

INTERNET OF THINGS (IOT) BASED INTEGRATED DEVICE TO MONITOR AND CONTROL EVENTS IN AN ENVIRONMENT

5 TECHNICAL FIELD

The present subject matter is related, in general to real-time monitoring devices and more particularly, but not exclusively to an Internet of Things (IoT) based integrated device for monitoring and controlling one or more events in an environment.

10 BACKGROUND

Presently, environments like commercial buildings, office space, retail outlets, small shops, medium and high-end residences, unmanned kiosks, telecom towers, Bank ATM locations, Bank branches, Insurance company offices, financial institutions, government offices or jewelry shops are configured with some sort of monitoring devices
15 like smoke sensors, energy meters, door sensors, person movement sensors, surveillance cameras etc. for monitoring various events in these surroundings. At present, alarms and indications are generated locally by the monitoring devices and are not notified to the concerned persons in real-time over a wide area network. For example, in case of a fire event in a retail shop at night when no one is around, the shop owner would be notified
20 about the fire event only after the intensity of the fire has increased or only when the shop owner visits the shop after the fire event has taken place.

Further, almost all monitoring devices that are in existence today are independent in nature and they are deployed independently and connected to a controller through
25 multiple wires or wireless connections. This would increase the number of sensors deployed in a room along with increased number of electric wiring and connections. This in turn would lead to higher cost of ownership, unattractive aesthetics due to many sensors installed in a room, lower reliability due to wiring issues and more complexity. Further, presently there are no means to communicate with these monitoring devices directly
30 without communicating through their respective controllers. Also, none of these monitoring devices can be configured for various applications, thereby limiting their use to specific applications.

Additionally, in cases where the surveillance cameras and image and/or video capturing devices are used for monitoring the environment, the images and videos captured by those devices must be transmitted to edge nodes or cloud servers for analytics and correlation. However, transmitting substantial number of images and videos to these external nodes on a regular basis would consume lot of network resources and thus, is not efficient.

SUMMARY

Disclosed herein is an Internet of Things (IoT) based integrated device to monitor and control one or more events in an environment. The integrated device comprises one or more replaceable sensors to detect the one or more events in the environment. The integrated device also comprises at least one programmable image or video capturing device, interfaced with the one or more replaceable sensors, to capture one or more images and videos of the environment in real-time. Further, the integrated device comprises a processor. The processor is communicatively connected to each of the one or more replaceable sensors and the at least one programmable image or video capturing device. Furthermore, the integrated device comprises a memory that is communicatively coupled to the processor. The memory stores processor-executable instructions, which on execution, causes the processor to receive sensor data and data related to the one or more images and videos related to the one or more events from the one or more replaceable sensors and the at least one programmable image or video capturing device respectively. Upon receiving the data, the processor correlates the sensor data with the data related to the one or more images and videos using one or more correlation rules to validate occurrence of the one or more events. Finally, the processor transmits information related to the one or more events being validated to at least one of an edge node, cloud server or one or more sensor nodes associated with the integrated device or a user device.

Further, the present disclosure discloses a method for monitoring and controlling one or more events in an environment. The method comprises receiving, by a processor of an integrated device, sensor data and data related to the one or more images and videos related to the one or more events from one or more replaceable sensors and at least one programmable image or video capturing device respectively. The one or more replaceable sensors are configured to detect the one or more events in the environment. Also, at least

one programmable image or video capturing device is interfaced with the one or more replaceable sensors and is configured to capture one or more images and videos of the environment in real-time. Upon receiving the data, the method comprises correlating the sensor data with the data related to the one or more images and videos using one or more correlation rules for validating occurrence of the one or more events. Based on the validation of occurrence of the one or more events, the method further comprises transmitting information related to the one or more events being validated to at least one of an edge node, cloud server or one or more sensor nodes associated with the integrated device or one or more user devices.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, explain the disclosed principles. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the figures to reference like features and components. Some embodiments of system and/or methods in accordance with embodiments of the present subject matter are now described, by way of example only, and regarding the accompanying figures, in which:

FIG. 1 shows an exemplary environment comprising an integrated device for monitoring and controlling one or more events in the environment in accordance with some embodiments of the present disclosure;

FIG. 2A shows a functional block diagram of the integrated device in accordance with some embodiments of the present disclosure;

FIG. 2B shows an exemplary view of the integrated device in accordance with some embodiments of the present disclosure; and

FIG. 3 shows a flowchart illustrating a method for monitoring and controlling one or more events in an environment in accordance with some embodiments of the present disclosure.

5

It should be appreciated by those skilled in the art that any block diagrams herein represent conceptual views of illustrative systems embodying the principles of the present subject matter. Similarly, it will be appreciated that any flow charts, flow diagrams, state transition diagrams, pseudo code, and the like represent various processes which may be substantially represented in computer readable medium and executed by a computer or processor, whether such computer or processor is explicitly shown.

10

DETAILED DESCRIPTION

In the present document, the word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any embodiment or implementation of the present subject matter described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments.

15

While the disclosure is susceptible to various modifications and alternative forms, specific embodiment thereof has been shown by way of example in the drawings and will be described in detail below. It should be understood, however that it is not intended to limit the disclosure to the specific forms disclosed, but on the contrary, the disclosure is to cover all modifications, equivalents, and alternative falling within the scope of the disclosure.

20

The terms "comprises", "comprising", "includes", or any other variations thereof, are intended to cover a non-exclusive inclusion, such that a setup, device or method that comprises a list of components or steps does not include only those components or steps but may include other components or steps not expressly listed or inherent to such setup or device or method. In other words, one or more elements in a system or apparatus preceded by "comprises... a" does not, without more constraints, preclude the existence of other elements or additional elements in the system or method.

25

30

The present disclosure is related to an integrated device, which is an IoT sensor that integrates the functionality of a controller and various event monitoring sensors such as programmable image/video capturing device, a smoke detection sensor, a Passive Infrared (PIR) sensor, an alarm, an air conditioning IR controller, an IR code learner, a
5 Low Power Wireless (LPW) access point, a temperature sensor, a basic Network Video Recorder (NVR), a humidity sensor, a light level detection sensor, a noise detection sensor, a microphone and a speaker, and other similar sensors in a single unit.

In an embodiment, the integrated device can integrate each of the above event monitoring sensors into a single sensor assembly, which is controlled by a controller,
10 using a configurable logic. The programmable image/video capturing device may be made smart by integrating various image analytics functions on the programmable image/video capturing device. Further, each communication interface, controller functionality, sensors and actuators are integrated into the integrated device, thereby reducing cost of ownership and deployment, improving reliability, enabling easy installation, and commissioning of
15 sensors, and tremendously improving aesthetics of the environment.

The present disclosure discloses concept of integrating at least one programmable image/video capturing device with the sensor assembly so that the programmable image/video capturing device can act like a door sensor, smoke sensor, fire sensor, occupancy sensor and other similar sensors, in addition to capturing images and/or
20 recording videos of the environment. This provides proof and improves reliability of performance of the sensor assembly since the events detected by the event monitoring sensors can be cross-verified based on the images and/or videos recorded by the programmable image/video capturing device. For example, even if the smoke sensor fails to detect presence of smoke in the environment, the programmable image/video capturing
25 device may detect the presence of smoke based on image analytics configured in the programmable image/video capturing device.

In the following detailed description of the embodiments of the disclosure, reference is made to the accompanying drawings that form a part hereof, and which are shown by way of illustration specific embodiments in which the disclosure may be
30 practiced. These embodiments are described in sufficient detail to enable those skilled in

the art to practice the disclosure, and it is to be understood that other embodiments may be utilized and that changes may be made without departing from the scope of the present disclosure. The following description is, therefore, not to be taken in a limiting sense.

FIG. 1 shows an exemplary environment **100** comprising an integrated device **101** for monitoring and controlling one or more events in the environment **100** in accordance with some embodiments of the present disclosure.

In an embodiment, the environment **100** may be any user surroundings such as a commercial building, an office space, a retail outlet, small shops, medium and high-end residences, unmanned kiosks, telecom towers, Bank ATMs, Insurance company offices, financial institutions, government offices, jewelry shops, and the like, which require continuous surveillance/monitoring. In an implementation, the integrated device **101** comprises one or more replaceable sensors **103** for monitoring and controlling one or more events occurring in the environment **100**. As an example, the one or more events that may occur in the environment **100** may include, without limiting to, occurrence of fire/smoke in the environment **100**, theft, burglary, or intrusion in the environment **100** or any unexpected variations in normal conditions of the environment **100**. Further, the one or more replaceable sensors **103** may include, without limiting to, a smoke detection sensor, a fire detection sensor, a Passive Infrared (PIR) sensor, air condition controlling module, a temperature sensor, a humidity sensor, a noise sensor, a door sensor, an occupancy detection sensor, a light sensor, or a motion sensor.

In an embodiment, each of the one or more replaceable sensors **103** may be communicatively connected to a processor **109** in the integrated device **101** for receiving one or more instructions from the processor **109** and to transmit sensor data **104** to the processor **109**. In some implementations, the one or more replaceable sensors **103** may be dynamically detached and/or replaced from the integrated device **101** based on the application of monitoring and nature of the environment **100**. Similarly, a user may dynamically attach/add and interface one or more new sensors with the already existing one or more replaceable sensors **103** in the integrated device **101** based on the requirement of monitoring and nature of the environment **100**.

Further, the integrated device **101** comprises at least one programmable image/video capturing device **105** for capturing one or more images and videos of the one environment **100**. As the name indicates, the at least one programmable image/video capturing device **105** may be programmed to perform one or more predetermined operations. As an example, the programmable image/video capturing device **105** may be configured to perform image analytics of the one or more images of the environment **100** for detecting occurrence of one or more events in the environment **100**. An advantage of integrating the programmable image/video capturing device **105** within the integrated device **101** is that, each of the one or more captured images and videos of the environment **100** may be processed and analyzed locally in the integrated device **101** itself, thereby eliminating the need for transmitting the one or more captured images and videos to a computing platform such as a server. Thus, performing image analytics locally in the integrated device **101** results in reduced cost and enhanced speed of operations.

In some implementations, the one or more replaceable sensors **103** and the at least one programmable image/video capturing device **105** may be interfaced such that, the at least one programmable image/video capturing device **105** are activated to capture the one or more images and videos of the environment **100** upon detection of the one or more events by the one or more replaceable sensors **103**. Alternatively, the at least one programmable image/video capturing device **105** may trigger the one or more replaceable sensors **103** to capture sensor data **104** related to the one or more events upon capturing the one or more images and videos of the one or more events.

In an embodiment, the processor **109** is associated with a co-processor **107**. The co-processor **107** may be responsible for receiving the sensor data **104** from each of the one or more replaceable sensors **103**. In an embodiment, the co-processor **107** may analyze the received sensor data **104** and compare values of the received sensor data **104** with a set of predetermined values to determine if there are any deviation in the values of the received sensor data **104**.

Further, the co-processor **107** may be responsible for generating a suitable alarm and/or a notification to the users upon determining the deviation in the sensor data **104**. As an example, suppose a temperature sensor in the integrated device **101** which is deployed

in the environment **100** would continuously monitor the temperature of the environment **100** and transmit minute-by-minute recorded temperature data to the co-processor **107**. Subsequently, the co-processor **107** would compare the received temperature data with the predetermined temperature value to determine the deviation in the temperature of the environment **100**. Suppose, the predetermined temperature value is 30° Celsius. Here, if the recorded temperature value is more than the predetermined temperature value, say 31° Celsius, then the co-processor **107** would detect a deviation in the temperature value and would raise an alarm/siren through the speaker **213** or transmit a notification to the user for indicating the possibility of fire, smoke, or air conditioner failure or extreme heat in the environment **100**. A correlated image/video would show that there is no fire or smoke and it is only an air conditioner failure.

In an embodiment, the processor **109** may be responsible for coordinating each of the one or more replaceable sensors **103**, the co-processor **107**, the at least one programmable image/video/audio capturing device **105** and other components in the integrated device **101**. In some implementation, the processor **109** may be used to re-configure or program the at least one programmable image/video capturing device **105** as per the required application of monitoring.

As an example, suppose, initially the at least one programmable image/video capturing device **105** was configured with image analytics instructions that can detect occurrence of fire in the environment **100** by comparing the captured images and videos of the environment **100** with predetermined images of the environment **100**. Subsequently, if the at least one programmable image/video capturing device **105** must be additionally configured for detecting an intrusion into the environment **100**, then image analytics instructions that are necessary for intrusion detection may be programmed or configured onto the at least one programmable image/video capturing device **105** through at least one of an edge node **115A**, a cloud server **115B**, one or more user devices **115C** or one or more sensor nodes associated with the integrated device **101** using the processor **109**. As an example, the edge node **115A** may include, without limiting to, an embedded edge/gateway node. The one or more user devices **115C** may include, without limiting to, a personal computer, a laptop and/or a smartphone associated with the user. In an implementation, the user may flexibly modify the image capturing device **101** to monitor

occurrence of one or more events of interest to the user by modifying the configurations of the at least one programmable image/video capturing device **105** through a mobile application running on the smartphone or any other user devices **115C** associated with the user.

5

Additionally, the processor **109** may be responsible for correlating the sensor data **104** with data related to the one or more images and videos **106** for verifying and validating the occurrence of any event in the environment **100**. Suppose, there is an event of 'Fire' in the environment **100**. Here, the sensor data **104**, which is obtained by the temperature sensor in the integrated device **101** deployed in the environment **100** would indicate a high range of temperature values.

Similarly, the one or more images and videos captured by the at least one programmable image/video capturing device **105** would indicate the occurrence of fire in the environment **100**. Here, the processor **109** may correlate the sensor data **104** obtained from the temperature sensor with the data related to the one or more images and videos **106** received from the at least one programmable image/video capturing device **105** for validating the occurrence of fire in the environment **100**. By correlating the sensor data **104** and the data related to the one or more images and videos **106**, the processor **109** enhances the accuracy of surveillance/monitoring of the environment **100** and eliminates chances of false alarms or notifications provided to the users.

In an embodiment, the communication unit **113** may be responsible for transmitting event information **111** related to an event which has occurred in the environment **100** to at least one of the edge node **115A**, the cloud server **115B** or the one or more user devices **115C** for further analysis and storage of the event information **111**. The event information **111** includes the information related to the one or more events such as, name of the event occurred, total time elapsed after the occurrence of the event and the like. It is also possible that even when there is no external event, a periodic message (once in every 30 minutes) containing the sensor data **104** and the data related to the one or more images/videos **106** could be sent to one or more edge nodes **115A**, the cloud server **115B**, or the one or more user devices **115C**. As an example, the communication unit **113** may include a wired network interface such as, an ethernet LAN or a gateway interface, and one or more wireless network interfaces, such as Wi-Fi and/or Wi-Fi hotspot interface,

30

Bluetooth interface, Infrared interface, an application specific low-power wireless interface, and one of a 2G, 3G, 4G or any other compatible versions of wireless two-way communication interfaces. In some implementations, the communication unit **113** may also be used for transmitting one or more instructions and/or configuration details to the processor **109** from the edge node **115A**, the cloud server **115B**, the one or more user devices **115C** or one or more sensor nodes associated with the integrated device **101**.

In an implementation, the transmission of data and/or instructions between the processor **109**, the edge node **115A**, the cloud server **115B**, the one or more user devices **115C**, or the one or more sensor nodes associated with the integrated device **101** may be secured by an application specific secure packet service or standard Hyper Text Transfer Protocol Secure (HTTPS) protocol or any other security mechanism. The packet structure of the data and/or instructions may be determined based on open standards so that the integrated device **101** may be connected to an IoT gateway, a cloud application or any other third-party cloud applications and software.

In an embodiment, the notification unit **112** may be responsible for notifying the occurrence of the one or more events to a user associated with the integrated device **101** or to one or more persons concerned with the environment **100**. The notification unit **112** may include, without limiting to, an alarm/siren, one or more Light Emitting Diodes (LED) indicators **211** and a speaker **213**.

In some implementations, the integrated device **101** may be configured such that, the integrated device **101** acts as an IoT gateway as well. In such a scenario, in addition to monitoring of the environment **100**, the integrated device **101** may also function as an IoT gateway by combining sensor data **104** and data related to the one or more images and videos **106** from each of the one or more replaceable sensors **103** and the programmable image/video capturing device **105** and then directly communicating the collected data with the cloud server **115B**. It is also possible for authorized external sensors (not present physically on the integrated device) to communicate to the cloud servers through the IoT gateway on the integrated device **101** in a secure manner.

FIG. 2A shows a functional block diagram of the integrated device **101** in accordance with some embodiments of the present disclosure.

As indicated in **FIG. 2A** each of the one or more replaceable sensors **103** are
5 communicatively connected to the co-processor **107**. The co-processor **107** receives the
sensor data **104** from the one or more replaceable sensors **103** and processes the received
sensor data **104** for determining the occurrence of the one or more events in the
environment **100**. Further, the co-processor **107** communicates the processed sensor data
10 **104** to the processor **109** for correlating the sensor data **104** with the data related to the one
or more images and videos **106**, thereby validating the occurrence of the one or more
events.

In an embodiment, the one or more images and videos captured by the at least one
programmable image/video capturing device **105** may be processed by an image/video
15 processor **204**, which converts the one or more images into digital information format of
the data related to the one or more images and videos **106**. The data related to the one or
more images and videos **106**, which is in the form of digital information, is received by the
processor **109** and is correlated with the sensor data **104** for validating the occurrence of
the one or more events.

20 In an embodiment, the integrated device **101** may be configured with an audio
recorder **205**, such as a microphone, for capturing and recording one or more sounds in the
environment **100** to determine occurrence of the one or more events. Further, the one or
more sounds recorded by the audio recorder **205** are processed by an audio processor **207**.
25 The audio processor **207** converts the one or more recorded sounds into a digital format,
which is subsequently transmitted to the processor **109** for determining occurrence of the
one or more events. Further, the integrated device **101** may be configured with a video
recorder for recording the one or more images and videos of the environment **100** and to
subsequently transmit the recorded one or more images and videos to the processor **109**
30 for further analysis and processing.

In an embodiment, the integrated device **101** may be configured with an Infrared
(IR) controller **202**. The IR controller **202** may be interfaced with the replaceable sensors

103 and the at least one programmable image/video capturing device **105** to operate and control one or more electronic devices, such as Televisions, Air conditioners and the like, present in the environment **100**. For example, consider that the integrated device **101** is deployed in living room of the user. Suppose, the living room includes a Television (TV) and the user switches it on as soon as the user enters the living room. Later, the user may move out of the living room, without switching off the TV. However, the integrated device **101** would determine absence of the user in the living room based on the one or more images/videos captured by the at least one programmable image/video capturing device **105**. Subsequently, the co-processor **107** in the integrated device **101** transmits a signal to the IR controller **202**, indicating the absence of user in the living room. As a result, the IR controller **202** would automatically switch the TV off.

Thus, the integrated device **101**, in addition to monitoring the one or more events in the environment **100**, may also be used to operate and control one or more other devices in the environment **100** using the IR controller **202**. Further, the integrated device **101** may be interfaced with a gateway network or a wireless communication interface to establish wireless connectivity with the one or more devices in the environment **100** and to control the operation of the one or more devices.

In an embodiment, the notification unit **112** may be responsible for notifying the occurrence of the one or more events to a user of the integrated device **101** or to one or more persons concerned with the environment **100**. The notification unit **112** may include, without limiting to, an alarm/siren, one or more Light Emitting Diodes (LED) indicators **211** and a speaker **213**. In an implementation, the integrated device **101** may be equipped with a set of multi-color LED indicators **211**, such that each LED indicator **211** is associated with one or more events, so that the occurrence of the one or more events may be easily identified based on the color of the LED indicator **211** being lit. In an embodiment, the integrated device **101** may use the alarm and/or the speaker **213** to announce the occurrence of the one or more events to the user. In some implementations, the notification unit **112**, through the communication unit **113**, may transmit a suitable message to one or more user devices associated with the user for instantly notifying the user about the occurrence of the one or more events, so that the user is notified about the occurrence of the event even when the user is not present near the environment **100**.

In an embodiment, the communication unit **113** may be responsible for exchanging data and/or instructions between the integrated device **101** and the edge node **115A**, the cloud server **115B**, the one or more user devices **115C** or one or more sensor nodes associated with the integrated device **101**. As an example, the communication unit **113** may include a wired network interface such as, an ethernet LAN or a gateway interface, and one or more wireless network interfaces, such as Wi-Fi and/or Wi-Fi hotspot interface, Bluetooth interface, Infrared interface, an application specific low-power wireless interface, and one of a 2G, 3G, 4G or any other compatible versions of wireless two-way communication interfaces.

In an embodiment, each of the one or more replaceable sensors **103**, the at least one programmable image/video capturing device **105**, the co-processor **107**, the processor **109**, the notification unit **112**, the communication unit **113**, and other components of the integrated device **101** are powered by a power source **201**. In an implementation, the power source **201** may be configured to appropriately distribute required amount of power to each component of the integrated device **101**. As an example, the power source **201** may include, without limiting to, an Alternate Current (A/C) power supply, a Direct Current (DC) power supply, a rechargeable battery, a solar based rechargeable battery, and the like. Further, the power source **201** may be configured to monitor and manage various cut-off parameters such as an over charging cut-off value during charge, an under-voltage cut-off value during discharge, a high temperature cut-off and the like to protect the power source **201** and the integrated device **101** from any electrical damage.

As per embodiments of the present disclosure, the at least one programmable image/video capturing device **105** in the integrated device **101** may be programmed in such a manner that, the image analytics, which is required to be performed on the one or more images of the environment **100** for detecting occurrence of the one or more events, is performed locally on the programmable image/video capturing device **105** itself. By performing the required image analytics locally on the programmable image/video capturing device **105**, the integrated device **101** would reduce amount of bandwidth and other network resources that are required to transmit the one or more captured images and videos to central locations, such as the edge node **115A**, the cloud server **115B**, the one or

more user devices **115C** or the one or more sensor nodes associated with the integrated device **101**, for performing image analytics on the one or more captured images and videos.

5 Further, the programmable image/video capturing device **105**, in contrary to continuous monitoring of the environment **100**, may be programmed to detect and capture the one or more images and videos of the environment **100** only during occurrence of one or more events that are related to a specific application of monitoring. For example, consider the integrated device **101** which is configured in premises of a school for
10 monitoring behaviour and movement of each student in the school. Here, the programmable image/video capturing device **105** in the integrated device **101** may be customized to capture one or more images and videos of the school environment only during operating hours of the school, and to remain in a sleep mode during non-operating hours of the school. The above customization would reduce number of images and videos
15 being captured by the programmable image/video capturing device **105**, thereby reducing storage space required for storing the one or more captured images and videos and, also reducing amount of image analytics required to be performed.

In the above example, in addition to the programmable image/video capturing
20 device **105**, one or more replaceable sensors **103** may be configured in the school environment for enhancing accuracy of monitoring of the school environment. Here, the programmable image/video capturing device **105** may be interfaced with the one or more replaceable sensors **103** and may be configured to capture the one or more images and videos of the school environment in response to detection of an event by the one or more
25 replaceable sensors **103**. In other words, the one or more replaceable sensors **103** would initiate the programmable image/video capturing device **105** to capture images and videos of the school environment based on detection of an event in the school environment.

FIG. 2B shows a perspective view of the integrated device **101** in accordance with
30 some embodiments of the present disclosure.

In some embodiments, the integrated device **101** may be designed in various physical configurations based on various chipset manufacturer platforms. Following are

some of the physical configurations and/or forms in which the integrated device **101** may be deployed in an environment **100**:

- Roof mounted integrated device **101** (as shown in the **FIG. 2B**)
- 5 ○ Wall mounted integrated device **101**
- Wall mounted integrated device **101** having additional sensors for monitoring indoor air quality.
- Pole mounted integrated device **101** for outdoor applications like management of smart cities, traffic management and telecom service.
- 10 ○ Solar powered integrated device **101** for remote, unmanned locations like remote traffic signals, agricultural fields for crop management and the like.
- Specially engineered, application specific integrated device **101**.

FIG. 2B shows a bottom view of a roof mounted integrated device **101**. The one or
15 more replaceable sensors **103** are integrated together into a single assembly of sensors, which are internally connected to the co-processor **107** and the processor **109** (not seen in **FIG. 2B**). The at least one programmable image/video capturing device **105** may be configured on either side of the integrated device **101**, such that maximum region of the environment **100** is under the coverage of the at least one programmable image/video
20 capturing device **105**. The multi-color LED indicators **211** may be configured on the outer surface of the integrated device **101**, such that the LED indicators **211** are clearly visible when they are lighted up due to occurrence of an event in the environment **100**. The representation of the integrated device **101** in **FIG. 2B** is not definitive and the actual structure/configuration of the integrated device **101** may be modified based on
25 convenience, number, and type of replaceable sensors **103**, application of surveillance/monitoring, nature of the environment **100** and other factors.

FIG. 3 shows a flowchart illustrating a method for monitoring and controlling one or more events in an environment **100** in accordance with some embodiments of the
30 present disclosure.

As illustrated in **FIG. 3**, the method **300** includes one or more blocks illustrating a method for monitoring and controlling one or more events in an environment **100** using an integrated device **101**. The method **300** may be described in the general context of computer executable instructions. Generally, computer executable instructions can include
5 routines, programs, objects, components, data structures, procedures, modules, and functions, which perform specific functions or implement specific abstract data types.

The order in which the method **300** is described is not intended to be construed as a limitation, and any number of the described method blocks can be combined in any order
10 to implement the method. Additionally, individual blocks may be deleted from the methods without departing from the spirit and scope of the subject matter described herein. Furthermore, the method can be implemented in any suitable hardware, software, firmware, or combination thereof.

At block **301**, the method **300** includes receiving, by a processor **109** of the integrated device **101**, sensor data **104** and data related to the one or more images and videos **106** related to the one or more events from the one or more replaceable sensors **103**
15 and the at least one programmable image/video capturing device **105** respectively. The one or more replaceable sensors **103** may be configured for detecting the one or more events in the environment **100**. As an example, the one or more replaceable sensors **103** may include, without limiting to, a smoke detection sensor, a fire detection sensor, a Passive Infrared (PIR) sensor, air condition controlling module, a temperature sensor, a humidity sensor, a noise sensor, a door sensor, an occupancy detection sensor, a light sensor, or a motion sensor. In an embodiment, at least one programmable image/video capturing
20 device **105** may be interfaced with the one or more replaceable sensors **103** and may be configured to capture one or more images and videos of the environment **100** in real-time.

In an implementation, the one or more replaceable sensors **103** and the at least one programmable image/video capturing device **105** may be interfaced such that, the at least
30 one programmable image/video capturing device **105** are activated to capture the one or more images and videos of the environment **100** upon detection of the one or more events by the one or more replaceable sensors **103**. Further, the at least one programmable image/video capturing device **105** may trigger the one or more replaceable sensors **103** to

capture sensor data **104** related to the one or more events upon capturing the one or more images and videos of the one or more events.

In an embodiment, the occurrence of the one or more events may be validated
5 using the data related to the one or more images and videos **106**. The at least one programmable image/video capturing device **105** may be configured to continuously monitor and capture one or more images and videos of an environment **100**, in which the integrated device **101** is deployed. Suppose, a 'Fire' event has occurred in the environment **100**. Here, the integrated device **101** would detect occurrence of the 'Fire' event in the
10 environment **100** by performing image analytics on the one or more images and/or videos of the environment **100**. Thus, the integrated device **101** can detect and validate occurrence of the one or more events based on the one or more images of the environment **100**.

At block **303**, the method **300** includes correlating, by the processor **109**, the
15 sensor data **104** with the data related to the one or more images and videos **106** using one or more correlation rules to validate occurrence of the one or more events. In some embodiments, the one or more correlation rules are one or more preconfigured correlation rules obtained from the edge node **115A**, the cloud server **115B** or through the
20 one or more user devices **115C**. In other embodiments, the one or more correlation rules are one or more dynamic correlation rules obtained in real-time based on self-learning from historical correlation data.

For example, a smoke sensor in the integrated device **101** may be configured with
25 a preconfigured correlation rule to detect and verify the occurrence of smoke or fire in the environment **100**. Initially, the smoke sensor may detect the presence of smoke and notify the co-processor **107** about presence of smoke in the environment **100**. Subsequently, the co-processor **107** may use the preconfigured correlation rule to verify presence of smoke in the environment **100** based on the one or more images/videos of the environment **100**,
30 captured in real-time, by the at least one programmable image/video capturing device **105**. Suppose, the one or more images/videos show the presence of smoke in the environment **100**, then the occurrence of smoke in the environment **100** is verified and confirmed. Alternatively, if the one or more images/videos show presence of fire, then the occurrence

of fire is confirmed in the environment **100**. In each of the above circumstances, i.e. occurrence of smoke or fire, the co-processor **107** may produce an alarm/notification to the user through the processor **109**.

5 On the other hand, if the one or more images/videos does not show signs of both smoke and fire in the environment, then the co-processor **107** treats the detection of smoke in the environment **100** to be a false event. The embodiments of the above example are not limited to combination of the smoke sensor and the programmable image/video capturing device **105**. Instead, the programmable image/video capturing device **105** may be
10 interfaced with any other replaceable sensor **103** in the integrated device **101** to verify and confirm the occurrence of various events in the environment **100**. Hence, the above arrangement helps in reducing and/or eliminating false alarms or notifications related to occurrence of events in the environment **100**.

15 In an implementation, the processor **109** further comprises notifying the occurrence of the one or more events to a user associated with the environment **100** through one or more user devices associated with the user, using a notification unit **112** associated with the integrated device **101**. As an example, the notification unit **112** may include, without limiting to, at least one of one or more programmable Light Emitting Diode (LED)
20 indicators **211**, an alarm or a speaker **213**.

 At block **305**, the method **300** includes transmitting, by the processor **109**, information related to the one or more events being validated to at least one of an edge node **115A**, cloud server **115B**, the one or more user devices **115C** or one or more sensor
25 nodes associated with the integrated device **101**. Additionally, the integrated device **101** may be configured to transmit the event information **111** to one or more users of the integrated device **101** and/or to one or more persons concerned with the environment **100**.

 In an embodiment, each of the one or more replaceable sensors **103** may be
30 interfaced with the processor **109** and a memory configured in the integrated device **101** using a co-processor **107** communicatively coupled to the processor **109** and each of the one or more replaceable sensors **103**. The co-processor **107** may be responsible for interfacing each of the one or more replaceable sensors **103** with the processor and the

memory, and to analyze digital information obtained from a signal processing unit for detecting the occurrence of the one or more events. The signal processing unit may be configured for processing the sensor data **104** and the data related to the one or more images and videos **106** before transmitting the sensor data **104** and the data related to the one or more images and videos **106** to the co-processor **107**.

In an embodiment, the information related to the one or more events may be transmitted to at least one of the edge node **115A**, the cloud server **115B**, the one or more sensor nodes associated with the integrated device **101** or one or more user devices **115C** associated with the user using a communication unit **113** configured in the integrated device **101**. Further, the integrated device **101** may comprise a data recorder, which may be configured to record and store the sensor data **104** and the data related to the one or more images and videos **106** on a memory of the integrated device **101** when there are no communication interfaces available in the environment **100** for transmitting the recorded data to the cloud server **115B**. The data stored on the data recorder may be transmitted to the cloud server **115B** as soon as the communication interface are available in the environment **100**. The data may be stored for backup purposes as well even when the communication interfaces are available.

In an implementation, the recorded data may be transmitted between the at least one of the edge node **115A**, the cloud server **115B**, the one or more user devices **115C** or the one or more sensor nodes associated with the integrated device **101**, and each of the one or more replaceable sensors **103** using a low power wireless transceiver configured in the integrated device **101**.

In an embodiment, the processor **109** in the integrated device **101** may be further configured to record audio information in the environment **100** using an audio recorder **205** configured in the integrated device **101**. In some implementations, the integrated device **101** may be powered using a power source **201**. As an example, the power source **201** may include, without limiting to, at least one of a rechargeable battery, a power generator, or a replaceable battery.

In some implorations, the integrated device **101** may be deployed in one or more forms selected from at least one of a roof mounted form, wall mounted form, or a pole mounted form in at least one of an indoor environment or an outdoor environment. In other implementations, the integrated device **101** may be configured as an Internet of Things (IoT) gateway to combine and transmit the sensor data **104** and the data related to the one or more images and videos **106** to the cloud server **115B**. Hence, the integrated device **101**, as an IoT gateway, facilitates the one or more detached sensors and the one or more detached programmable image/video capturing device **105** to transmit the sensor data **104** and the data related to the one or more images and videos **106** to the cloud server **115B**.

System architecture:

In an implementation, the processor **109** may include at least one data processor for executing program components consistent with the present disclosure. The processor **109** may also include specialized processing units such as integrated system (bus) controllers, memory management control units, floating point units, graphics processing units, digital signal processing units, and the like, which are necessary within the scope of the present disclosure.

Also, the processor **109** may be disposed in communication with one or more user devices via an I/O interface associated with the communication unit **113**. The I/O interface may employ communication protocols/methods such as, without limitation, audio, analog, digital, stereo, IEEE-1394, serial bus, Universal Serial Bus (USB), infrared, PS/2, BNC, coaxial, component, composite, Digital Visual Interface (DVI), high-definition multimedia interface (HDMI), Radio Frequency (RF) antennas, S-Video, Video Graphics Array (VGA), IEEE 802.n /b/g/n/x, Bluetooth, cellular (e.g., Code-Division Multiple Access (CDMA), High-Speed Packet Access (HSPA+), Global System For Mobile Communications (GSM), Long-Term Evolution (LTE) or the like.

The communication unit **113** may employ connection protocols including, without limitation, direct connect, Ethernet (e.g., twisted pair 10/100/1000 Base T), Transmission Control Protocol/Internet Protocol (TCP/IP), token ring, IEEE 802.11a/b/g/n/x, and the like. In an implementation, using the communication unit **113**, the integrated device **101**

may communicate with at least one of an edge node **115A**, a cloud server **115B**, the one or more user devices **115C** or one or more sensor nodes associated with the integrated device **101** for transmitting information related to the one or more events being validated in the environment **100**.

- 5 In some embodiments, the processor **109** may be disposed in communication with a memory (e.g., a RAM, or a ROM, via a storage interface. The storage interface may connect to the memory by employing connection protocols such as Serial Advanced Technology Attachment (SATA), Integrated Drive Electronics (IDE), IEEE-1394, Universal Serial Bus (USB), fiber channel, Small Computer Systems Interface (SCSI), etc.
- 10 The memory drives may further include a drum, magnetic disc drive, magneto-optical drive, optical drive, Redundant Array of Independent Discs (RAID), solid-state memory devices, solid-state drives, and the like.

- Furthermore, one or more computer-readable storage media may be utilized in implementing embodiments consistent with the present invention. A computer-readable
- 15 storage medium refers to any type of physical memory on which information or data readable by the processor **109** or the co-processor **107** may be stored. Thus, a computer-readable storage medium may store instructions for execution by one or more processors, including instructions for causing the processor(s) to perform steps or stages consistent with the embodiments described herein. The term “computer-readable medium” should be
- 20 understood to include tangible items and exclude carrier waves and transient signals, i.e., non-transitory.

Advantages of the embodiment of the present disclosure are illustrated herein.

- In an embodiment, the present disclosure discloses an Internet of Things (IoT) based integrated device for real-time monitoring of one or more events occurring in an
- 25 environment.

- In an embodiment, the integrated device of the instant disclosure integrates a programmable image/video capturing device with the one or more sensors, thereby providing a proof for the actual event detected by the sensors. Hence, the integrated device
- 30 enhances the quality of sensor data, improves reliability, and provides better value to the users.

In an embodiment, the programmable image/video capturing device used in the integrated device can be locally configured to perform analytics of images of the environment to detect occurrence of events, thereby eliminating need for transmitting the captured images and videos to cloud server, edge nodes or one or more sensor nodes associated with the integrated device for analytics.

In an embodiment, the integrated device of the present disclosure allows users to easily add and/or remove any sensor unit from a design perspective of the integrated device, whenever a required monitoring application must be met.

In an embodiment, the integrated device of the present disclosure integrates various sensors, so that correlation of data between the sensors is easier and automatic actions can be taken easily. The correlation between the sensors helps in reducing false alarms.

In an embodiment, the integrated device of the present disclosure eliminates/reduces electric wiring between the sensors, thereby improving ease of installation and commissioning of the device, increasing reliability of surveillance/monitoring of an environment, and reducing the electrical wiring, and maintenance costs for the users.

The terms "an embodiment", "embodiment", "embodiments", "the embodiment", "the embodiments", "one or more embodiments", "some embodiments", and "one embodiment" mean "one or more (but not all) embodiments of the invention(s)" unless expressly specified otherwise.

The terms "including", "comprising", "having" and variations thereof mean "including but not limited to", unless expressly specified otherwise.

The enumerated listing of items does not imply that any or all the items are mutually exclusive, unless expressly specified otherwise.

The terms "a", "an" and "the" mean "one or more", unless expressly specified otherwise. A description of an embodiment with several components in communication

with each other does not imply that all such components are required. On the contrary, a variety of optional components are described to illustrate the wide variety of possible embodiments of the invention.

5 When a single device or article is described herein, it will be readily apparent that more than one device/article (whether or not they cooperate) may be used in place of a single device/article. Similarly, where more than one device or article is described herein (whether or not they cooperate), it will be readily apparent that a single device/article may be used in place of the more than one device or article or a different number of
10 devices/articles may be used instead of the shown number of devices or programs. The functionality and/or the features of a device may be alternatively embodied by one or more other devices which are not explicitly described as having such functionality/features. Thus, other embodiments of the invention need not include the device itself.

15 Finally, the language used in the specification has been principally selected for readability and instructional purposes, and it may not have been selected to delineate or circumscribe the inventive subject matter. It is therefore intended that the scope of the invention be limited not by this detailed description, but rather by any claims that issue on an application based here on. Accordingly, the embodiments of the present invention are
20 intended to be illustrative, but not limiting, of the scope of the invention, which is set forth in the following claims.

 While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and
25 embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

5

Referral Numerals:

Reference Number	Description
100	Environment
101	Integrated device
103	Replaceable sensors
104	Sensor data
105	Programmable image/video capturing device
106	Data related to images and videos
107	Co-processor
109	Processor
111	Event information
112	Notification unit
113	Communication unit
115A	Edge node
115B	Cloud server
115C	User devices
201	Power source
202	IR controller
203	Video recorder
204	Image/Video processor
205	Audio recorder
207	Audio processor
211	LED indicators
213	Speaker