 2022 (19.11.2022) IN

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,

(54) Title: A SYSTEM AND METHOD FOR EXTRACTION AND RECREATION OF GEOMETRY INFORMATION FROM INTERIOR AND/OR EXTERIOR DRAWINGS OF A BUILDING

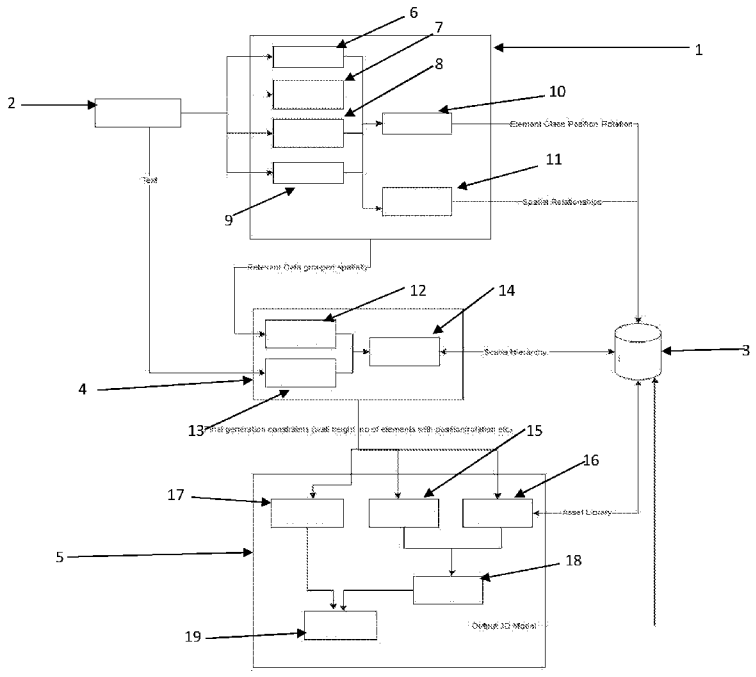

FIG. 1

(57) Abstract: A System and Method for Extraction and Recreation of Geometry Information from Interior and/or Exterior Drawings of a Building A system for extraction and recreation of geometry information from interior and/or exterior drawings of a building comprises an extraction module (1), adapted to receive drawings through user input data module (2) about interior / exterior of a building is provided to extract data about walls, floor, and object and supply the same to a database (3) provided to store information/data An interpretation module (4), adapted to be connected with the extraction module (1) and user input data module (2) is provided to receive information from the extraction module (1) and interpret the same into different classes, and send the same to the said database (3). A generation module (5), adapted to be connected to the interpretation module is provided to generate a 3 dimensional (3D) building

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[Continued on next page]

TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

information model (BIM) and store the same in the said database (3). A display unit is provided to display the 3-dimensional (3D) building information model (BIM).

TITLE

A System and Method for Extraction and Recreation of Geometry Information from Interior and/or Exterior Drawings of a Building

FIELD OF THE INVENTION

This invention relates to a system and method for the extraction and recreation of geometry information from interior and/or exterior drawings of a building. In particular, this invention relates to a system and method for extracting 2-Dimensional images such as images of floor plans, tables, chairs, doors, etc., and converting them into 3-Dimensional models and also, recreating the images.

BACKGROUND OF THE INVENTION

2-dimensional images such as a floor plan is a basic layout showing the dimensions of a different room in an architectural plan and the position of a different object such as tables, chairs, doors, etc. to be placed in a floor plan. Building Information Modelling (BIM) is used to make 2-Dimensional floor plans more realistic. Building Information Modelling (BIM) converts these 2-Dimensional floor plans into a 3-Dimensional model of a building and also acts as a centralized database that is shared throughout the engineering process. However, building this 3-Dimensional model manually requires a specialized skill-set and a tedious process that limits the fast completion of construction projects.

US Patent Application No. US9025861B2, discloses a computer-implemented method for generating a three-dimensional model of a building, the method comprising estimating, by one or more computing systems, a floor height and a ceiling height of the building, identifying, by one or more computing systems, a core region of a two-dimensional graph, the core region corresponding to an interior of the building, determining, by one or more computing systems, a solution path that circumnavigates the core region and minimizes a cost formula, the cost formula providing an

edge cost for each of a plurality of edges, wherein each edge cost includes a fixed constant that biases the solution path towards fewer edges overall, and generating, by one or more computing systems, a three-dimensional model of the interior of the building based on the floor height, the ceiling height, and the solution path.

Spanish Patent Application No. ES2906990T3, discloses an information processing apparatus (1) comprising a first input unit (100A) receiving an input of a floor plan image of a real estate property; a second input unit (100B) that receives a property information input including real estate property area information; a floor plan identification unit (200) that generates floor plan information based on the floor plan image; a model generation unit (300) that generates a three-dimensional model of the real estate using the floor plan information; and an output unit (400) that produces the generated three-dimensional model, wherein the floor plan identification unit (200) includes: a line segment detection unit (220) that performs an erosion process and then a line segment detection process on an image resulting from a binarization process performed on the floor plan image, and performs clustering on detected line segments, thereby detecting a line segment corresponding to a wall in a floor plan; a segmentation processing unit (230) that performs a morphological opening operation, which is a combination of a dilation process and an erosion process, and then a segmentation process on the floor plan image, thereby identifying a room region corresponding to a room in the floor plan; a character recognition unit (240) that recognizes a character string included in the floor plan image; a fixture detecting unit (250) that detects a fixture sign included in the floor plan image; Y an integration unit (260) that identifies a room type of the room region based on the identified room region, as a result of recognizing the character string and as a result of detecting the accessory sign, and complements a room structure based on the room region and the detection result by the line segment detection unit (220), and the model generation unit (300) includes:

an estimation unit (320) that estimates a floor plan scale based on the identified floor plan from the floor plan information and the area information included in the property information; Y a generation unit (360) that generates a three-dimensional model of the real estate property based on the identified floor plan from the floor plan information, the scale, and an estimated ceiling height.

US Patent Application No. US20070285424, discloses a method for generating an annotation graphic in two-dimensional (2D) form to model a three-dimensional (3D) element, comprising automatically generating an annotation graphic of an element in 2D form based on a 3D model of the element and a position of a 2D view plane with respect to the element, the annotation graphic indicating whether the element is below the 2D view plane or rises above the 2D view plane.

There are disadvantages associated with the system and method known in the prior art. One of the disadvantages is that the known system and method is time-consuming as it requires to build an entire 3-dimensional model from a 2-dimensional image manually thereby delaying the construction project.

Another disadvantage associated with the known system and method is that the system and method need to operate by a specialized skill set.

Yet another disadvantage associated with the known system and method is that is not effective as it misses other details like objects in the room and windows.

Still, another disadvantage associated with the known system and method is that they do not have end-to-end commercial solutions so far (doors + internal furniture items) because of accuracy issues.

Further, disadvantage associated with the known system and method is that the existing solutions are not capable of rotating the detected objects.

Another disadvantage associated with the known system and method is that are not capable to generalize for different symbols/representations of classes to be detected.

OBJECTS OF THE INVENTION

Therefore, an object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building that obviates the disadvantages associated with the known devices.

Another object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building which reduces the time required to build an entire 3-dimensional model from a 2-dimensional image.

Yet another object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building which can be operated by a person having normal skills.

Still another object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building which is capable to generate better visualization of a floor plan.

A further object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building which provides better assistance to construction firms for the rapid completion of projects.

Another object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building which drastically reduces the time required

to build an entire 3D floor plan from scratch and tedious tasks like placement of individual components (street lamps, trees, etc) can be automated.

Yet another object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building which is capable to generate buildings automatically by sequencing floorplans and stacking the individually generated floors cohesively.

Still, another object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building which allows export in neutral computer-aided design (CAD) and 3D formats like IFC, GLB, and FBX for easy integration to preferred BIM/Modelling.

A further object of the present invention is to provide a system and method for the extraction and recreation of geometry information from interior and/or exterior drawings of a building which is capable to provide understanding of the position and rotation of the furniture items present inside a floorplan, allowing for accurate placement of detected objects.

Another object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building which provides spatial relationship/ hierarchy of the constituting elements in the form of a graph.

Yet another object of the present invention is to provide a system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building that aims to have a user interaction approach allowing for more guided generation.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a system for extraction

and recreation of geometry information from interior and/or exterior drawing of a building comprising an extraction module adapted to receive drawings provided by a user input data module about interior / exterior of a building is provided to extract data about walls, floor, and object and supply the same to a database provided to store information/data. An interpretation module, adapted to be connected with the extraction module and the user input data module is provided to receive information from the extraction module and interpret the same into different classes and send the same to the said database. A generation module, adapted to be connected to the interpretation module is provided to generate a 3-dimensional (3D) building information model (BIM) and store the same in the said database. A display unit connected to the database is provided to display the 3-dimensional (3D) building information model (BIM) generated by the generation module.

Further, according to the present invention, the extraction module comprises a wall extractor, adapted to receive information from user input data module, being provided to identify exterior and/or interior walls. An element extractor, adapted to receive information from user input data module, is provided to identify location of various elements, for example, furniture, windows, ledges, etc. A room extractor adapted to receive information from user input data module is provided to identify different rooms. A text extractor adapted to receive information from user input data module, is provided to extract plurality textual data within the drawing such that to obtain information about scale of objects, for example, dishwasher, washing machine, refrigerator, etc. A vectorization unit adapted to receive data from wall extractor, element extractor, room extractor and a text extractor, is provided to vectorize raster image elements for accurate and precise representation. A relationship extractor adapted to receive data from the wall extractor, element extractor, room extractor and text extractor is provided to maintain graph-based spatial structural relationships between various elements, for example, room connectivity and pathways etc., and exterior structural relationships, for example, multiple floors, windows,

windowsill, etc.

Still, according to the present invention, the interpretation module comprises a room classifier to identify different rooms. A user constraint manager to override or set constraints from the user input data module or through a document. A hierarchy manager to represent a hierarchy of all constituting elements within a scene depending on the number and type of drawings fed.

Yet, according to the present invention, the generation module comprises a wall generator to extrude walls so as to generate an empty shell of the detected drawing. An element initiator to place interior and exterior elements at their detected locations. An exterior generator to generate facades and roof of a building/plan. A floor manager to maintain hierarchy between the different floors, in case of multiple floors ensuring correct connections between the same and generate stairs, floors, etc. to connect individually generated floorplans. A file exporter to export the interior/exterior or both in the formats supported.

BRIEF DESCRIPTION OF THE INVENTION

A system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building in a preferred embodiment is herein described and illustrated in the accompanying drawings wherein;

FIG. 1, illustrates the block diagram of the system for extraction and recreation of geometry information from interior and/or exterior images of a building.

FIG. 2, illustrates the flowchart of the method for extraction and recreation of geometry information from interior and/or exterior drawings of a building.

DESCRIPTION OF THE INVENTION

A system and method for extraction and recreation of geometry information from interior and/or exterior images of a building is herein described and

illustrated with numerous specific details so as to provide a complete understanding of the invention. However, these specific details are exemplary details and should not be treated as a limitation to the scope of the invention. The invention may be performed with slight modifications. Throughout this specification, the word “comprise” or variations such as “comprises or comprising”, will be understood to imply the inclusions of a stated element, integer or step, or group of elements, integers, or steps, but not the exclusions of any other element, integer or step or group of elements, integers or steps. Same or similar reference numerals are used in the drawings and the description to refer to the same or like parts or steps.

Referring to the drawings, particularly Fig. 1, a block diagram in a preferred embodiment of a system for extraction and recreation of geometry information from interior and/or exterior images of a building is shown. The system for extraction and recreation of geometry information from interior and/or exterior images of a building comprises an extraction module (1) adapted to receive drawings of interior / exterior of a building through a user input data module (2). The said extraction module (1) is provided to extract data, for example, data of walls, floors, and other related objects, etc. and supply the same extracted to a database (3) connected herewith. The said database is provided to store information/data and supply data as required. An interpretation module (4) adapted to be connected with the extraction module (1) and user input data module (2) is provided to receive information/data from the extraction module (1) and to interpret the received information/data into different classes. Further, the interpretation module (4) sends the interpreted data to the said database (3) connected therewith. In one embodiment, an input unit connected with the interpretation module (4) is provided to feed the user command to the interpretation module (4) directly. A generation module (5) is adapted to be connected to the interpretation module and the database to receive the data, for example, interpreted data and data of asset library, etc. The mask for the walls along

with objects detected along with their transforms are sent to the generation module which then generates the walls and stairs based on the information inferred from the image and user constraints for wall height, stair spacing etc. The furniture items are loaded from the asset library and placed according to their transforms and the entire hierarchy is saved and sent as a single file. The said generation module (5) is provided to generate a - 3-dimensional (3D) building information model (BIM) based on received data and after generation, send the generated - 3-dimensional (3D) building information model (BIM) to the said database to store the generated model. A display unit (not shown in Fig.) connected to the database is provided to display the 3-dimensional (3D) building information model (BIM) generated by the generation module (5).

In an embodiment of the present invention, a generative adversarial network (GAN) module is connected to extraction module (1) through the the user input data module (2) to check the resolution of the drawings/images received from the user input data module (2).

The extraction module (1) comprises a wall extractor (6) adapted to connect the user input unit to receive information/data from the user input data module (2). The wall extractor is provided to identify exterior and/or interior walls from data. The said wall extractor (6) uses morphological operations on a mask obtained from a wall detection machine learning (ML) model. An element extractor (7) is adapted to connect the user input data module (2) to receive information/data from the user. The said element extractor (7) is provided to identify the location of various elements, for example, furniture, windows, ledges, stairs, etc. The element extractor detects various symbols and representations that stand for objects of interest in the floorplan/elevation plan and classifies them accordingly. A room extractor (8), adapted to connect the user input data module (2) to receive information/data from the user. The said room extractor (8) is provided to identify different rooms from received information/data. A text extractor (9)

is adapted to connect the user input data module (2) to receive information/data from the user. The said text extractor (9) is provided to extract plurality textual data within the drawing such that to obtain information about the scale of objects, for example, dishwasher, washing machine, refrigerator, etc. The text extractor (9) also obtains dimensions of various elements in exterior elevation plans. A vectorization unit (10) is adapted to connect with the wall extractor (6), the element extractor (7), the room extractor (8), and the text extractor (9) to receive the required data therefrom. The vectorization unit (10) is provided to process the received information/data to vectorize raster image elements for accurate and precise representation along with any text information extracted for manipulation and generation. A relationship extractor (11) is adapted to connect with the wall extractor (6), the element extractor (7), the room extractor (8), and the text extractor (9) to receive the required data therefrom. The said relationship extractor (11) is provided to maintain graph-based spatial structural relationships between various elements, for example, room connectivity and pathways, etc., and exterior structural relationships, for example, multiple floors, windows, windowsill, etc.

The wall extractor (6) comprises a U-Net segmentation unit provided therewith to extract segment masks of walls from the interior and/or exterior drawings of a building. The U-Net unit is trained using a combination of datasets, which contains annotated floor plan images specifically for wall segmentation to identify and extract segment masks corresponding to the walls within the floor plan image accurately, and to enable further analysis and processing of the floor plan layout. Also, an OpenCV is provided with wall extractor for morphological iterative actions to obtain boundaries and wall masks for wall generation.

The element extractor (7) comprises a mask region-based convolutional neural network (R-CNN) unit provided therewith to extract polygonal coordinates of structural elements from the interior floorplan images and

elevation drawing images. This unit is trained using the existing datasets, which contains annotated floor plan images with various structural elements such as doors, windows, sofas, dining tables, and more. Mask R-CNN is a powerful deep-learning model that excels in object detection and instance segmentation tasks. By leveraging the trained Mask R-CNN model, the system can accurately detect and segment different structural elements in the floor plan image, providing precise masks for each element. This enables further analysis and processing of the individual structural components within the floor plan layout. A Keypoint model is provided to obtain both position within the image and a front and back keypoint. These keypoints offer us additional information from each detected structure apart from the box coordinates. For an object like a chair or sofa, we obtain two additional keypoints front and back which allow us to know the direction in which the object is facing, for objects like doors, we obtain the hinge end and swinging and allowing us to understand which side the hinge for the door generated should be placed.

The text extractor (9) comprises an optical character recognition (OCR) unit to extract text and numbers from the interior and/or exterior drawing of a building. The OCR unit extracts values of height and width from the text on the exterior/interior images/ drawings of a building and in case no text is found on the exterior/interior images/ drawings of a building, default values are assigned.

In an embodiment of the present invention the wall extractor (6), the element extractor (7), the room extractor (8), and the text extractor (9) are interconnected with each other. Similarly in another embodiment of the present invention, the vectorization unit (10) and the relationship extractor (11) are interconnected with each other.

The interpretation module (4) comprises a room classifier (12) connected with the extraction module (1) to receive information/data to identify different

rooms based on the objects found within the room used for décor item generation. A user constraint manager (13) is connected with the user input data module (2) to take commands from the user to override or set constraints from the user or through a document, for example, the wall height can be an additional input from the user. A hierarchy manager (14) connected with the room classifier (12) and the user constraint manager (13) to receive classified data and override commands to represent a hierarchy of all constituting elements within a scene depending on the number and type of drawings. In the hierarchy manager (14) main source of management of all objects and is constantly updated to ensure the integrity of constituting elements and their relationships with each other. Further, the hierarchy manager (14) is connected with the database (3) to send the obtained hierarchy data to store in the database.

In an embodiment of the present invention, the room classifier (12) and the user constraint manager (13) are connected with each other.

The generation module (5) comprises a wall generator (15) connected with the output of the interpretation module (4) to receive interpreted information/data to extrude walls that have been detected on a floor plan so as to generate an empty shell of the detected image. An element initiator (16) is connected with the output of the interpretation module (4) to place interior and exterior elements at their detected locations. An exterior generator (17) connected with the output of the interpretation module (4) to receive interpreted information/data to generate facades and roof of a building/plan. A floor manager (18) connected with the output of the wall generator and element initiator to receive wall information/data and object information/data is provided to maintain hierarchy between the different floors, in case of multiple floors ensuring correct connections between the same and generate stairs, floors, etc. to connect individually generated floorplans. A file exporter (19) connected with the output of the exterior generator (17) and the floor manager (18) is provided to export the

interior/exterior or both of the drawings in the formats supported.

In an embodiment of the present invention, the wall generator (15), the element initiator (16), the exterior generator (17), the floor manager (18), and the file exporter (19) are interconnected with each other.

Referring to the drawing, particularly Fig. 2, a flow diagram of a process for extraction and recreation of geometry information from interior and/or exterior images of a building in a preferred embodiment is shown. A process recreation of geometry information from interior and/or exterior drawing of a building comprising in the following steps: drawings/images of the interior / exterior of a building are fed by a user through the input unit for example, user fed the interior floorplan drawing/images or elevation drawing/images. After that, the resolution of the drawings/images are determined by the extraction module to check whether the images are of standard resolution or low resolution. In the case of standard resolution images, send it to the different extractors, for example, wall extractor (6), element extractor (7), room extractor (8), and text extractor (9), directly for preprocessing the drawing/image and in case of low-resolution, send it to a generative adversarial network (GAN) to enhance the resolution of the drawings/images and then send it to the said extractors for example the wall extractor (6), the element extractor (7), the room extractor (8), and the text extractor (9), for preprocessing the drawings/images. After that, the preprocessed drawings/images are checked by the user to obtain whether the drawings/images are related to the interior floorplan or elevation drawing images. In the case of the interior floorplan drawings/images, sent preprocessed drawings/images to each extractor, for example, wall extractor (6), element extractor (7), room extractor (8), and text extractor (9), for extracting the textual information like room names and measurements and detecting furniture, walls, rooms, etc. to generate a graph representation hierarchy and sent the generated graph representation hierarchy to vectorization (10) for vectorizing the hierarchy.

In case of elevation drawings/images sent preprocessed drawings/images to the wall extractor (6), element extractor (7) room extractor (8), and text extractor (9), for extracting the textual information like heights and widths of different elements and detecting facade, windows, doors, balconies, walls, etc. to generate a graph representation hierarchy and send the generated graph representation hierarchy to vectorization (10) for vectorizing the hierarchy. The vectorized drawings/images are represented in a graphical user interface (GUI) to the user to allow editing vector components of the drawings/images. After that, take a user confirmation by vectorization (10) through a display (web app/desktop app GUI) to finalize the detected elements to generate a 3D model of the building and display the same on a display module.

In one embodiment, in the case of invalidating print input found at the process step of checking the drawing/images, a message about invalidation input is sent by the GAN module to the user input data module (2) to inform the user.

The working of the system and method for extraction and recreation of geometry information from interior and/or exterior drawings of a building is explained in the following. The user feeds the scanned drawings/images of the interior / exterior of a building through the input unit for example the user feeds interior and/or exterior drawings of a 2 – BHK flat. After that, the resolution of the drawings/images is determined to see whether the images are of standard resolution or low resolution. In the case of standard resolution images, send it to directly for pre-processing and in case of low-resolution, to enhance the resolution of the drawings/images and then send it for pre-processing. After that, the pre-processed drawings/images are checked to obtain that whether the drawings/images are related to interior floorplan or elevation drawing images. In the case of the interior floorplan drawings/images, detecting of furniture, walls, rooms, etc. is done to generate a graph representation hierarchy and sent the generated graph

representation hierarchy for vectorizing the hierarchy. In case of elevation drawings/images detecting facade, elements, etc. is done to generate a graph representation hierarchy and sent the generated graph representation hierarchy for vectorizing the hierarchy. The furniture items, walls, rooms, facade, elements, etc. are loaded from the asset library and placed according to their transforms and the entire hierarchy is saved and sent as a single file. The vectorized drawings/images are represented in a graphical user interface (GUI) to the user to allow editing of vector components of the drawings/images. The mask for the walls along with objects detected along with their transforms are sent to the generation module which then generates the walls and stairs based on the information inferred from the image and user constraints for wall height, stair spacing, etc. After that, take a user confirmation to finalize the detected elements to generate a 3D model of the building and display the same on a display module.

In the initial phase of floor plan processing, the system takes an input image of the exterior/interior drawings. The system then uses computer vision techniques to perform wall segmentation and detection to identify and outline the walls. The system then extracts room boundaries by analyzing the segmented walls. It also identifies and extracts structural elements such as doors, windows, stairs, and columns. Additionally, optical character recognition (OCR) techniques are applied to extract text and numbers from the floor plan image. These steps enable the system to extract vital information including wall segmentation, room boundaries, structural elements, and text/numbers, forming the basis for further processing and analysis.

Wall Detection (U-Net/OpenCV)

To extract segment masks of walls from the floor plan image, a U-Net segmentation unit was employed. This unit was trained using a combination

of datasets, which contains annotated floor plan images specifically for wall segmentation. The U-Net architecture is well-known for its effectiveness in image segmentation tasks, particularly in scenarios where precise boundary delineation is required. By leveraging the trained U-Net model, the system can accurately identify and extract segment masks corresponding to the walls within the floor plan image, enabling further analysis and processing of the floor plan layout. Also, OpenCV was used for morphological iterative actions to obtain boundaries and wall masks for wall generation.

Structural Elements Recognition (Mask RCNN/Yolov7/Keypoint)

To extract polygonal coordinates of structural elements in the floor plan image, the Mask R-CNN model was utilized. This model was trained using the existing datasets, which contains annotated floor plan images with various structural elements such as doors, windows, sofas, dining tables, and more. Mask R-CNN is a powerful deep learning model that excels in object detection and instance segmentation tasks. By leveraging the trained Mask R-CNN model, the system can accurately detect and segment different structural elements in the floor plan image, providing precise masks for each element. This enables further analysis and processing of the individual structural components within the floor plan layout.

Keypoint models are also being explored to obtain both position within the image and a front and back keypoint. These keypoints offer us additional information from each detected structure apart from the box coordinates. For an object like a chair or sofa, we obtain two additional keypoints front and back which allow us to know the direction in which the object is facing, For objects like doors, we obtain the hinge end and swinging end allowing us to understand which side the hinge for the door generated should be placed.

Room Separation / Detection

To extract vertices and edges of walls, contour detection and polygon approximation techniques are applied to the segmented mask of walls. The contours of the segmented walls are identified, and then a polygon

approximation algorithm is used to approximate the contours detected to account for curved walls.

Additionally, the bounding box coordinates of the doors from Structural Elements Recognition are utilized to connect the walls and doors. By incorporating the door coordinates into the segmented mask of walls, the gaps between different rooms can be bridged, ensuring a complete representation of the floor plan layout.

To separate the individual rooms, a pixel inversion process is performed on the bridged segmented mask. By inverting the pixels, the rooms are extracted separately from the bridged mask which represents combined walls and doors. Finally, connected component analysis is employed to extract n+1 components, where n represents the number of rooms, and 1 represents the bridged wall-door component. This analysis helps identify and isolate each room as an individual component within the floor plan, allowing for further analysis and processing on a per-room basis.

By utilizing the wall coordinates and room coordinates, the system can associate each wall with its corresponding room. With this association, the system accurately determines the boundaries of each room, enabling later processes such as texture assignment and object localization based on individual rooms. In later processes, this capability allows for the customization and differentiation of room aesthetics by assigning unique textures to individual rooms or groups of rooms, as well as facilitating precise object localization within specific room contexts.

Text Recognition (EasyOCR)

To extract measurements of different entities in the floor plan, text recognition techniques are applied to the floor plan images. Numeric text is specifically targeted to capture dimensions and other relevant measurements. This extracted information plays a crucial role during the 3D conversion process, as it provides valuable scaling data. One commonly

used model is the Tesseract OCR (Optical Character Recognition) engine, which is known for its accuracy and versatility in recognizing text from various sources,

By incorporating the extracted measurements, the system ensures accurate scaling of the 3D model, aligning it with the real-world dimensions represented in the floor plan. This enables a more realistic and precise representation of the spatial relationships and proportions within the 3D model.

Walls - 2D to 3D Conversion

a. Extrusion: The first step is to extend the refined 2D wall segments vertically to provide depth or thickness, thereby transforming them into a 3D representation of the walls. The extrusion height and width can be extracted from text recognition if available; otherwise, default values are assigned.

b. Mapping Wall Segments to 3D Space: In this step, the wall segments are mapped to a 3D Cartesian coordinate system (X, Y, Z). A reference plane is set, and the X and Y values from the 2D representation are preserved. The wall segments are expanded horizontally by adjusting their X and Y coordinates based on the desired thickness. Additionally, the extrusion height is added to the existing Z-coordinate values to extend the wall segments vertically.

c. Creating 3D Wall Geometry: To form the 3D representation of the walls, the following sub-steps are performed for face generation:

i.Front and Back Faces: The front and back faces of each wall segment are parallel and located at the minimum and maximum depths (Z-coordinate values) of the segment. The appropriate vertices of the wall segment are connected in a counter clockwise or clockwise order to generate rectangular faces for the front and back surfaces.

ii. Side Faces: The side faces of the wall segment are parallel to each other and perpendicular to the front and back faces. The corresponding vertices

of adjacent segments or within the same segment are connected to create these side faces.

iii. Top and Bottom Faces: The top and bottom faces of the wall segment are parallel and positioned at the maximum and minimum heights (Z-coordinate values) of the segment. Connecting the relevant vertices in a counter clockwise or clockwise order generates rectangular faces for the top and bottom surfaces.

Structural Elements - 2D to 3D

After obtaining the coordinates of the structural elements using Mask R-CNN, it is important to note that the representation of these elements in the floor plan might not be realistic or suitable for direct extrusion, as is the case with walls. To accurately represent the structural elements in a 3D environment, two approaches can be followed:

a. Placing Existing 3D Objects:

One approach is to utilize pre-existing 3D models of the required structural elements and position them in the corresponding detected locations. These 3D models can be obtained from libraries or databases that contain a wide range of ready-made objects. By accurately aligning the existing 3D objects with the detected coordinates, a realistic representation of the structural elements can be achieved.

b. Generating New 3D Objects:

Alternatively, new 3D objects can be generated specifically for each structural element to be placed in the appropriate location. By employing generative AI technology, custom 3D objects can be created by employing text prompting to incorporate specific styles or variations into 3D objects.

Texture Assignment

After constructing the 3D representation of the floor plan from 2D floor plan,

the next step involves the assignment of textures. This process offers the opportunity to enhance the visual appeal and realism of the 3D model. There are different approaches to texture assignment.

a. Default Textures: By default, generic textures can be applied to the surfaces of the walls and objects within the 3D representation. These default textures provide a basic appearance that can be modified later if desired.

b. Room-based Texture Generation: To add more customization and uniqueness to each room, textures can be generated specifically for individual rooms. Generative models like dream fusion can be employed to achieve this task.

Certain features of the invention have been described with reference to the example embodiments. However, the description is not intended to be construed in a limiting sense. Various modifications of the example embodiments and other embodiments of the invention, which are apparent to the persons skilled in the art to which the invention pertains, are deemed to lie within the spirit and scope of the invention.

We Claim:

1. A system for extraction and recreation of geometry information from interior and/or exterior drawings of a building comprising an extraction module (1), adapted to receive drawings through user input data module (2) about interior / exterior of a building, being provided to extract data about walls, floor, and object and supply the same to a database (3) provided to store information/data; an interpretation module (4), adapted to be connected with the extraction module (1) and user input data module (2), being provided to receive information from the extraction module (1) and interpret the same into different classes and send the same to the said database (3); a generation module (5), adapted to be connected to the interpretation module, being provided to generate a 3 dimensional (3D) building information model (BIM) and storing the same in the said database (3); and a display unit being provided to display the 3 dimensional (3D) building information model (BIM).

2. The system for extraction and recreation of geometry information from interior and / or exterior drawings of a building as claimed in claim 1, wherein the extraction module comprises a wall extractor (6), adapted to be receive information from user input data module (2), being provided to identify exterior and/or interior walls; an element extractor (7), adapted to be receive information from user input data module (2), being provided to identify location of various elements, for example, furniture, windows, ledges, etc.; a room extractor (8), adapted to be receive information from the user input data module (2), being provided to identify different rooms, a text extractor (9), adapted to be receive information from the user input data module (2), being provided to extract plurality textual data within the drawing such that to obtain information about scale of objects, for example, furniture, room, walls dishwasher, washing machine, refrigerator etc.;

vectorization unit (10), adapted to receive data from wall extractor, element extractor, room extractor and text extractor, being provided to vectorize raster image elements for accurate and precise representation; a relationship extractor (11), adapted to receive data from wall extractor, element extractor, room extractor and a text extractor, being provided to maintain graph based spatial structural relationships between various elements, for example, room connectivity and pathways etc., and exterior structural relationships, for example, multiple floors, windows, windowsill, etc.

3. The system for extraction and recreation of geometry information from interior and/or exterior drawings of a building as claimed in claim 2, wherein the wall extractor comprises a U-Net segmentation unit to extract segment masks of walls from the interior and/or exterior drawings of a building.

4. The system for extraction and recreation of geometry information from interior and/or exterior drawings of a building as claimed in claim 2, the element extractor comprises mask region-based convolutional neural network (R-CNN) unit to extract polygonal coordinates of structural elements from the interior floorplan images and elevation drawing images.

5. The system for extraction and recreation of geometry information from interior and/or exterior drawings of a building as claimed in claim 2, wherein the text extractor comprises an optical character recognition (OCR) unit to extract text and numbers from the interior and/or exterior drawing of a building.

6. The system for extraction and recreation of geometry information from interior and/or exterior drawings of a building as claimed in claim 5, wherein the OCR unit extracts values of height and width from the text on the exterior/interior images/ drawings of a building and in case

no text is found on the exterior/interior images/ drawings of a building, default values are assigned.

7. The system for extraction and recreation of geometry information from interior and/or exterior drawings of a building as claimed in claim 1, wherein the interpretation module comprises a room classifier (12) to identify different rooms; a user constraint manager (13) to override or set constraints from the user input data module (2) or through a document; and a hierarchy manager (14) to represent a hierarchy of all constituting elements within a scene depending on the number and type of drawings fed.

8. The system for extraction and recreation of geometry information from interior and/or exterior drawings of a building as claimed in claim 1, wherein the generation module comprises a wall generator (15) to extrude walls so as to generate an empty shell of the detected drawing; an element initiator (16) to place interior and exterior elements at their detected locations; an exterior generator (17) to generate facades and roof of a building/plan; a floor manager (18) to maintain hierarchy between the different floors, in case of multiple floors ensuring correct connections between the same and generate stairs, floors, etc. to connect individually generated floorplans, and a file exporter (19) to export the interior/exterior or both in the formats supported.

9. A process for extraction and recreation of geometry information from interior and/or exterior drawings of a building comprising in the following steps:
    i. Feeding drawings/images of the interior / exterior of a building by a user,
    ii. Determining resolution of the drawings/images and sending the same for preprocessing in case of high-resolution,

iii. Checking preprocessed images to see whether the images relate to interior floorplan or elevation drawing images,

iv. Extracting textual information from the drawings/images and detecting the presence of furniture, walls, rooms, etc. in case of interior floorplan images and generating a graph representation hierarchy and vectorizing the same,

v. Extracting textual information from the drawings/images and detecting the presence of windows, doors, balconies, walls, etc. in case of elevation drawing images and generating a graph representation hierarchy and vectorizing the same,

vi. Representing vectorized images as editable vector components in a graphical user interface (GUI),

vii. Accepting user confirmation about the detected elements and generating a 3D model and displaying the same in a display module, and

viii. Invalidating print input in case elevation drawing not detected.

10. The process for extraction and recreation of geometry information from interior and/or exterior drawings of a building as claimed in claim 9, wherein the resolution of the drawing/image being upscaled, in case of low-resolution, using a generative adversarial network (GAN).

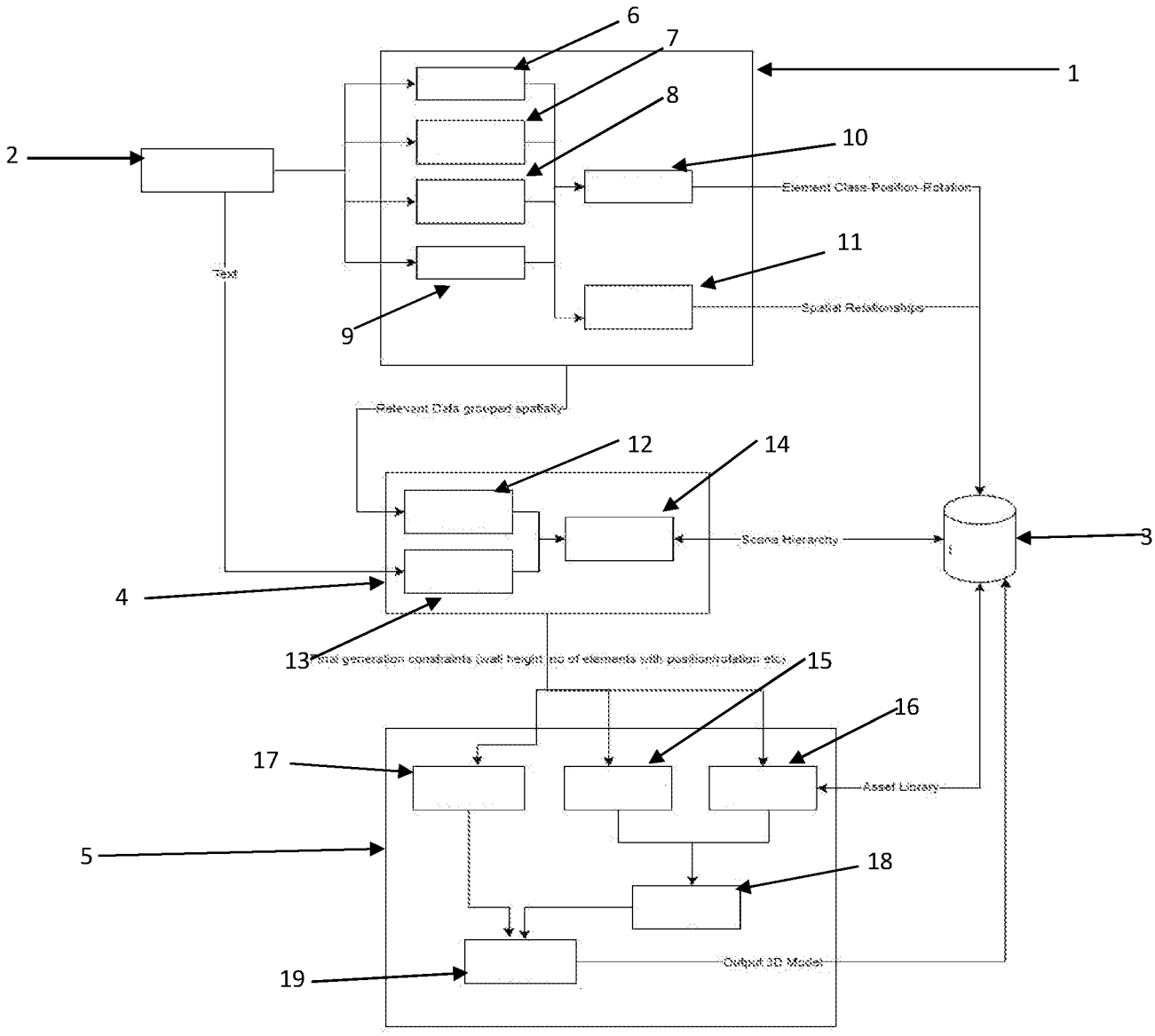
6
7
1
8
2
10
Element Class Position Rotation
Text
11
9
Spatial Relationships
Relevant Data grouped spatially
12
14
Scene Hierarchy
3
4
13
15
16
17
Asset Library
5
18
19
Output 3D Model

FIG. 1

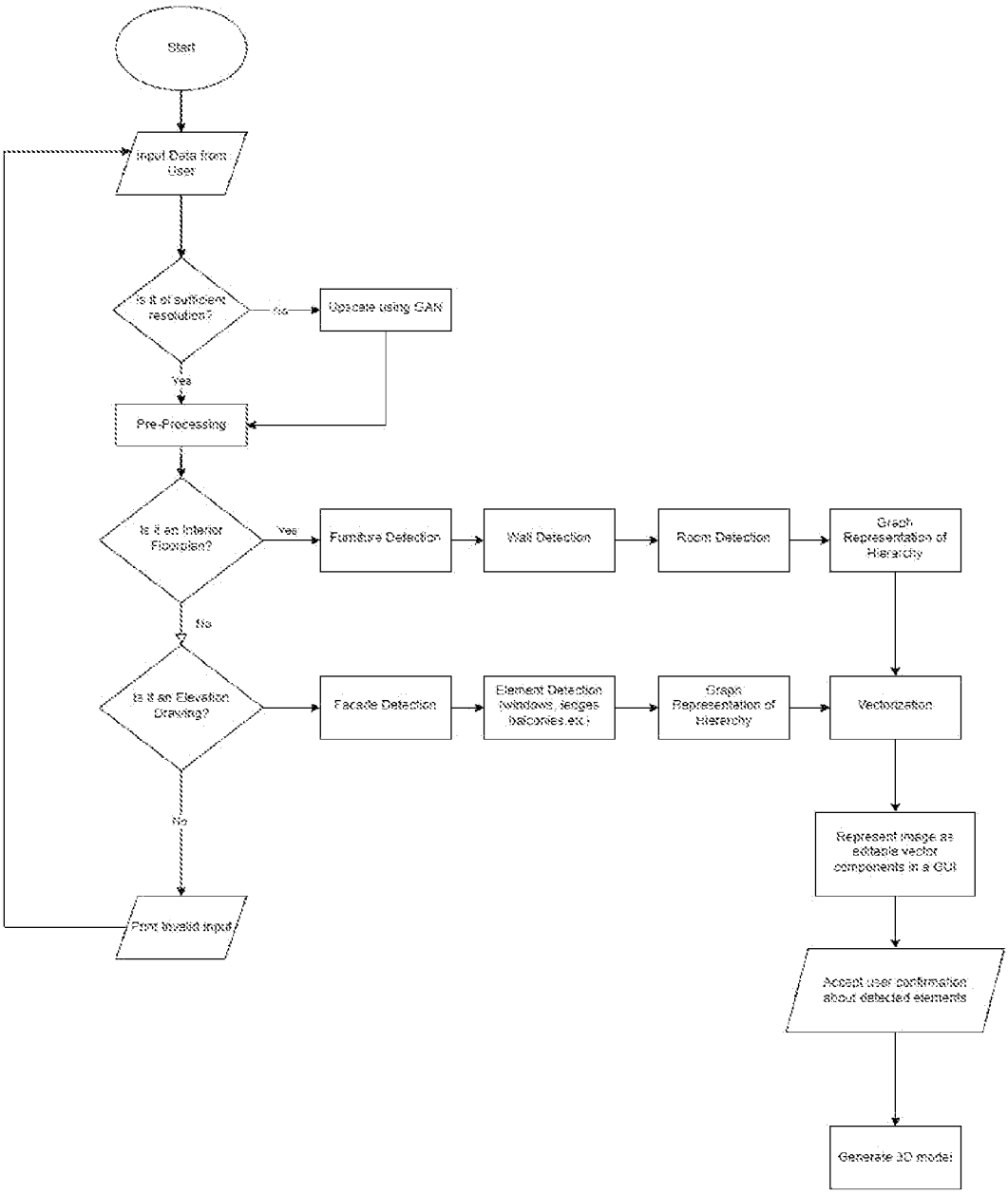
Start
Input Data from User
Is it of sufficient resolution?
No
Upscale using GAN
Yes
Pre-Processing
Is it an Interior Floorplan?
Yes
Furniture Detection
Wall Detection
Room Detection
Graph Representation of Hierarchy
No
Is it an Elevation Drawing?
Facade Detection
Element Detection (windows, sedges balconies,etc)
Graph Representation of Hierarchy
Vectorization
No
Represent image as editable vector components in a GUI
Print Invalid input
Accept user confirmation about detected elements
Generate 3D model

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2023/051068

A. CLASSIFICATION OF SUBJECT MATTER
G06F30/13,G06T7/60,G06T15/10 Version=2024.01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06T, G06F, G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

PatSeer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US20170315696A1 (CRESTRON ELECTRONICS INC) 02 November 2017 paragraphs [0018-0039, 0325, 0347-0355]	1
Y	US20170315696A1 (CRESTRON ELECTRONICS INC) 02 November 2017 paragraphs [0018-0039, 0325, 0347-0355]	2-10
Y	US20210073433A1 (BEAMUP LTD) 11 March 2021 paragraphs [0673, 0824, 0124, 0710, 0128, 0856, 0137, 0334, 0396, 0397, 0398, 0399, 0400, 0824, 0839, 0840, 0856]	2-10
Y	Mohamad Amran, Mohd Fahmi & Sulaiman, Riza & Kahar, Saliyah & Marjudi, Suziyanti & Abdullah, Khairul & Adnan, Zuraidy. (2011). A Comparative Study on Extraction Method of Non-Geometry Information in Engineering Drawing. ISBEI 2011 - 2011 IEEE Symposium on Business, Engineering and Industrial Applications. DOI: 10.1109/ISBEIA.2011.6088887 01 December 2011 The whole document	3, 4, 9, 10

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14-02-2024	14-02-2024
Name and mailing address of the ISA/ Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Authorized officer Gaurav Kumar Rawat Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2023/051068

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	---------- Su, Wanchao & Du, Dong & Yang, Xin & Zhou, Shizhe & Fu, Hongbo. (2018). Interactive Sketch-Based Normal Map Generation with Deep Neural Networks. Proceedings of the ACM on Computer Graphics and Interactive Techniques. 1. 1-17. DOI: 10.1145/3203186. 25 July 2018 Section 2.2, Section 3.1	10

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2023/051068

Citation	Pub.Date	Family	Pub.Date
US 20170315696 A1	02-11-2017	US 10190791 B2	29-01-2019
		US 10190792 B2	29-01-2019
US 20210073433 A1	11-03-2021	EP 4026037 A1	13-07-2022
		US 11392736 B2	19-07-2022
		US 20230153485 A1	18-05-2023