US012386348B1

(12) **United States Patent**
Buehrle et al.

(10) **Patent No.: US 12,386,348 B1**
(45) **Date of Patent: Aug. 12, 2025**

(54) **BUILDING INSPECTION SYSTEMS AND METHODS UTILIZING MANEUVERABLE BUILDING DETECTION DEVICES**

(71) Applicant: **United Services Automobile Association (USAA)**, San Antonio, TX (US)

(72) Inventors: **Amber K. Buehrle**, Phoenix, AZ (US); **Ramsey Devereaux**, San Antonio, TX (US); **Michael Hertz**, San Antonio, TX (US); **Michael Kyne**, Saint Petersburg, FL (US); **Theresa Marie Matowitz**, San Antonio, TX (US); **Steven Robert Seigler**, Tampa, FL (US)

(73) Assignee: **United Services Automobile Association (USAA)**, San Antonio, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 167 days.

(21) Appl. No.: **17/245,272**

(22) Filed: **Apr. 30, 2021**

Related U.S. Application Data

(60) Provisional application No. 63/018,251, filed on Apr. 30, 2020.

(51) **Int. Cl.**
G05D 1/00 (2024.01)
B62D 57/024 (2006.01)
G06Q 40/08 (2012.01)

(52) **U.S. Cl.**
CPC ***G05D 1/0088*** (2013.01); ***B62D 57/024*** (2013.01); ***G05D 1/0011*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. G05D 1/0088; G05D 1/0011; G05D 1/0231; G05D 1/101; B62D 57/024; B62D 57/04; G06Q 40/08
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,115,694 A 9/2000 Cheetham et al.
9,852,487 B1 12/2017 Farnsworth et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2018105846 A * 7/2018 ..... B64C 39/024
JP 2019084868 A * 6/2019 ..... G06K 15/10
(Continued)

OTHER PUBLICATIONS

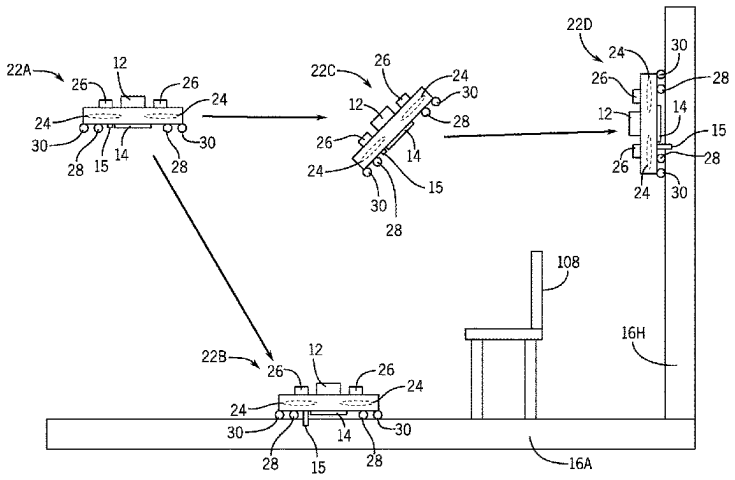
Machine translation WO 2017183636 (year: 2017).*
(Continued)

Primary Examiner — Anne Marie Antonucci
Assistant Examiner — Jordan T Smith
(74) *Attorney, Agent, or Firm* — Fletcher Yoder P.C.

(57) **ABSTRACT**

Systems and methods of the present disclosure include a system that includes a maneuverable building detection device configured to engage and maneuver along a wall of a building comprised of a plurality of building components. The maneuverable building detection device includes at least one building component detection sensor device. Each building component detection sensor device is configured to detect data relating to at least one building component of the plurality of building components. In certain embodiments, the system also includes a building component property determination system configured to automatically determine one or more properties of the at least one building component based at least in part on the data detected by the at least one building component detection sensor device. In addition, in certain embodiments, the system further includes a building insurance determination system configured to automatically determine insurance rates and/or insurance coverage for the building based at least in part on the one or more properties of the at least one building component determined by the building component property determination system.

19 Claims, 6 Drawing Sheets



(52) **U.S. Cl.**
CPC ***G05D 1/0231*** (2013.01); ***G05D 1/101*** (2013.01); ***G06Q 40/08*** (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,939,810	B1	4/2018	Matheson et al.	
10,162,348	B1	12/2018	Scott et al.	
10,163,326	B1	12/2018	Billman et al.	
10,354,386	B1	7/2019	Farnsworth et al.	
10,365,646	B1	7/2019	Farnsworth et al.	
10,373,256	B1	8/2019	Allen et al.	
10,444,107	B1	10/2019	Flachsbart et al.	
10,453,146	B1	10/2019	Stricker et al.	
10,510,121	B2	12/2019	Allen et al.	
10,521,865	B1	12/2019	Spader et al.	
10,552,911	B1	2/2020	Allen et al.	
11,105,735	B1 *	8/2021	Gray	G01M 5/0033
2004/0153330	A1	8/2004	Miller et al.	
2009/0265193	A1 *	10/2009	Collins	G06Q 30/0185 901/46
2014/0279593	A1	9/2014	Pershing	
2015/0088556	A1	3/2015	Convery et al.	
2015/0094952	A1	4/2015	Moeglein et al.	
2015/0228031	A1	8/2015	Emison et al.	
2015/0235322	A1	8/2015	Emison	
2015/0310557	A1	10/2015	Engelhorn	
2015/0370986	A1	12/2015	Hayward	
2017/0066530	A1 *	3/2017	Salzmann	B64C 27/04
2017/0123435	A1 *	5/2017	Myeong	B25J 9/1676
2018/0068185	A1 *	3/2018	Schultz	G01S 19/39
2018/0130196	A1 *	5/2018	Loveland	B64D 47/08
2019/0394448	A1	12/2019	Ziegler et al.	
2020/0142052	A1 *	5/2020	Liu	G01S 13/865
2020/0174478	A1 *	6/2020	Abdellatif	G05D 1/2446

FOREIGN PATENT DOCUMENTS

KR	20130098062 A *	9/2013		
WO	WO-2017183636 A1 *	10/2017		B62D 57/04

OTHER PUBLICATIONS

Machine Translation JP 2018105846 (Year: 2018).*

Machine Translation of JP2019084868A (Year: 2019).*

Machine Translation of KR20130098062 (Year: 2013).*

S. Jung, J.-U. Shin, W. Myeong and H. Myung, "Mechanism and system design of MAV(Micro Aerial Vehicle)-type wall-climbing robot for inspection of wind blades and non-flat surfaces," 2015 15th International Conference on Control, Automation and Systems (ICCAS), Busan, Korea (South), 2015, pp. 1757-1761. (Year: 2015).*

Y. K. Song, C. M. Lee, I. M. Koo, D. T. Tran, H. Moon and H. R. Choi, "Development of wall climbing robotic system for inspection purpose," 2008 IEEE/RSJ International Conference on Intelligent Robots and Systems, Nice, France, 2008, pp. 1990-1995, doi: 10.1109/IROS.2008.4650885. (Year: 2008).*

Moreno et al.; "Recognition of Materials and Damage on Historical Buildings Using Digital Image Classification," South African Journal of Scient, vol. 111, n. 1-2 Pretoria Jan./Feb. 2015.

* cited by examiner

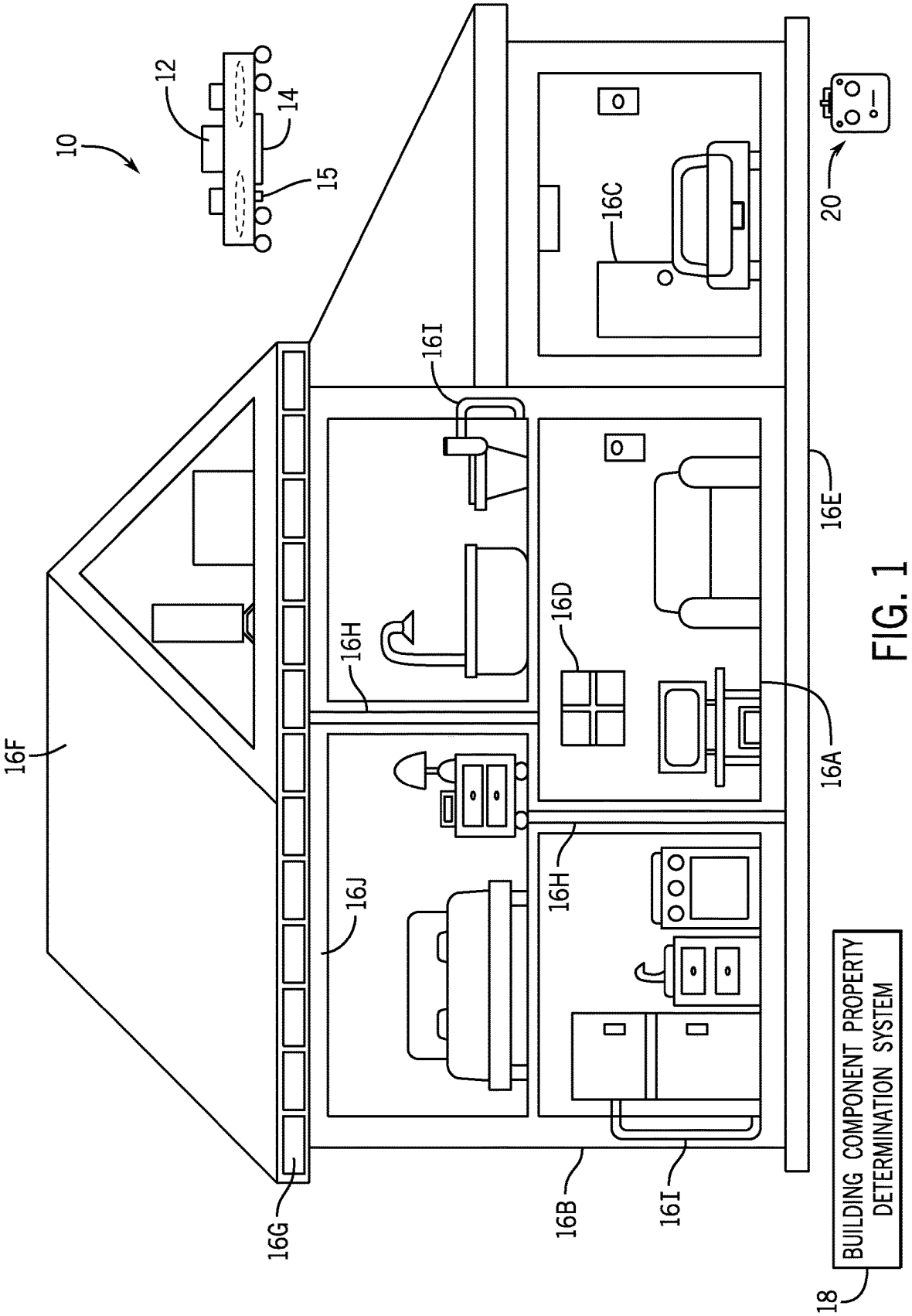

10
12
14
15
16C
20
16I
16E
16D
16H
16A
16F
16J
16H
16G
16B
16I
BUILDING COMPONENT PROPERTY DETERMINATION SYSTEM
18

FIG. 1

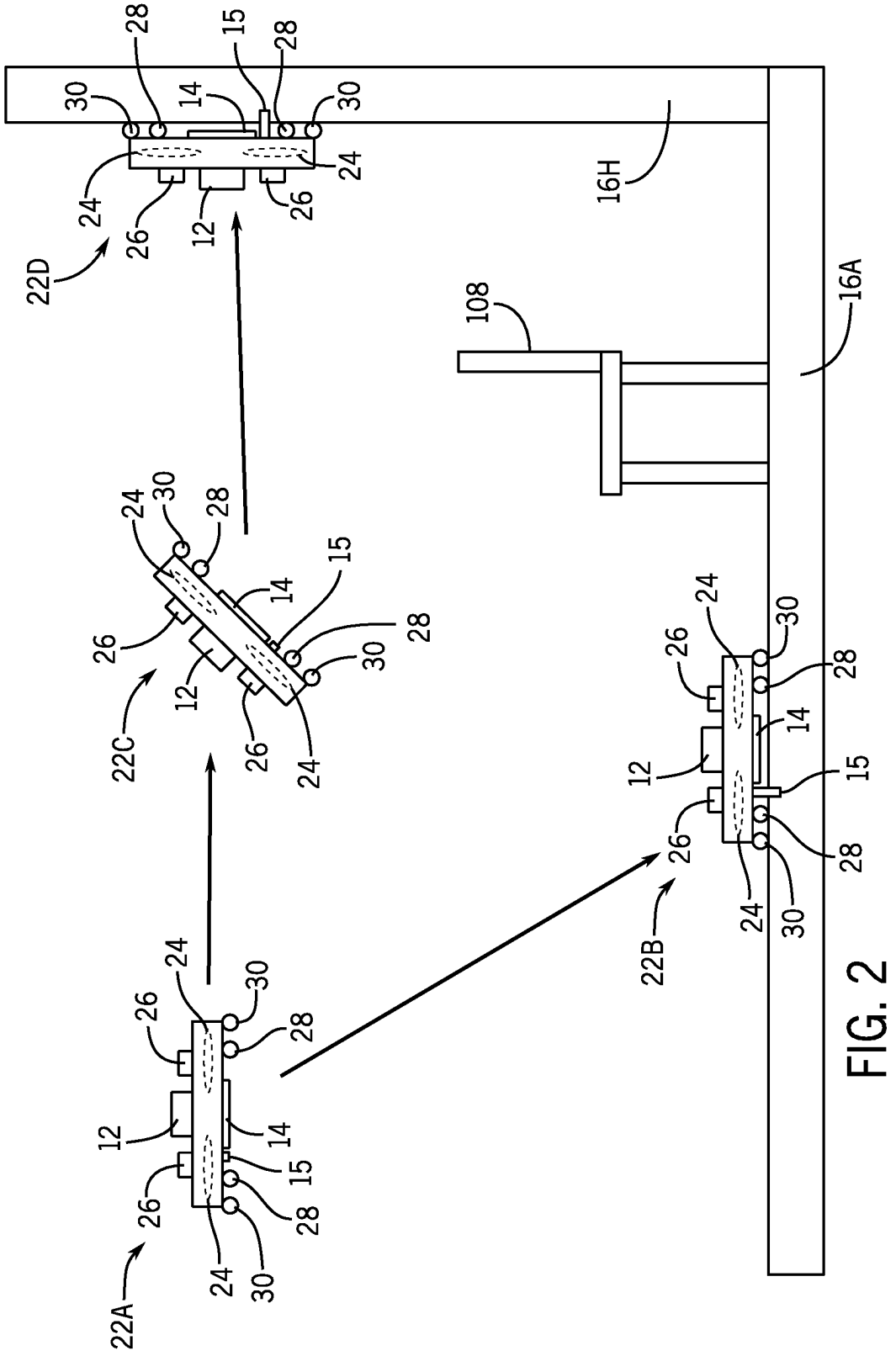


FIG. 2

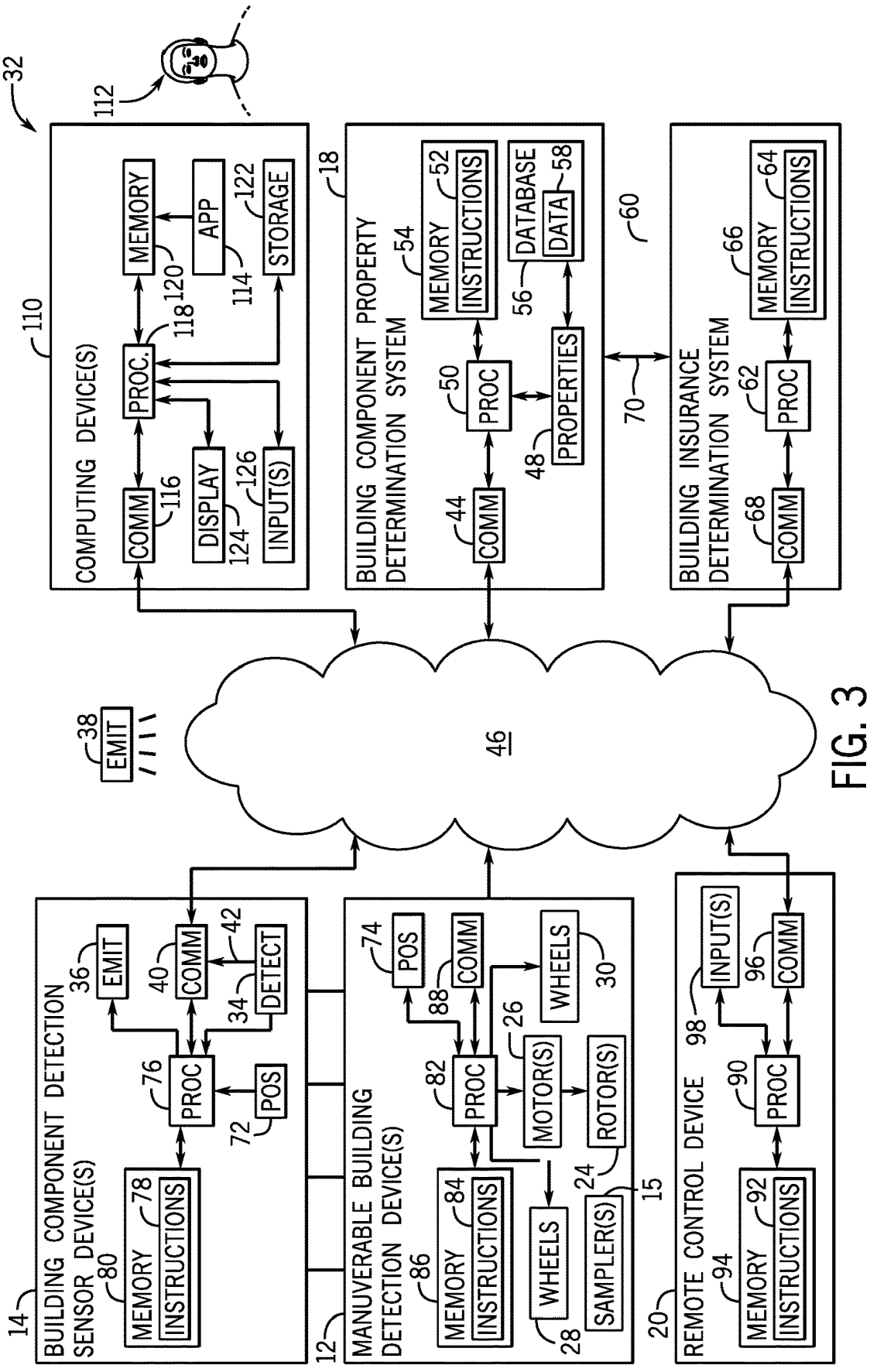

32
112
110
COMPUTING DEVICE(S)
MEMORY
APP
STORAGE
120
118
114
122
PROC.
COMM
116
DISPLAY
126
124
INPUT(S)
18
BUILDING COMPONENT PROPERTY DETERMINATION SYSTEM
MEMORY
INSTRUCTIONS
52
54
DATABASE
DATA
58
56
50
PROC
PROPERTIES
48
44
COMM
60
70
BUILDING INSURANCE DETERMINATION SYSTEM
MEMORY
INSTRUCTIONS
64
66
62
PROC
68
COMM
38
EMIT
46
14
BUILDING COMPONENT DETECTION SENSOR DEVICE(S)
36
EMIT
40
COMM
42
34
DETECT
76
PROC
72
POS
MEMORY
INSTRUCTIONS
78
80
12
MANUVERABLE BUILDING DETECTION DEVICE(S)
74
POS
88
COMM
WHEELS
30
26
82
PROC
MOTOR(S)
ROTOR(S)
24
15
MEMORY
INSTRUCTIONS
84
86
WHEELS
28
SAMPLER(S)
20
REMOTE CONTROL DEVICE
98
INPUT(S)
96
COMM
90
PROC
MEMORY
INSTRUCTIONS
92
94

FIG. 3

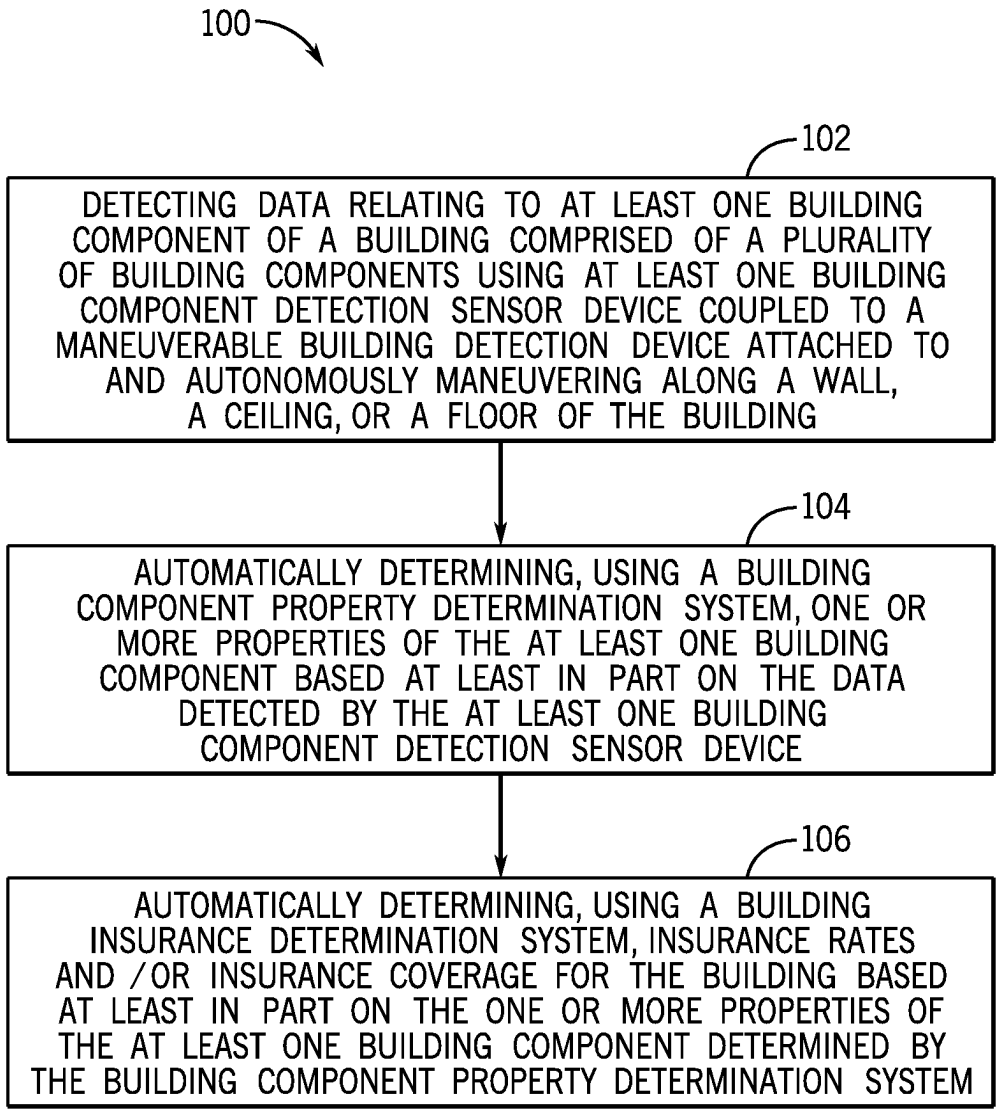

100
102
DETECTING DATA RELATING TO AT LEAST ONE BUILDING COMPONENT OF A BUILDING COMPRISED OF A PLURALITY OF BUILDING COMPONENTS USING AT LEAST ONE BUILDING COMPONENT DETECTION SENSOR DEVICE COUPLED TO A MANEUVERABLE BUILDING DETECTION DEVICE ATTACHED TO AND AUTONOMOUSLY MANEUVERING ALONG A WALL, A CEILING, OR A FLOOR OF THE BUILDING
104
AUTOMATICALLY DETERMINING, USING A BUILDING COMPONENT PROPERTY DETERMINATION SYSTEM, ONE OR MORE PROPERTIES OF THE AT LEAST ONE BUILDING COMPONENT BASED AT LEAST IN PART ON THE DATA DETECTED BY THE AT LEAST ONE BUILDING COMPONENT DETECTION SENSOR DEVICE
106
AUTOMATICALLY DETERMINING, USING A BUILDING INSURANCE DETERMINATION SYSTEM, INSURANCE RATES AND/OR INSURANCE COVERAGE FOR THE BUILDING BASED AT LEAST IN PART ON THE ONE OR MORE PROPERTIES OF THE AT LEAST ONE BUILDING COMPONENT DETERMINED BY THE BUILDING COMPONENT PROPERTY DETERMINATION SYSTEM

FIG. 4

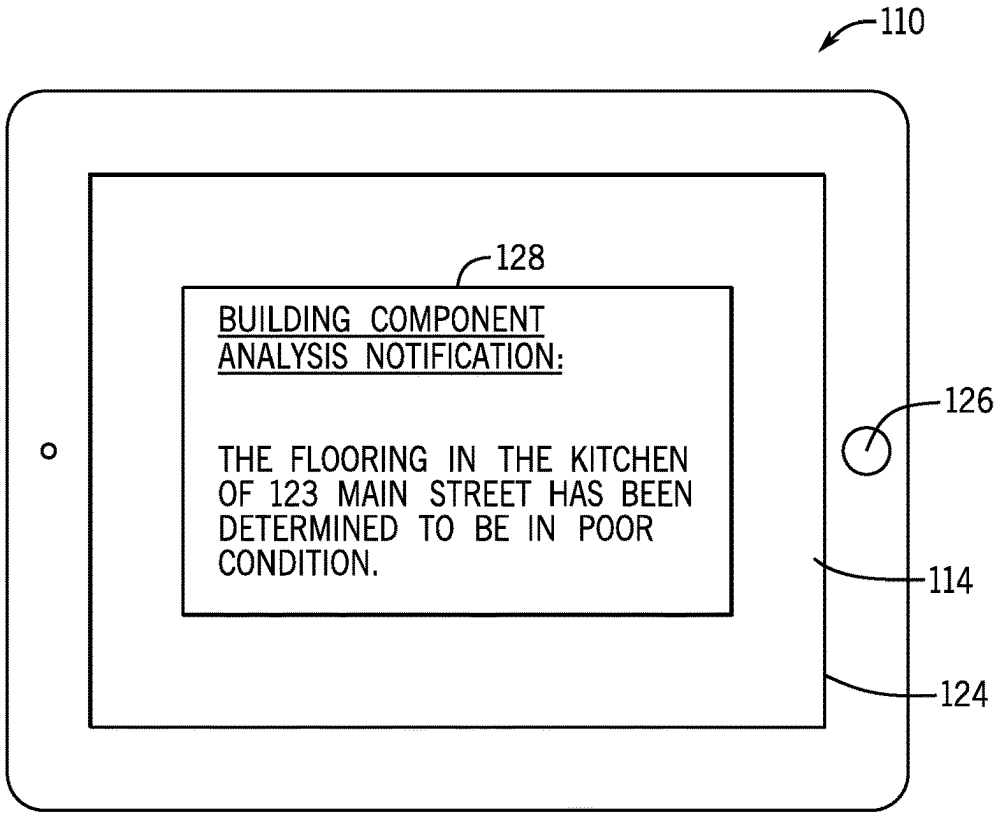

110
128
BUILDING COMPONENT ANALYSIS NOTIFICATION:
THE FLOORING IN THE KITCHEN OF 123 MAIN STREET HAS BEEN DETERMINED TO BE IN POOR CONDITION.
126
114
124

FIG. 5A

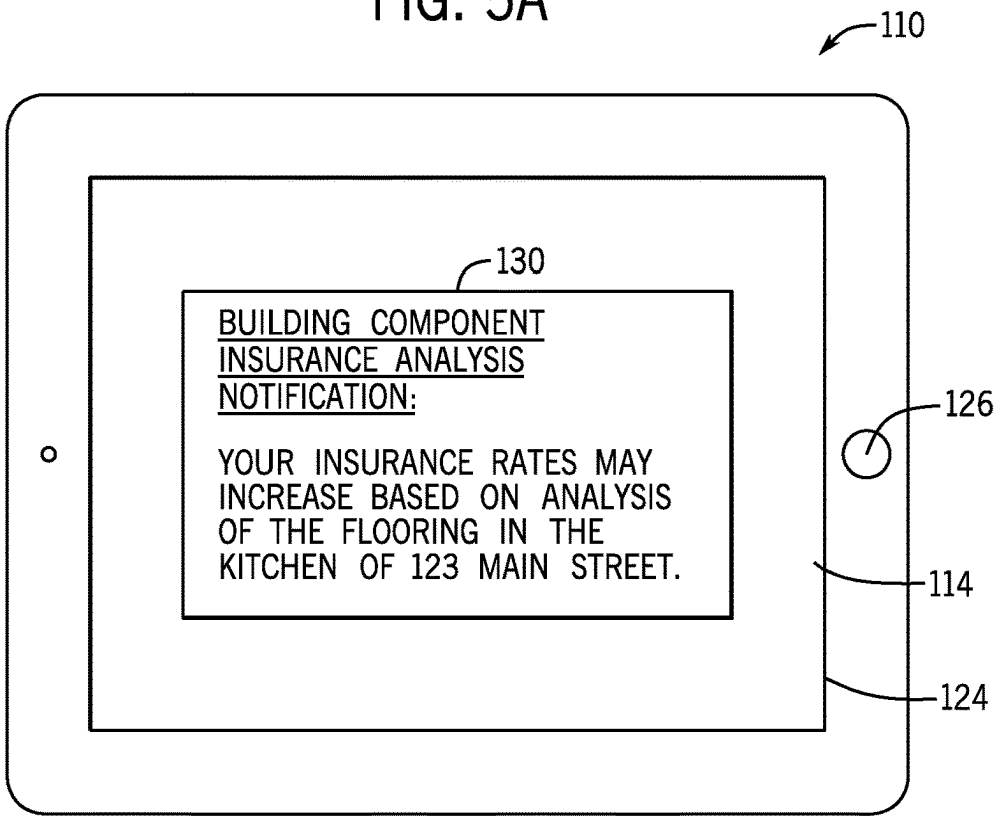

110
130
BUILDING COMPONENT INSURANCE ANALYSIS NOTIFICATION:
YOUR INSURANCE RATES MAY INCREASE BASED ON ANALYSIS OF THE FLOORING IN THE KITCHEN OF 123 MAIN STREET.
126
114
124

FIG. 5B

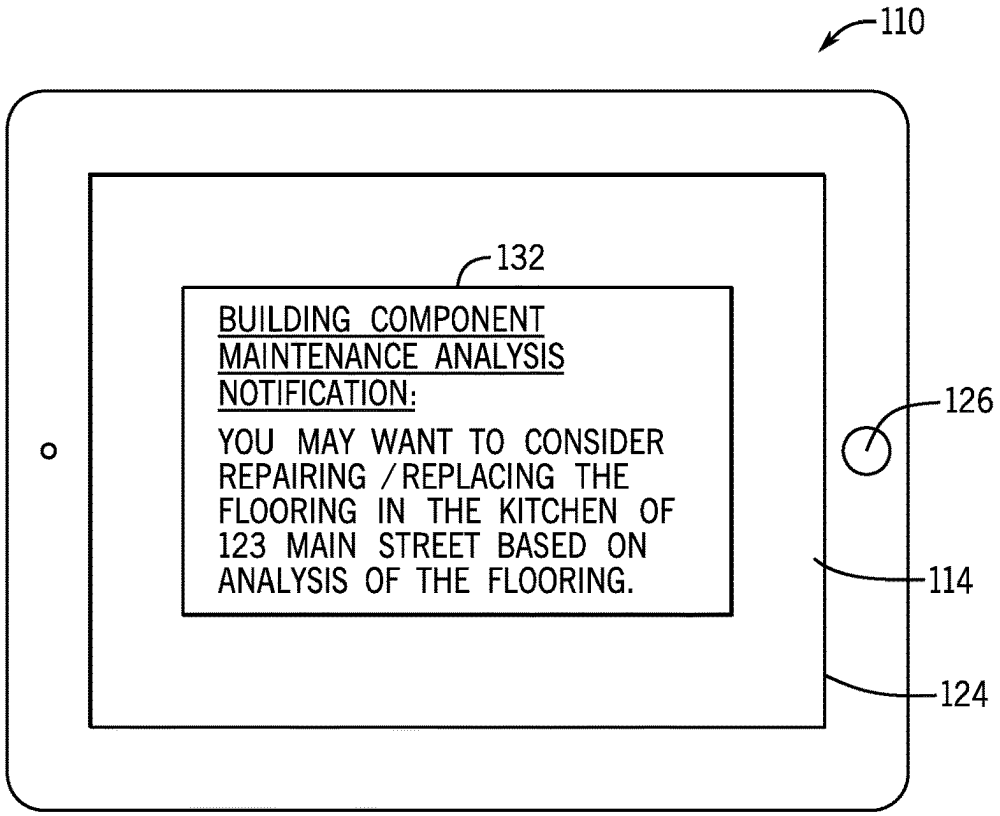

110
132
BUILDING COMPONENT MAINTENANCE ANALYSIS NOTIFICATION:
YOU MAY WANT TO CONSIDER REPAIRING / REPLACING THE FLOORING IN THE KITCHEN OF 123 MAIN STREET BASED ON ANALYSIS OF THE FLOORING.
126
114
124

FIG. 5C

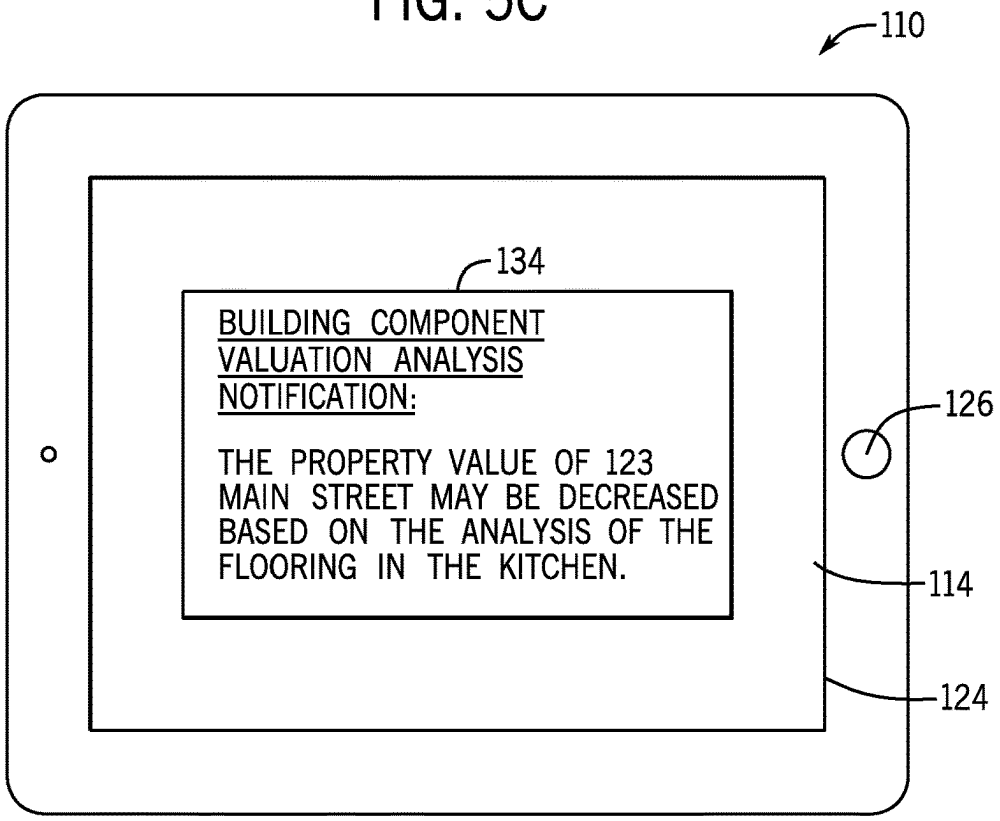

110
134
BUILDING COMPONENT VALUATION ANALYSIS NOTIFICATION:
THE PROPERTY VALUE OF 123 MAIN STREET MAY BE DECREASED BASED ON THE ANALYSIS OF THE FLOORING IN THE KITCHEN.
126
114
124

FIG. 5D

BUILDING INSPECTION SYSTEMS AND METHODS UTILIZING MANEUVERABLE BUILDING DETECTION DEVICES

CROSS-REFERENCE TO RELATED APPLICATION

The present disclosure is related to, and claims priority to, U.S. Provisional Patent Application Ser. No. 63/018,251, titled "Building Inspection Systems and Methods Utilizing Maneuverable Building Detection Devices," which was filed on Apr. 30, 2020, and which is herein incorporated by reference in its entirety for all purposes.

BACKGROUND

The present disclosure relates generally to building inspection detection systems. More specifically, the present disclosure relates to maneuverable building detection devices configured to detect properties of building components of buildings for the purpose of building inspections.

Buildings, such as houses used as homes, often need to be inspected to, for example, ascertain appropriate insurance rates and coverage, appraisals for mortgages, home valuations, and so forth. However, building inspections generally require building inspectors to inspect numerous components of the building, which can take a lot of time for individual building inspectors. As such, building inspection processes may benefit from advanced building component detection techniques.

This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present techniques, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

BRIEF DESCRIPTION

Systems and methods of the present disclosure include a system that includes a maneuverable building detection device configured to engage and maneuver along a wall, a ceiling, and a floor of a building comprised of a plurality of building components. The maneuverable building detection device includes at least one building component detection sensor device. Each building component detection sensor device is configured to detect data relating to at least one building component of the plurality of building components. In certain embodiments, the system also includes a building component property determination system configured to automatically determine one or more properties of the at least one building component based at least in part on the data detected by the at least one building component detection sensor device. In addition, in certain embodiments, the system further includes a building insurance determination system configured to automatically determine insurance rates and/or insurance coverage for the building based at least in part on the one or more properties of the at least one building component determined by the building component property determination system.

In certain embodiments, a system includes a maneuverable building detection device configured to engage and autonomously maneuver along a wall, a ceiling, and a floor of a building comprised of a plurality of building components. The maneuverable building detection device is coupled to at least one building component detection sensor device. Each building component detection sensor device is configured to detect data relating to at least one building component of the plurality of building components.

In other embodiments, a method includes detecting data relating to at least one building component of a building comprised of a plurality of building components using at least one building component detection sensor device coupled to a maneuverable building detection device attached to and autonomously maneuvering along a wall, a ceiling, and a floor of the building. The method also includes automatically determining, using a building component property determination system, one or more properties of the at least one building component based at least in part on the data detected by the at least one building component detection sensor device.

In other embodiments, a system includes a maneuverable building detection device configured to engage and autonomously maneuver along a wall, a ceiling, and a floor of a building comprised of a plurality of building components. The maneuverable building detection device is coupled to at least one building component detection sensor device configured to detect data relating to at least one building component of the plurality of building components. The system also includes a building component property determination system configured to automatically determine one or more properties of the at least one building component based at least in part on the data detected by the at least one building component detection sensor device. The system further includes a building insurance determination system configured to automatically determine insurance rates and/or insurance coverage for the building based at least in part on the one or more properties of the at least one building component determined by the building component property determination system.

It is appreciated that implementations in accordance with the present disclosure can include any combination of the aspects and features described herein. That is, implementations in accordance with the present disclosure are not limited to the combinations of aspects and features specifically described herein, but also include any other appropriate combinations of the aspects and features provided.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present disclosure will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

FIG. **1** illustrates a maneuverable building detection device and a building (e.g., a house) through and around which the maneuverable building detection device may be maneuvered such that one or more building component detection sensor devices coupled to the respective maneuverable building detection device may be brought into close proximity with building components of interest for the building, in accordance with embodiments described herein;

FIG. **2** illustrates various movement modes of a maneuverable building detection device relative to flooring and a wall of a building, in accordance with embodiments described herein;

FIG. **3** is a block diagram of a system that includes a building component property determination system configured to automatically determine properties of one or more building components of a building using data detected by

one or more building component detection sensor devices, in accordance with embodiments described herein;

FIG. **4** is a flow diagram of a method of operating the system of FIG. **3**, in accordance with embodiments described herein;

FIG. **5**A illustrates a notification being presented to a user via an application when a particular property for a particular building component of interest has been analyzed, in accordance with embodiments described herein;

FIG. **5**B illustrates a notification being presented to a user via an application when insurance rates and/or insurance coverage have been affected, in accordance with embodiments described herein;

FIG. **5**C illustrates a notification being presented to a user via an application when maintenance (e.g., repair or replacement) of a particular building component of interest is recommended, in accordance with embodiments described herein; and

FIG. **5**D illustrates a notification being presented to a user via an application when property value of a building having a particular building component of interest may be adjusted, in accordance with embodiments described herein.

DETAILED DESCRIPTION

One or more specific embodiments will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

When introducing elements of various embodiments of the present disclosure, the articles "a," "an," and "the" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements. Additionally, it should be understood that references to "one embodiment" or "an embodiment" of the present disclosure are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features.

As used herein, the term "insurance" may refer to a contract between an insurer, also known as an insurance company, and an insured, also known as a policyholder, in which the insurer agrees to indemnify the insured for specified losses, costs, or damage on specified terms and conditions in exchange of a certain premium amount paid by the insured. In a typical situation, when the insured suffers some loss for which he/she may have insurance the insured makes an insurance claim to request payment for the loss. It is to be appreciated for the purpose of the embodiments described herein, the insurance policy is not to be understood to be limited to a residential or homeowners insurance policy, but can be for a commercial, umbrella, and other insurance policies known by those skilled in the art.

As used herein, the terms "automatic" and "automatically" may refer to actions that are performed by a computing device or computing system (e.g., of one or more computing devices) without human intervention. For example, automatically performed functions may be performed by computing devices or systems based solely on data stored on and/or received by the computing devices or systems despite the fact that no human users have prompted the computing devices or systems to perform such functions. As but one non-limiting example, the computing devices or systems may make decisions and/or initiate other functions based solely on the decisions made by the computing devices or systems, regardless of any other inputs relating to the decisions.

In addition, as used herein, the terms "autonomous" and "autonomously" may refer to actions (e.g., movements) that are performed by a maneuverable building detection device that is configured to maneuver about a physical environment (e.g., within and/or around a building) without human intervention. For example, autonomous movement of a maneuverable building detection device may be accomplished by the maneuverable building detection device without any guidance from a user, for example, using a remote control device to manually maneuver the maneuverable building detection device.

As used herein, the terms "real time" and substantially real time" may refer to actions that are performed substantially simultaneously with other actions, without any human-perceptible delay between the actions. For example, two functions performed in substantially real time occur within seconds (or even within milliseconds) of each other. As but one non-limiting example, two functions performed in substantially real time occur within 1 second, within 0.1 second, within 0.01 second, and so forth, of each other.

As used herein, the term "application" may refer to one or more computing modules, programs, processes, workloads, threads, and/or computing instructions executed by a computing system. Example embodiments of an application include software modules, software objects, software instances, and/or other types of executable code.

Present embodiments are generally directed toward using maneuverable building detection devices configured to detect properties of building components of buildings for the purpose of building inspections. In particular, the maneuverable building detection devices described herein may be configured to fly within or around a building of interest, as well as to drive around on floors and other generally horizontal surfaces of the building of interest, as well as climb walls and other generally vertical surfaces of the building of interest, such that the maneuverable building detection devices may be maneuvered adjacent building components of the building of interest for the purpose of detecting properties of the building components. For example, in certain embodiments, the maneuverable building detection devices may include building component detection sensor devices that, when the respective maneuverable building detection device is maneuvered adjacent a building component of interest, the building component detection sensor devices may detect properties of interest for the building component of interest. In certain embodiments, the maneuverable building detection devices may be remotely controllable. However, in other embodiments, the maneuverable building detection devices may be autonomous and may maneuver themselves proximate building components of interest by, for example, using image and/or position sensors as positioning feedback. Indeed, in certain embodiments, the maneuverable building detection devices may be configured to operate in both a manual maneuvering mode and an autonomous maneuvering mode, and may be

configured to switch between the modes depending on a setting of the respective maneuverable building detection device, which may be toggled by a user of the respective maneuverable building detection device, for example.

In addition, instead of (or in addition to) being configured to drive around on floors and/or to climb walls, in certain embodiments, the maneuverable building detection devices may include optional extension attachments that are configured to be coupled to building component detection sensor devices and to move the building component detection sensor devices adjacent the floors and/or walls. For example, in such embodiments, the maneuverable building detection devices may remain in a relatively fixed position on the floors and/or walls while actuating the extension attachments to maneuver the building component detection sensor devices adjacent the floors and/or walls (e.g., with less pressure than the maneuverable building detection devices themselves would apply) to enable the building component detection sensor devices to detect properties of interest for the building component of interest.

In certain embodiments, the building component detection sensor devices of the maneuverable building detection devices may include sound detection sensor devices, vibration detection sensor devices, light detection sensor devices, temperature detection sensor devices, pressure detection sensor devices, humidity detection sensor devices, camera devices configured to capture images relating to the building components and/or the building itself, and so forth, which are configured to collect data relating to the building. In certain embodiments, a building component property determination system may automatically determine certain properties of certain building components of the building based at least in part on the data collected by the building component detection sensor devices. For example, a building component detection sensor device of a maneuverable building detection device may be maneuvered into close proximity to a building component, such as flooring, siding, doors, windows, foundation, roof, insulation, pier and beam construction, and so forth, and may detect sound, vibration, light, and so forth, in the area of the building component. Based at least in part on the detected sound, vibration, light, and so forth, the building component property determination system may automatically determine properties of the building component, such as a type of material the building component is made of, a quality of the building component, an integrity of the building component, and other conditions of the building component.

In certain embodiments, the determined properties may be used to verify construction standards for the building, such as maximum winds that may be withstood by the building. In addition, in certain embodiments, a building insurance determination system may automatically determine insurance rates and/or insurance coverage based at least in part on these determined properties. Alternatively, or in addition to, in certain embodiments, the determined properties may be used to automatically determine other things related to the building including, but not limited to, appraisals for mortgages relating to the building, inspections and/or home valuations relating to the building (e.g., for banks, tax offices, and so forth), and so forth.

The embodiments described herein provide numerous advantages over prior art systems. For example, the maneuverable building detection devices described herein enable more automated detection of properties of building components of buildings. In certain embodiments, prior to using this system, the layout (e.g., size of a room, wall positioning, furniture positioning, and so forth) of the building (or portion of the building, such as a room) may be assessed and utilized for calibration. For example, in certain embodiments, the layout may be manually input, for example, using a user interface with an interactive map displayed therein. In certain embodiments, the layout of the building may be imported from public data, such as publicly available floor plans. In other embodiments, camera data and/or sound data may be utilized to establish the layout of the building (or portion of the building, such as a room). Furthermore, in other embodiments, wireless signals transmitted via a local wireless network may be utilized to detect the layout of the building (or portion of the building, such as a room). For example, in certain embodiments, a signal strength of a wireless signal (e.g., such as a WiFi™ signal) broadcast throughout the building may be detected by a device, and the layout of the building may be automatically determined based on signal strength variations as the device moves through the building. In addition, in certain embodiments, the layout of the building may be automatically determined based on images and/or video captured by a camera device associated with the maneuverable building detection devices described herein.

In certain embodiments, one or more maneuverable building detection devices may be utilized to maneuver their respective building component detection sensor devices through or around (e.g., flying through or around the building, driving over floors or other generally horizontal surfaces of the building, and/or climbing up walls or other generally vertical surfaces of the building, to bring the building component detection sensor devices into position proximate to building components of interest, and so forth) the building (or portion of the building, such as a room). In certain embodiments, corrections for movement of the maneuverable building detection devices may be detected to more accurately assess, for example, reflected sound and automatically determine associated relative distances, materials, and so forth. In certain embodiments, the maneuverable building detection devices may only listen for or only provide the sound while other devices may provide the corresponding sound emission or listening function. In embodiments utilizing multiple devices (e.g., a single sound emission source is used with multiple detection devices), access to a local wireless network may facilitate location determination of relevant building components.

The embodiments described herein may also enable identification of plumbing disposed within the building. In addition, the embodiments described herein may also facilitate tree identification and/or the presence of certain soil characteristics, such as soil root, limestone shelf, and so forth, which may be used to provide suggestions for placement of trees around the building. In addition, the embodiments described herein may facilitate the detection of early warning signals of potential or impending damage to the building in order to prevent and/or minimize costs of losses due to delay in maintenance or emergency mitigation response, which may be detected by the building component detection sensor devices described herein. For example: early detection of certain conditions, such as foundation issues, roof damage, cracks, unexpected heat or temperature change patterns, moisture content, presence of mold in walls, and so forth, may all be detected by the building component detection sensor devices described herein, and may be acted upon by the building component property determination system described herein.

By way of introduction, FIG. **1** illustrates a building **10** (e.g., a house) through and around which one or more maneuverable building detection devices **12** may be maneu-

vered such that one or more building component detection sensor devices **14** coupled to the respective maneuverable building detection devices **12** may be brought into close proximity with building components **16** of interest for the building **10** such that the building component detection sensor devices **14** may detect properties of the building components **16**. As used herein, the terms "proximate to" and "in close proximity" are intended to mean, for example, positioning of a maneuverable building detection device **12** and/or a building component detection sensor device **14** within or around the building **10** in close enough proximity (e.g., within 20 feet, within 15 feet, within 10 feet, within 5 feet, within 2 feet, within 1 foot, or even closer) to a building component **16** of interest such that the building component detection sensor device **14** may collect data associated with the building component **16** of interest. In addition, in certain embodiments, the maneuverable building detection devices **12** may include one or more sampling devices **15** configured to take samples relating to building components **16** when the respective maneuverable building detection device **12** maneuvers the sampling devices **15** into close proximity with a building component **16** of interest or, indeed, when the respective maneuverable building detection device **12** is engaging (e.g., is attached to) and maneuvering along a wall, a ceiling, or a floor of the building **10**, as described in greater detail herein.

As described in greater detail herein, the building component detection sensor devices **14** may include, but are not limited to, sound detection sensor devices, vibration detection sensor devices, light detection sensor devices, temperature detection sensor devices, pressure detection sensor devices, humidity detection sensor devices, moisture detection sensor devices, camera devices (e.g., either standard camera devices or thermal imaging devices, as described in greater detail herein) configured to capture images relating to the building components and/or the building itself, and so forth. In addition, as also illustrated in FIG. **1**, in certain embodiments, certain building components **16** of interest of the building **10** may include, but are not limited to, flooring **16**A, siding **16**B, doors **16**C, windows **16**D, foundation **16**E, roof **16**F, insulation **16**G, pier and beam construction within walls **16**H, plumbing **16**I, and so forth.

In general, the building component detection sensor devices **14** of the maneuverable building detection devices **12** may be maneuvered into close proximity to building components **16** of interest of a building **10** for the purpose of collecting data relating to the building components **16** to enable a building component property determination system **18** to automatically determine properties of the building components **16**, such as types of materials the building components **16** are made of, qualities of the building components **16**, integrities of the building components **16**, and other conditions (e.g., age, degree of wear, and so forth) of the building components **16** for the purpose of aiding a building inspector inspecting the building **10**. Furthermore, as described in greater detail herein, in certain embodiments, the determined properties of the one or more building components **16** may be used to automatically determine insurance rates and/or insurance coverage relating to the building **10**. Alternatively, or in addition to, in certain embodiments, the determined properties of the one or more building components **16** may be used to automatically determine other things related to the building **10** including, but not limited to, appraisals for mortgages relating to the building **10**, home valuations relating to the building **10** (e.g., for banks, tax offices, and so forth), and so forth.

Various types of building component detection sensor devices **14** may be used to detect various types of data relating to properties of building components **16** of buildings **10**. For example, in certain embodiments, sound detection sensor devices **14** may be used to detect sound waves reflected off of a particular building component **16**. In certain embodiments, the sound detection sensor devices **14** may emit sound waves that are reflected back from the particular building component **16**. However, in other embodiments, the sound waves that are reflected off of the particular building component **16** may emanate from other external sound sources. In other embodiments, vibration detection sensor devices **14** may be used to detect other types of vibrations reflected off of a particular building component **16**. Similar to the sound detection sensors devices **14**, in certain embodiments, the vibration detection sensor devices **14** may emit the vibrations that are reflected back from the particular building component **16**. However, in other embodiments, the vibrations that are reflected off of the particular building component **16** may emanate from other external vibration sources. In other embodiments, light detection sensor devices **14** may be used to detect light reflected off of a particular building component **16**. Similar to the sound detection sensors devices **14** and the vibration detection sensor devices **14**, in certain embodiments, the light detection sensor devices **14** may emit the light that is reflected back from the particular building component **16**. However, in other embodiments, the light that is reflected off of the particular building component **16** may emanate from other external light sources.

In certain embodiments, multiple types of building component detection sensor devices **14** may be coupled to a respective maneuverable building detection device **12**. In such embodiments, the multiple building component detection sensor devices **14** may communicate with each other using communication circuitry, as described in greater detail herein, to coordinate detection of properties of the building components **16**. In addition, in certain embodiments, the multiple building component detection sensor devices **14** may also communicate with the respective maneuverable building detection device **12** using communication circuitry, as described in greater detail herein, to enable the respective maneuverable building detection device **12** to autonomously maneuver the multiple building component detection sensor devices **14** such that the multiple building component detection sensor devices **14** may detect properties of the building components **16**, for example, one after the other. In addition, in certain embodiments, processing circuitry of the multiple building component detection sensor devices **14** and the maneuverable building detection device **12**, as described in greater detail herein, may coordinate with each other to automatically switch operation between the building component detection sensor devices **14** depending on, for example, the type of property of interest of a particular building component **16** that is of interest, a type of building component **16** to which the maneuverable building detection device **12** is proximate, and so forth. For example, in certain embodiments, the processing circuitry of the multiple building component detection sensor devices **14** and/or of the maneuverable building detection device **12**, described in greater detail herein, may be configured to individually and/or collectively determine a type of a particular building component **16** of interest, may automatically determine which building component detection sensor device **14** should be used at any given time based on the determined type of the particular building component **16** of interest and/or based on a particular property of interest for the

particular building component **16** of interest, and may automatically switch operation to the determined building component detection sensor device **14**.

In addition, in certain embodiments, processing circuitry of the building component detection sensor devices **14** and/or of the maneuverable building detection device **12**, described in greater detail herein, may be configured to automatically adjust operating parameters of the respective building component detection sensor devices **14**, for example, based on a determined type of the particular building component **16** of interest and/or based on a particular property of interest for the particular building component **16** of interest to enable the building component detection sensor devices **14** to more accurately detect the properties of interest of the particular building component **16** of interest. For example, if the particular building component **16** of interest is determined to be a particular type of flooring **16**A, the processing circuitry of a sound detection sensor device **14** may adjust the frequency of sound waves emitted from the sound detection sensor device **14** to more accurately detect the condition of the particular type of flooring **16**A.

In certain embodiments, camera devices **14** may be used to capture images relating to the building components **16** and/or the building **10** itself to, for example, capture time lapse video around the building **10** to show progression of construction of the building **10** over the time it is built. For example, in certain embodiments, a camera device **14** may include a combination of a visible light (RGB) camera configured to detect visible light (e.g., light having a wavelength of between approximately 380 nanometers and approximately 740 nanometers) and an infrared camera configured to detect invisible light (e.g., light having a wavelength of between approximately 740 nanometers and approximately 1 millimeter). In such embodiments, the visible light (RGB) camera of the camera device **14** may be configured to detect certain visible properties of the building components **16** (e.g., types of material, visible cracks, and so forth), whereas the infrared camera of the camera device **14** may be configured to detect certain properties of the building components **16** that are not visible to the camera device **14** (e.g., internal damage, leaks in pipes behind walls **16**H, cracks within a foundation **16**E, and so forth). In addition, in such embodiments, the camera device **14** may be configured to use both the visible light (RGB) camera and the infrared camera together (e.g., at the same time), or may automatically switch between the visible light (RGB) camera and the infrared camera depending on, for example, the type of property of interest of a particular building component **16** that is of interest, a type of building component **16** to which the camera device **14** is proximate, and so forth. For example, in certain embodiments, processing circuitry of the camera device **14** and/or of the maneuverable building detection device **12**, described in greater detail herein, may be configured to determine a type of a particular building component **16** of interest, may automatically determine which type of camera should be used based on the determined type of the particular building component **16** of interest and/or based on a particular property of interest for the particular building component **16** of interest, and may automatically switch operation to the determined type of camera.

Regardless of the type of building component detection sensor devices **14** used, the relative position of the building component detection sensor devices **14** with respect to building components **16** of interest will have an effect on the determination of the properties of the building components **16**, which is performed by the building component property determination system **18**. To that end, as described in greater detail herein, the relative position of the maneuverable building detection device **12** (i.e., having the building component detection sensor devices **14**) with respect to building components **16** of interest may be automatically determined by the building component property determination system **18** using, for example, position data received from the particular maneuverable building detection device **12** and/or its associated building component detection sensor devices **14**, data relating to layouts of building components **16** and other features of the building **10**, and so forth.

Although described in reference to FIG. **1** as being building component detection sensor devices **14** that have a particular type of detection functionality, in certain embodiments, a given building component detection sensor device **14** may actually include multiple different types of sensors that are configured to detect multiple different types of properties relating to multiple different types of building components **16**, and the different sensors may be used at different times. For example, in certain embodiments, a given building component detection sensor device **14** may include any combination of sound detection sensors, vibration detection sensors, light detection sensors, temperature detection sensors, pressure detection sensors, humidity detection sensors, camera devices configured to capture images relating to the building components and/or the building itself, and so forth, and the various sensors may be activated at different times. In addition, in certain embodiments, the different combinations of sensors in any given building component detection sensor device **14** may be used together to determine the properties of building components **16**. As but one non-limiting example, a given building component detection sensor device **14** may include both a pressure detection sensor and a humidity detection sensor, the data detected by both being usable to determine moisture experienced by a particular building component **16**.

In certain embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, automatically determine a type and/or quality of material (e.g., type of tile or wood) of which flooring **16**A of the building **10** is comprised. For example, in certain embodiments, sound and/or vibration may be detected by sound detection sensor devices **14** and/or vibration detection sensor devices **14** that are proximate to the flooring **16**A. In certain embodiments, the one or more building component detection sensor devices **14** may be brought into close proximity to the flooring **16**A by a maneuverable building detection device **12** that flies proximate the flooring **16**A and/or drives directly over the flooring **16**A, as described in greater detail herein.

In other embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, automatically determine a type and/or quality of material of which siding **16**B of the building **10** is comprised. For example, in certain embodiments, sound, vibration and/or temperature differentials may be detected by sound detection sensor devices **14**, vibration detection sensor devices **14**, and/or temperature and/or pressure detection sensor devices **14** that are proximate to the siding **16**B. In certain embodiments, the one or more building component detection sensor devices **14** may be brought into close proximity to the siding **16**B by a maneuverable

building detection device **12** that flies proximate the siding **16**B and/or climbs the siding **16**B, as described in greater detail herein.

In other embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, automatically determine a type and/or quality of material of which a door **16**C of the building **10** is comprised, an integrity of the door **16**C, and so forth. For example, in certain embodiments, sound and/or vibration may be detected by sound detection sensor devices **14** and/or vibration detection sensor devices **14** that are proximate to the door **16**C. In certain embodiments, the one or more building component detection sensor devices **14** may be brought into close proximity to the door **16**C by a maneuverable building detection device **12** that flies proximate the door **16**C and/or climbs the door **16**C, as described in greater detail herein.

In other embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, automatically determine a type and/or quality of material (type of a pane of glass of the window **16**D, type of safety/UV film of the window **16**D, and so forth) of which a window **16**D of the building **10** is comprised, an integrity of the window **16**D, number of panes of glass of the window **16**D, and so forth. For example, in certain embodiments, light and/or temperature differentials may be detected by light detection sensor devices **14** and/or temperature and/or pressure detection sensor devices **14** that are proximate to the window **16**D. In certain embodiments, the one or more building component detection sensor devices **14** may be brought into close proximity to the window **16**D by a maneuverable building detection device **12** that flies proximate the window **16**D and/or climbs the window **16**D, as described in greater detail herein.

In other embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, automatically determine a type of foundation **16**E of the building **10**, an integrity of the foundation **16**E, and so forth. In addition, in certain embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, detect slopes of the foundation **16**E and/or whether or not drainage created by the foundation **16**E is designed to lead water away from the building **10**. For example, in certain embodiments, sound and/or vibration may be detected by sound detection sensor devices **14** and/or vibration detection sensor devices **14** that are proximate to the foundation **16**E. In certain embodiments, the one or more building component detection sensor devices **14** may be brought into close proximity to the foundation **16**E by a maneuverable building detection device **12** that flies proximate the foundation **16**E and/or drives directly over the foundation **16**E, as described in greater detail herein.

In other embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, automatically determine a type and/or quality of material of which a roof **16**F of the building **10** is comprised, whether solar panels are being used for the building **10**, and so forth. For example, in certain embodiments, sound and/or vibration may be detected by sound detection sensor devices **14** and/or vibration detection sensor devices **14** that are proximate to the roof **16**F. In certain embodiments, the one or more building component detection sensor devices **14** may be brought into close proximity to the roof **16**F by a maneuverable building detection device **12** that flies proximate the roof **16**F and/or drives directly over the roof **16**F, as described in greater detail herein.

In other embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, automatically determine a type of insulation **16**G of the building **10**. For example, in certain embodiments, sound, vibration, and/or temperature differentials may be detected by sound detection sensor devices **14**, vibration detection sensor devices **14**, and/or temperature and/or pressure detection sensor devices **14** that are proximate to the insulation **16**G. In certain embodiments, the one or more building component detection sensor devices **14** may be brought into close proximity to the insulation **16**G by a maneuverable building detection device **12** that flies proximate flooring **16**A, a wall **16**H, and/or a ceiling **16**J that is adjacent the insulation **16**G, climbs a wall **16**H that is adjacent the insulation **16**G, and/or drives directly over flooring **16**A that is adjacent the insulation **16**G, as described in greater detail herein.

In other embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, automatically determine a type or location of pier and beam construction within walls **16**H of the building **10**. For example, in certain embodiments, sound and/or vibration may be detected by sound detection sensor devices **14** and/or vibration detection sensor devices **14** that are proximate to the pier and beam construction. In addition, in certain embodiments, moisture detection sensor devices **14** and/or camera devices **14** (e.g., thermal imaging devices) may be used to detect moisture within and/or on surfaces of walls **16**H of the building **10**, which may indicate the presence of mold within and/or on the surfaces of the walls **16**H. In certain embodiments, the one or more building component detection sensor devices **14** may be brought into close proximity to the walls **16**H by a maneuverable building detection device **12** that flies proximate the walls **16**H and/or climbs the walls **16**H, as described in greater detail herein.

In other embodiments, data collected by one or more building component detection sensor devices **14** may be used by the building component property determination system **18** to, for example, automatically determine a type or location of plumbing **16**I of the building **10**. For example, in certain embodiments, sound and/or vibration may be detected by sound detection sensor devices **14** and/or vibration detection sensor devices **14** that are proximate to the plumbing **16**I. In certain embodiments, the one or more building component detection sensor devices **14** may be brought into close proximity to the plumbing **16**I by a maneuverable building detection device **12** that flies proximate flooring **16**A, a wall **16**H, and/or a ceiling **16**J that is adjacent the plumbing **16**I, climbs a wall **16**H that is adjacent the plumbing **16**I, and/or drives directly over flooring **16**A that is adjacent the plumbing **16**I, as described in greater detail herein.

As illustrated in FIG. **1**, in certain embodiments, a maneuverable building detection device **12** may be used to carry one or more building component detection sensor devices **14** within an interior of the building **10** and/or around an exterior of the building **10** such that the one or more building component detection sensor devices **14** may detect data relating to one or more building components **16** of the

building **10**. In particular, in certain embodiments, the maneuverable building detection device **12** may be directly coupled to the one or more building component detection sensor devices **14**, and may maneuver the one or more building component detection sensor devices **14** into close proximity to (e.g., landing on, flying/driving over, climbing, and so forth) the building components **16** such that the one or more building component detection sensor devices **14** may detect data relating to the building components **16**.

In such embodiments, the building component property determination system **18** may take position and movement of the maneuverable building detection device **12** into consideration when determining the properties of the building components **16**. For example, a current position of the maneuverable building detection device **12** may be used by the building component property determination system **18** to automatically determine a current position of the one or more building component detection sensor devices **14** of the maneuverable building detection device **12**, which in turn may be used by the building component property determination system **18** to automatically determine a relative position of the one or more building component detection sensor devices **14** of the maneuverable building detection device **12** to a building component **16** of interest for the purpose of determining the properties of the building component **16**, as well as determining how to maneuver the maneuverable building detection device **12** proximate to the building component **16** of interest. In addition, in certain embodiments, images of at least portions of the building **10** may be captured by cameras of the one or more building component detection sensor devices **14**, and the captured images may be used to automatically determine relative positioning of a respective building component detection sensor device **14** of the maneuverable building detection device **12** relative to a particular building component **16** captured in the images for the purpose of determining how to maneuver the respective building component detection sensor device **14** relative to the particular building component **16**, for example, via a respective maneuverable building detection device **12**.

As such, in certain embodiments, the building component property determination system **18** may be configured to autonomously maneuver the maneuverable building detection devices **12** relative to building components **16** of buildings **10**. However, in other embodiments, the maneuverable building detection devices **12** may be configured to autonomously maneuver themselves relative to building components **16** of buildings **10**, for example, based on instructions stored and executed internally by the maneuverable building detection devices **12**. In contrast, in other embodiments, a remote control device **20** may be used, for example, by a building inspector to manually manipulate the positioning of the maneuverable building detection devices **12** relative to building components **16** of buildings **10** by, for example, sending control signals to the maneuverable building detection devices **12**. In certain embodiments, a combination of automatic maneuvering and manual maneuvering of the maneuverable building detection devices **12** may be used. For example, in certain embodiments, the maneuverable building detection devices **12** may be configured to operate in both a manual maneuvering mode and an autonomous maneuvering mode, and may be configured to switch between the maneuvering modes depending on a setting of the respective maneuverable building detection device **12**, which may be toggled by a user of the respective maneuverable building detection device **12**, for example.

To illustrate the functionality of the maneuverable building detection devices **12** described herein, FIG. **2** illustrates various movement modes of a maneuverable building detection device **12** relative to flooring **16**A and a wall **16**H of a building **10**. For example, FIG. **2** illustrates a maneuverable building detection device **12** in a flight mode **22**A utilizing a plurality of rotors **24**, each driven by a respective motor **26**, to control flight of the maneuverable building detection device **12**. From the flight mode **22**A, the maneuverable building detection device **12** may land on the flooring **16**A such that a plurality of wheels **28** contact the flooring **16**A. At this point, the plurality of wheels **28** may be used to control movement of the maneuverable building detection device **12** along the flooring **16**A in a driving mode **22**B such that a building component detection sensor device **14** coupled to the maneuverable building detection device **12** may detect one or more properties of the flooring **16**A or other building components **16** proximate the flooring **16**A, as described in greater detail herein. Conversely, from the flight mode **22**A, the maneuverable building detection device **12** may instead engage (e.g., attach to) and maneuver along (e.g., climb) the wall **16**H. To do so, the plurality of rotors **24** may be manipulated by the plurality of motors **26** to cause the maneuverable building detection device **12** to slowly change attitude in a wall-approach mode **22**C until a plurality of wall-attachable wheels **30** make contact with the wall **16**H in a wall/ceiling attachment mode **22**D. At this point, the plurality of wall-attachable wheels **30** may be used to control climbing of the maneuverable building detection device **12** along the wall **16**H such that the building component detection sensor device **14** may detect one or more properties of the wall **16**H or other building components **16** proximate the wall **16**H, as described in greater detail herein. Various types of wall-attachable wheels **30** may be used including, but not limited to, magnetic wheels, adhesive wheels, vacuum adhesion wheels, and so forth. It will be appreciated that the wall-attachable wheels **30** may also enable the maneuverable building detection device **12** to engage (e.g., attach to) ceilings **16**J, flooring **16**A, and other structures within the building **10**.

In addition, instead of (or in addition to) being configured to drive around on floors **16**A and/or to climb walls **16**H, in certain embodiments, the maneuverable building detection devices **12** may include optional extension attachments that are configured to be coupled to building component detection sensor devices **14** and to move the building component detection sensor devices **14** adjacent the floors **16**A and/or walls **16**H. For example, in such embodiments, the maneuverable building detection devices **12** may remain in a relatively fixed position on the floors **16**A and/or walls **16**H while actuating the extension attachments to maneuver the building component detection sensor devices **14** adjacent the floors **16**A and/or walls **16**H (e.g., with less pressure than the maneuverable building detection devices **12** themselves would apply) to enable the building component detection sensor devices **14** to detect properties of interest for the building component **16** of interest.

In addition, in certain embodiments, the maneuverable building detection devices **12** may include one or more sampling devices **15** configured to take samples relating to building components **16** when the respective maneuverable building detection device **12** maneuvers the sampling devices **15** into close proximity with a building component **16** of interest or, indeed, when the respective maneuverable building detection device **12** is engaging (e.g., is attached to) and driving along the flooring **16**A in the driving mode **22**B or climbing the wall **16**H in the wall/ceiling attachment

mode **22**D, as described in greater detail herein. For example, as illustrated in FIG. **2**, at certain times when the maneuverable building detection device **12** is proximate a building component **16** of interest (e.g., flooring **16**A in a driving mode **22**, a wall **16**H in a wall/ceiling attachment mode **22**D, and so forth), a sampling device **15** may be extended into the building component **16** to extract a small portion of the building component **16** and/or to directly sample a property (e.g., moisture, integrity, and so forth) of the building component **16**. In certain embodiments, the sampling devices **15** may include tiny needle-like extensions configured to extend into building components **16**, tiny scoop-like devices configured to scrape and scoop small portions of building components **16**, or any other suitable sampling devices **15**. It will be appreciated that manipulation of the sampling devices **15** may be accomplished either manually via human manipulation of a remote control device **20** or automatically via processing circuitry of the building component detection sensor devices **14** and/or of the maneuverable building detection devices **12**, as described in greater detail herein.

FIG. **3** is a block diagram of a system **32** that includes a building component property determination system **18** configured to determine properties of one or more building components **16** of a building **10** using data detected by one or more building component detection sensor devices **14**, in accordance with embodiments described herein. As illustrated in FIG. **3**, each of the building component detection sensor devices **14** may include detection components **34** configured to detect, for example, certain types of sound waves, vibration waves, light waves, or combinations thereof. In addition, as described in greater detail herein, the building component detection sensor devices **14** may include emitter components **36** configured to emit, for example, certain types of sound waves, vibration waves, light waves, or combinations thereof, which are reflected back from building components **16** of interest. However, as also described in greater detail herein, the building component detection sensor devices **14** may not include emitter components **36** but, rather, may detect waves that are emitted by one or more external emitter sources **38**, such as equipment specifically configured to emit, for example, certain types of sound waves, vibration waves, light waves, or combinations thereof. Indeed, in certain embodiments, the one or more external emitter sources **38** may simply include environmental sources, for example, ambient sound, vibration, light, and so forth. In addition, as described in greater detail herein, in certain embodiments, the detection components **34** of the building component detection sensor devices **14** may also include other types of detection sensors, such as temperature detection sensors, pressure detection sensors, humidity detection sensors, camera devices configured to capture images relating to building components **16** and/or a building **10** itself, and so forth, which are configured to detect various other properties of building components **16** and/or a building **10** itself.

As also illustrated in FIG. **3**, each of the building component detection sensor devices **14** may include communication circuitry **40** configured to communicate data **42** relating to the detected properties of interest for building components **16** of interest to communication circuitry **44** of the building component property determination system **18** via a communication network **46**. In certain embodiments, the communication network **46** may include a wireless communication network, such as a WiFi™ network of the building **10**, a wireless hot spot network established by the building component detection sensor devices **14**, a Bluetooth® network established by the building component detection sensor devices **14**, a Zigbee network established by the building component detection sensor devices **14**, a ZWave(+) network established by the building component detection sensor devices **14**, a LoRaWAN network established by the building component detection sensor devices **14**, an RF/IR network established by the building component detection sensor devices **14**, or any other suitable wireless network.

As described in greater detail herein, the building component property determination system **18** is configured to determine one or more properties **48** of building components **16** of interest based at least in part on the data **42** received from one or more building component detection sensor devices **14**. For example, in certain embodiments, the building component property determination system **18** may include at least one processor **50** configured to execute instructions **52** stored in at least one memory medium **54** of the building component property determination system **18**, wherein the instructions **52**, when executed by the at least one processor **50**, determine the one or more properties **48** of the building components **16** of interest based at least in part on the data **42** received from the one or more building component detection sensor devices **14** for the purpose of inspecting the building **10** that includes the building component **16**.

In certain embodiments, the building component property determination system **18** may include a building component database **56** that includes, for example, data **58** relating to various properties **48** of a plurality of building components **16**, such as a type of a respective building component **16**, type and/or quality of material of a respective building component **16**, size (e.g., thickness, depth, width, breadth, and so forth) of a respective building component **16**, density of a respective building component **16**, integrity of a respective building component **16**, and so forth, wherein the data **58** relating to the various properties **48** stored in the building component database **56** correlate to the data **42** detected by the building component detection sensor devices **14**. For example, in certain embodiments, the building component property determination system **18** may automatically determine which data **58** relating to the various properties **48** stored in the building component database **56** correlates best with the data **42** detected by the building component detection sensor devices **14**, thereby estimating the one or more properties **48** of the building component **16** of interest for the purpose of inspecting the building **10** that includes the building component **16**.

As described in greater detail above with respect to FIG. **1**, the properties **48** of building components **16** that may be automatically determined by the building component property determination system **18** include, but are not limited to, a type and/or quality of material (e.g., type of tile or wood) of which flooring **16**A of the building **10** is comprised, a type and/or quality of material of which siding **16**B of the building **10** is comprised, a type and/or quality of material of which a door **16**C of the building **10** is comprised, an integrity of the door **16**C, a type and/or quality of material (type of a pane of glass of the window **16**D, type of safety/UV film of the window **16**D, and so forth) of which a window **16**D of the building **10** is comprised, an integrity of the window **16**D, number of panes of glass of the window **16**D, a type of foundation **16**E of the building **10**, an integrity of the foundation **16**E, a degree of termite damage with respect to the foundation **16**E, a type and/or quality of material of which a roof **16**F of the building **10** is comprised, a type and/or quality of material of the insulation **16**G of the

building **10**, a type or location of pier and beam construction within walls **16**H of the building **10**, a type or location of plumbing **16**I of the building **10**, and so forth.

As illustrated in FIG. **3**, in certain embodiments, the system **32** may include a building insurance determination system **60** configured to automatically determine insurance rates and/or insurance coverage for the building **10** based at least in part on the one or more properties **48** of a building component **16** of interest determined by the building component property determination system **18**. For example, in certain embodiments, the building insurance determination system **60** may include at least one processor **62** configured to execute instructions **64** stored in at least one memory medium **66** of the building insurance determination system **60**, wherein the instructions **64**, when executed by the at least one processor **62**, automatically determine the insurance rates and/or insurance coverage for the building **10** based at least in part on the one or more properties **48** of the building component **16** of interest determined by the building component property determination system **18**. In certain embodiments, the building insurance determination system **60** may include communication circuitry **68** configured to facilitate communication with the communication circuitry **44** of the building component property determination system **18**, for example, via the communication network **46** or via communication cables **70** that directly communicatively couple the building insurance determination system **60** and the building component property determination system **18**.

In certain embodiments, the building component property determination system **18** may automatically determine the one or more properties **48** of a building component **16** of interest based at least in part on a layout of at least a portion of the building **10**. For example, the building component property determination system **18** may automatically determine the one or more properties **48** of a building component **16** of interest based at least in part on a size of a room of the building **10** that includes a building component **16** of interest, positioning of walls **16**H of the building **10**, furniture positioning within a room of the building **10** that includes a building component **16** of interest, and so forth. In certain embodiments, the layout of at least a portion of the building **10** may be at least partially manually entered, for example, by a building inspector. In other embodiments, the layout of at least a portion of the building **10** may be at least partially detected by the detection components **34** of the building component detection sensor devices **14**. In other embodiments, the layout of at least a portion of the building **10** may be at least partially detected using wireless signals communicated (e.g., via the communication network **46**) within the building **10**.

For example, in certain embodiments, a building component detection sensor device **14** or other suitable device (e.g., a user computing device, as described in greater detail herein) may detect the wireless signals while the particular device is being maneuvered within or around the building **10**, and may automatically determine at least a portion of the layout of the building **10** based, for example, on signal strength variations detected by the particular device as it moves through or around the building **10**. In addition, in certain embodiments, a camera device **14** as described in greater detail herein may capture images and/or video of the building **10**, and may automatically determine at least a portion of the layout of the building **10** based on the captured images and/or video. It will be appreciated that, in certain embodiments, the layout of at least a portion of the building **10** may be determined using a combination of the techniques described herein. For example, layout data detected using differing methods may be correlated with each other. In addition, as described in greater detail herein, the detected layout data may be correlated with positional data collected by the respective building component detection sensor devices **14**, and may be used to help an associated maneuverable building detection device **12** to determine how to autonomously maneuver itself to bring the building component detection sensor devices **14** in proximity to a building component **16** of interest.

In addition, in certain embodiments, the building component property determination system **18** may automatically determine the one or more properties **48** of a building component **16** of interest based at least in part on relative positioning of the building component detection sensor devices **14** with respect to a building component **16** of interest. For example, in certain embodiments, the building component detection sensor devices **14** may include position sensors **72** configured to automatically determine a position of the respective building component detection sensor device **14**. Alternatively, the maneuverable building detection device **12** may include a position sensor **74** configured to automatically determine a position of the maneuverable building detection device **12**, which may be used as a proxy for the position of the one or more building component detection sensor devices **14** being carried by the maneuverable building detection device **12**. In certain embodiments, the building component property determination system **18** may be configured to automatically determine the relative positioning of the building component detection sensor devices **14** and the building components **16** of interest based on the respective positions of the building component detection sensor devices **14** and the building components **16** of interest.

In addition, in certain embodiments, the positions of the building component detection sensor devices **14** and/or of the maneuverable building detection device **12** determined by the position sensors **72**, **74** of the building component detection sensor devices **14** and/or of the maneuverable building detection device **12** may be used by circuitry of the maneuverable building detection device **12** as position feedback for the purpose of controlling autonomous movement of the maneuverable building detection device **12**. For example, in certain embodiments, the maneuverable building detection device **12** may use the position feedback to determine how to maneuver itself proximate to a wall **16**H, a ceiling **16**J, or a floor **16**A of the building **10** to bring its respective building component detection sensor devices **14** in proximity with respect to building components **16** of interest.

In addition, in certain embodiments, the building component detection sensor devices **14** may include at least one processor **76** configured to execute instructions **78** stored in at least one memory medium **80** of the respective building component detection sensor device **14**, wherein the instructions **78**, when executed by the at least one processor **76**, cause the respective building component detection sensor device **14** to collect data relating to building components **16** of interest, as described in greater detail herein. Similarly, in certain embodiments, the maneuverable building detection devices **12** may also include at least one processor **82** configured to execute instructions **84** stored in at least one memory medium **86** of the respective maneuverable building detection device **12**, wherein the instructions **84**, when executed by the at least one processor **82**, cause the respective maneuverable building detection device **12** to maneuver one or more building component detection sensor devices **14** attached to the respective maneuverable building detection

device **12** based on control signals received, for example, via communication circuitry **88** of the respective maneuverable building detection device **12** from the building component property determination system **18** and/or the remote control device **20** (e.g., in embodiments where the respective maneuverable building detection device **12** is controlled, for example, by a building inspector).

However, in other embodiments, the instructions **84**, when executed by the at least one processor **82**, cause the respective maneuverable building detection device **12** to autonomously maneuver itself, for example, based at least in part on position feedback provided by position sensors **72**, **74** of the building component detection sensor devices **14** and/or of the maneuverable building detection device **12**, by a camera of a building component detection sensor device **14**, or by other components of the building component detection sensor devices **14** and/or of the maneuverable building detection device **12**. For example, in certain embodiments, the instructions **84**, when executed by the at least one processor **82**, cause the respective maneuverable building detection device **12** to align its respective wheels **28**, **30** with a wall **16**H, a ceiling **16**J, or a floor **16**A of the building **10** to bring its respective building component detection sensor devices **14** in proximity with respect to building components **16** of interest. In addition, in certain embodiments, the instructions **84**, when executed by the at least one processor **82**, cause the respective maneuverable building detection device **12** to maneuver itself based at least in part on a layout of a building **10** within or around which the maneuverable building detection device **12** is moving to bring its respective building component detection sensor devices **14** in proximity with respect to building components **16** of interest.

As described in greater detail herein, in certain embodiments, a combination of automatic maneuvering and manual maneuvering of the maneuverable building detection device **12** may be used. For example, in certain embodiments, the maneuverable building detection device **12** may be configured to operate in both a manual maneuvering mode and an autonomous maneuvering mode, and the instructions **84**, when executed by the at least one processor **82**, cause the respective maneuverable building detection device **12** to switch between the maneuvering modes depending on a setting of the maneuverable building detection device **12**, which may be toggled by a user of the maneuverable building detection device **12**, for example.

In embodiments where a remote control device **20** is used to manually control a maneuverable building detection device **12**, the remote control device **20** may also include at least one processor **90** configured to execute instructions **92** stored in at least one memory medium **94** of the respective remote control device **20**, wherein the instructions **92**, when executed by the at least one processor **90**, cause the respective remote control device **20** to send appropriate control signals to the maneuverable building detection device **12**, for example, via communication circuitry **96** of the respective remote control device **20**. In certain embodiments, the control signals sent to the maneuverable building detection device **12** may be based on inputs received via one or more input devices **98** of the respective remote control device **20**.

FIG. **4** is a flow diagram of a method **100** of operating the system **32** of FIG. **3**. As illustrated in FIG. **4**, in certain embodiments, the method **100** includes detecting data relating to at least one building component **16** of a building **10** comprised of a plurality of building components **16** using at least one building component detection sensor device **14** coupled to a maneuverable building detection device **12** attached to and autonomously maneuvering along a wall **16**H, a ceiling **16**J, or a floor **16**A of the building **10** (block **102**). In addition, in certain embodiments, the method **100** includes automatically determining, using a building component property determination system **18**, one or more properties of the at least one building component **16** based at least in part on the data detected by the at least one building component detection sensor device **14** (block **104**). In addition, in certain embodiments, the method **100** includes automatically determining, using a building insurance determination system **60**, insurance rates and/or insurance coverage for the building **10** based at least in part on the one or more properties of the at least one building component **16** determined by the building component property determination system **18** (block **106**).

As described in greater detail herein, in certain embodiments, the maneuverable building detection devices **12** described herein may be configured to automatically (e.g., without human intervention) maneuver themselves, for example, based at least in part on data detected by one or more building component detection sensor devices **14** coupled to the respective maneuverable building detection device **12**. For example, in certain embodiments, processing circuitry of the one or more building component detection sensor devices **14** and/or of the respective maneuverable building detection device **12**, described in greater detail herein, may be configured to determine a location of a particular building component **16** of interest (e.g., using images and/or video captured by one or more camera devices **14** coupled to the respective maneuverable building detection device **12**), and the processing circuitry of the respective maneuverable building detection device **12** may maneuver itself toward the particular building component **16** of interest to enable one or more of its associated building component detection sensor devices **14** to detect certain properties of interest relating to the particular building component **16** of interest. In addition, even once the maneuverable building detection device **12** has maneuvered itself proximate a particular building component **16** of interest, the maneuverable building detection device **12** may then change positioning of itself into different positions to enable different building component detection sensor devices **14** to be positioned relative to the particular building component **16** of interest at different times so that the building component detection sensor devices **14** may effectively detect their respective data relating to the particular building component **16** of interest.

Furthermore, in certain embodiments, the maneuverable building detection devices **12** described herein may be configured to automatically (e.g., without human intervention) maneuver themselves to avoid furniture, fixtures, and other obstacles in and around the building **10**, for example, based on the layout of the building **10**, which is detected as described in greater detail herein. For example, as illustrated in FIG. **2**, if a maneuverable building detection device **12** approaches a piece of furniture **108** disposed within the building **10**, a building component detection sensor device **14** (e.g., a camera device, a position sensing device, and so forth) coupled to the maneuverable building detection device **12** may detect the presence of the piece of furniture **108**, and the maneuverable building detection device **12** may maneuver itself around the piece of furniture **108** to avoid collision with the piece of furniture **108**.

As described in greater detail herein, the building component property determination system **18** and the building insurance determination system **60** may automatically perform calculations (e.g., determination of properties of build-

ing components **16** of interest, determination of insurance rates and/or insurance coverage for a building **10** of interest, and so forth) on the data detected by the building component detection sensor devices **14** in substantially real time. In addition, in certain embodiments, the building component property determination system **18** and/or the building insurance determination system **60** may also send control signals to one or more user computing devices **110** (e.g., smart phones, wearable computing devices, personal computers, tablet computers, laptop computers, and so forth) to notify users **112** in substantially real time regarding these calculations. For example, in certain embodiments, the control signals sent to the one or more user computing devices **110** may cause the one or more user computing devices **110** to automatically (e.g., without human intervention) launch an application **114** via the respective user computing device **110** such that messages relating to the calculations performed by the building component property determination system **18** and/or the building insurance determination system **60** may be presented to a user **112** associated with the respective user computing device **110**. Indeed, in certain embodiments, the building component property determination system **18** and/or the building insurance determination system **60** may be configured to automatically (e.g., without human intervention) send control signals to the one or more user computing devices **110** to automatically (e.g., without human intervention) launch the application **114** via specific communication channels to minimize the impact that the communication between the building component property determination system **18** and/or the building insurance determination system **60** and the one or more user computing devices **110** has on other applications running on the one or more user computing devices **110**, for example.

As illustrated in FIG. **2**, in certain embodiments, the user computing device(s) **110** may include at least one communication component **116**, at least one processor **118**, at least one memory **120**, and at least one storage device **122**, as well as other processing circuitry that enable the user computing device(s) **110** to launch the application **114** being executed on the user computing device(s) **110**. In addition, in certain embodiments, the user computing device(s) **110** described herein may also include a display **124** and at least one input **126**, which may facilitate a user **112** interacting with a respective user computing device **110**. For example, in certain embodiments, a user **112** of a user computing device **110** may manipulate the input(s) **126** of a user computing device **110** (e.g., by pressing a button, sliding an adjustable indicator, using voice commands, using gestures, and/or other suitable techniques) to manipulate one or more graphical user interfaces displayed on the display **124** via the application **114** being executed by the processor(s) **118** of the user computing device **110**, as described in greater detail herein.

Many different types of notifications may be presented to the users **112** via the application **114**. For example, FIG. **5**A illustrates a notification **128** being presented to a user **112** via the application **114** when a particular property for a particular building component **16** of interest has been analyzed by the building component property determination system **18**. In addition, FIG. **5**B illustrates a notification **130** being presented to a user **112** via the application **114** when insurance rates and/or insurance coverage have been affected, for example, based on analysis performed by the building insurance determination system **60**. In addition, FIG. **5**C illustrates a notification **132** being presented to a user **112** via the application **114** when maintenance (e.g., repair or replacement) of a particular building component **16** of interest is recommended, for example, based on analysis performed by the building component property determination system **18** and/or the building insurance determination system **60**. In addition, FIG. **5**D illustrates a notification **134** being presented to a user **112** via the application **114** when property value of a building **10** having a particular building component **16** of interest may be adjusted, for example, based on analysis performed by the building component property determination system **18** and/or the building insurance determination system **60**.

While the embodiments set forth in the present disclosure may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the disclosure is not intended to be limited to the particular forms disclosed. The disclosure is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the disclosure as defined by the following appended claims.

The techniques presented and claimed herein are referenced and applied to material objects and concrete examples of a practical nature that demonstrably improve the present technical field and, as such, are not abstract, intangible or purely theoretical. Further, if any claims appended to the end of this specification contain one or more elements designated as "means for [perform] ing [a function] . . . " or "step for [perform] ing [a function] . . . ", it is intended that such elements are to be interpreted under 35 U.S.C. § 112(f). However, for any claims containing elements designated in any other manner, it is intended that such elements are not to be interpreted under 35 U.S.C. § 112 (f).

The invention claimed is:

1. A system, comprising:

a maneuverable building detection device configured to attach to and autonomously maneuver along a wall, a ceiling, and a floor of a building comprised of a plurality of building components using a plurality of surface-attachable wheels of the maneuverable building detection device, wherein the maneuverable building detection device is coupled to at least one building component detection sensor device, each building component detection sensor device configured to detect data relating to at least one building component of the plurality of building components, wherein the maneuverable building detection device is configured to autonomously maneuver itself along the wall, the ceiling, or the floor of the building based at least in part on feedback relating to a position of attachment of the maneuverable building detection device relative to the at least one building component, and wherein the position of attachment of the maneuverable building detection device relative to the at least one building component is detected by the at least one building component detection sensor device;

a building component property determination system configured to automatically determine one or more properties of the at least one building component based at least in part on the data detected by the at least one building component detection sensor device, wherein the data detected by the at least one building component detection sensor device relates to sound, vibration, or light emitted from the at least one building component detection sensor device and reflected off of the at least one building component, and wherein the maneuverable building detection device is configured to autonomously adjust the position of attachment of the maneuverable building detection device along the wall,

the ceiling, or the floor of the building relative to the at least one building component using the plurality of surface-attachable wheels of the maneuverable building detection device based at least in part on the data detected by the at least one building component detection sensor device; and

a building insurance determination system configured to automatically determine insurance rates and/or insurance coverage for the building based at least in part on the one or more properties of the at least one building component determined by the building component property determination system.

2. The system of claim **1**, wherein the one or more properties of the at least one building component comprises a type of material and/or condition of the at least one building component.

3. The system of claim **1**, wherein the building component property determination system is configured to automatically determine the one or more properties of the at least one building component based at least in part on relative positioning of the at least one building component detection sensor device and the at least one building component.

4. The system of claim **1**, wherein the building component property determination system is configured to automatically determine the one or more properties of the at least one building component based at least in part on a layout of at least a portion of the building.

5. The system of claim **1**, wherein the maneuverable building detection device is configured to fly within or around the building.

6. The system of claim **1**, wherein the maneuverable building detection device comprises a sampling device configured to take a sample of the at least one building component while the maneuverable building detection device autonomously maneuvers itself along the wall, the ceiling, or the floor of the building using the plurality of surface-attachable wheels of the maneuverable building detection device.

7. The system of claim **1**, wherein the at least one building component detection sensor device comprises a combination of a visible light camera and an infrared camera, wherein the at least one building component detection sensor device is configured to automatically switch operation between the visible light camera and the infrared camera based at least in part on a type of the at least one building component.

8. The system of claim **1**, wherein the at least one building component comprises flooring of the building, siding of the building, a door of the building, a window of the building, a foundation of the building, a roof of the building, or some combination thereof.

9. The system of claim **1**, wherein the at least one building component detection sensor device comprises a sound detection sensor device, a vibration detection sensor device, a light detection sensor device, a temperature detection sensor device, a pressure detection sensor device, a humidity detection sensor device, a moisture detection sensor device, a camera device, or any combination thereof.

10. The system of claim **1**, wherein the plurality of surface-attachable wheels comprises adhesive wheels.

11. The system of claim **1**, wherein the plurality of surface-attachable wheels comprises vacuum adhesion wheels.

12. A method, comprising:

autonomously maneuvering a maneuverable building detection device along a wall, a ceiling, and a floor of a building using a plurality of surface-attachable wheels of the maneuverable building detection device based at least in part on feedback relating to a position of attachment of the maneuverable building detection device relative to at least one building component of a building comprised of a plurality of building components, wherein the position of attachment of the maneuverable building detection device relative to the at least one building component of the plurality of building components is detected by at least one building component detection sensor device coupled to the maneuverable building detection device;

detecting data relating to the at least one building component of the building using the at least one building component detection sensor device coupled to the maneuverable building detection device;

automatically determining, using a building component property determination system, one or more properties of the at least one building component based at least in part on the data detected by the at least one building component detection sensor device, wherein the data detected by the at least one building component detection sensor device relates to sound, vibration, or light emitted from the at least one building component detection sensor device and reflected off of the at least one building component;

autonomously adjusting, via the maneuverable building detection device, the position of attachment of the maneuverable building detection device along the wall, the ceiling, or the floor of the building relative to the at least one building component using the plurality of surface-attachable wheels of the maneuverable building detection device based at least in part on the data detected by the at least one building component detection sensor device; and

automatically determining, using a building insurance determination system, insurance rates and/or insurance coverage for the building based at least in part on the one or more properties of the at least one building component determined by the building component property determination system.

13. The method of claim **12**, comprising automatically determining, using the building component property determination system, the one or more properties of the at least one building component based at least in part on relative positioning of the at least one building component detection sensor device and the at least one building component.

14. The method of claim **12**, comprising automatically determining, using the building component property determination system, the one or more properties of the at least one building component based at least in part on a layout of at least a portion of the building.

15. The method of claim **12**, comprising maneuvering the maneuverable building detection device along the wall, the ceiling, or the floor of the building based at least in part on control signals received from a remote control device.

16. The method of claim **12**, wherein the at least one building component detection sensor device comprises a sound detection sensor device, a vibration detection sensor device, a light detection sensor device, a temperature detection sensor device, a pressure detection sensor device, a humidity detection sensor device, a moisture detection sensor device, a camera device, or any combination thereof.

17. The method of claim **12**, comprising taking a sample of the at least one building component using a sampling device of the maneuverable building detection device while the maneuverable building detection device autonomously maneuvers along the wall, the ceiling, or the floor of the

building using the plurality of surface-attachable wheels of the maneuverable building detection device.

18. A system, comprising:

a maneuverable building detection device configured to attach to and autonomously maneuver along a wall, a ceiling, and a floor of a building comprised of a plurality of building components using a plurality of surface-attachable wheels of the maneuverable building detection device, wherein the maneuverable building detection device is coupled to at least one building component detection sensor device configured to detect data relating to at least one building component of the plurality of building components, wherein the maneuverable building detection device is configured to autonomously maneuver itself based at least in part on feedback relating to a position of attachment of the maneuverable building detection device relative to the at least one building component, wherein the position of attachment of the maneuverable building detection device relative to the at least one building component is detected by the at least one building component detection sensor device, and wherein the at least one building component detection sensor device comprises a sound detection sensor device, a vibration detection sensor device, a light detection sensor device, a temperature detection sensor device, a pressure detection sensor device, a humidity detection sensor device, a moisture detection sensor device, a camera device, or any combination thereof,

a building component property determination system configured to automatically determine one or more properties of the at least one building component based at least in part on the data detected by the at least one building component detection sensor device, wherein the data detected by the at least one building component detection sensor device relates to sound, vibration, or light emitted from the at least one building component detection sensor device and reflected off of the at least one building component, and wherein the maneuverable building detection device is configured to autonomously adjust the position of attachment of the maneuverable building detection device along the wall, the ceiling, or the floor of the building relative to the at least one building component using the plurality of surface-attachable wheels of the maneuverable building detection device based at least in part on the data detected by the at least one building component detection sensor device; and

a building insurance determination system configured to automatically determine insurance rates and/or insurance coverage for the building based at least in part on the one or more properties of the at least one building component determined by the building component property determination system.

19. The system of claim **18**, wherein the maneuverable building detection device comprises a sampling device configured to take a sample of the at least one building component while the maneuverable building detection device autonomously maneuvers along the wall, the ceiling, or the floor of the building using the plurality of surface-attachable wheels of the maneuverable building detection device.

* * * * *