FORM 2
THE PATENTS ACT 1970
(39 of 1970)
&
The Patents [Amendment] Rules, 2006
COMPLETE SPECIFICATION

(See section 10 and rule 13)

1. TITLE OF THE INVENTION

A Method And A System For Monitoring Spread Of Transmissible Diseases

2. APPLICANT

NAME : National Institute of Technology, Kurukshetra

NATIONALITY : IN

ADDRESS : National Institute of Technology Kurukshetra, Kurukshetra - 136119, Haryana, India

3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is to be performed:

FIELD OF THE INVENTION

The present disclosure relates to a method and a system for monitoring spread of transmissible diseases.

BACKGROUND

Disease outbreaks are a major concern for many in today's social landscape. Specifically, outbreaks due to transmissible disease are difficult to curtail in highly populated areas. Such outbreaks have a tendency to spread at a rapid rate and become a pandemic which may sustain for years. For instance, initially, coronavirus outbreak affected a small region in one country. However, due to lack of any stipulated guidelines, such outbreaks rapidly reached to other countries and became a pandemic. In order to curtail the spread of any transmissible disease, it is important to identify infected persons and monitor their interaction with other persons in an environment.

Generally, a surveillance system may be deployed at public places such as hospitals, airports, markets, sports arena, and any other crowded place to identify an individual showing symptoms of the disease and monitor individual's movement to prevent the spread of disease to others in such public places. However, such systems fall under the categories of active and passive surveillance and lack in specific capabilities to effectively monitor the spread of the transmissible disease in the environment. The active surveillance system fails to automatically collect data associated with the infected person. Such a system requires human workforce to collect the data of the infected person. Further, the active surveillance system fails to track the movement of the infected person in a real-time. The active surveillance system is embodied as a database management system with a minuscule contribution towards preventing the spread of the transmissible diseases, such as COVID-19 or SARS, in the environment.

Further, the passive surveillance system lacks several features as mentioned below:

- No Unique ID or information regarding the infected and potential infected individual is present. The complete identification of an individual or tracking the individual is to be performed by a responder only.
- An area of the infected zone around a person in which disease can spread, i.e., social distance norms, has not been considered. Therefore, the passive surveillance system fails to monitor the interaction between the persons and fail to consider such interactions while monitoring the environment. Hence, such a system fails to track and monitor a potentially infected person who might inadvertently spread the transmissible disease to other persons in the environment.
- The infected individual cannot be marked independently. However, only the presence of an infected individual in the frame can be detected.

- The system cannot distinguish between head motion during cough and head movement during various other actions such as running, bowing down, sudden jumping.
- No database of potentially infected persons is maintained. Further, a database of infected individuals is maintained only manually which is a cumbersome task.
- While monitoring the environment, the passive surveillance system fails to determine a difference between moving objects with respect to other surrounding objects. This may result in ineffective tracking of each of the persons in the environment.

SUMMARY

This summary is provided to introduce a selection of concepts, in a simplified format, that are further described in the detailed description of the invention. This summary is neither intended to identify key or essential inventive concepts of the invention and nor is it intended for determining the scope of the invention.

In an embodiment, a method for monitoring spread of transmissible diseases is disclosed. The method includes receiving at least one video stream associated with an environment having a plurality of objects from at least one electronic device. Further, the method includes identifying at least one object from among the plurality of objects. The at least one object demonstrates at least one symptom associated with a transmissible disease. The method includes tracking movement of the identified object based on the captured video stream. Further, the method includes monitoring interaction of the identified object with at least another object from among the plurality of objects based on the movement of the identified object.

In another embodiment, a system for monitoring spread of transmissible diseases is disclosed. The system includes at least one processor is configured to receive, from at least one electronic device, at least one video stream associated with an environment having a plurality of objects. Further, the at least one processor is configured to identify at least one object from among the plurality of objects. The at least one object demonstrates at least one symptom associated with a transmissible disease. The at least one processor is configured to track movement of the identified object based on the captured video stream. Further, the at least one processor is configured to monitor interaction of the identified object with at least another object from among the plurality of objects based on the movement of the identified object.

To further clarify advantages and features of the present invention, a more particular description of the invention will be rendered by reference to specific embodiments thereof, which is illustrated in the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope. The invention will be described and explained with additional specificity and detail with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention 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:

Figure 1 illustrates a block diagram of a system for monitoring spread of transmissible disease in an environment, according to an embodiment of the present disclosure;

Figures 2a, 2b, and 2c illustrates an operation of the system to identify at least one object in the environment, according to an embodiment of the present disclosure;

Figures 3a, 3b, and 3c illustrates an operation of the system 100 to determine the location of the at least one object in the environment, according to an embodiment of the present disclosure;

Figure 4 illustrates a flowchart depicting operation of the system 100 to identify a source associated with at least one voice input and to determine a location of the at least one object, according to an embodiment of the present disclosure;

Figure 5 illustrates an operation of the system 100-1 to identify the source associated with at least one voice input in the environment, according to an embodiment of the present disclosure;

Figure 6 illustrates an exemplary three-dimensional map of the environment depicting at least one system 100 for monitoring the spread of transmissible disease in the environment, according to an embodiment of the present disclosure;

Figure 7 illustrates an exemplary operation of the system 100 to categorize at least one object in at least one of a plurality of categories, according to an embodiment of the present disclosure; and

Figure 8 illustrates a flowchart depicting a method 800 for monitoring spread of transmissible diseases in the environment, according to an embodiment of the present disclosure.

Further, skilled artisans will appreciate that elements in the drawings are illustrated for simplicity and may not have been necessarily been drawn to scale. For example, the flow charts illustrate the method in terms of the most prominent steps involved to help to improve understanding of aspects of the present invention. Furthermore, in terms of the construction of the device, one or more components of the device may have been represented in the drawings by conventional symbols, and the drawings may show only those specific details that are pertinent to understanding the embodiments of the present invention so as not to obscure the drawings with details that will be readily apparent to those of ordinary skill in the art having benefit of the description herein.

DETAILED DESCRIPTION OF FIGURES

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated system, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Embodiments of the present invention will be described below in detail with reference to the accompanying drawings.

Figure 1 illustrates a block diagram of a system for monitoring spread of transmissible disease in an environment, according to an embodiment of the present disclosure. In an embodiment, the system 100 may be deployed in the environment to identify and monitor at least one object suffered from a transmissible disease. The system 100 may be configured to monitor the spread of transmissible disease in at least one region within the environment. Referring to Figure 1, in the illustrated embodiment, a plurality of systems 100 may be deployed in the environment to monitor and identify the at least one object suffered from the transmissible disease. The plurality of systems 100 may individually be referred to as the system 100. In an embodiment, the at least one object may be embodied as at least one person, without departing from the scope of the present disclosure. The at least one object may interchangeably be referred to as the at least one person. Further, the at least one person may interchangeably be referred to as the persons, without departing from the scope of the present disclosure.

The plurality of systems 100 may individually be referred to as the system 100-1, the system 100-2, …., and the system 100-n, without departing from the scope of the present disclosure. Further, the plurality of systems 100 may interchangeably be referred to as the systems 100. For the sake of brevity, the present disclosure is explained with respect to only system 100-1 employed for monitoring spread of transmissible disease in at least one region within the environment. However, it should be appreciated by a person skilled in the art that it should not be construed as limiting, and the present disclosure is equally applicable to other systems 100-2, …., and 100-n, without departing from the scope of the present disclosure.

In an embodiment, the plurality of systems 100 may be deployed the environment, such as an outdoor environment including, but not limited to, streets, parks, and markets. Further, the plurality of systems 100 may be deployed in the environment, such as an indoor environment including, but not limited to, hotels, offices, hospitals, apartments, and residences. Each of the plurality of systems 100 may be positioned at a pre-defined distance D’ (as shown in Figure 6) from each other. Further, each of the plurality of systems 100 may be in communication with each other via a network. In an embodiment, the network may be a wired network or a wireless network. The network may include, but is not limited to, a mobile network, a broadband network, a Wide Area Network (WAN), a Local Area Network (LAN), and a Personal Area Network.

In one embodiment, the network connectivity provided to the system 100 may be an optical fibre or wireless GPRS or both. In case an optical fibre is deployed, the system can access internet or network using the optical fibre and act as a PICO cell for 5G signal transmission to local devices, such as electronic devices. In GPRS, the system may transmit data to a server and interact with the server. In case both the optic fibre and wireless GPRS are combined, GPRS can be used as a backup connectivity path from the system to the server.

It should be appreciated by a person skilled in the art that a number of the systems 100 deployed for monitoring spread of the transmissible disease may vary based on a type of environment which is required to be monitored. Referring to Figure 1, each of the systems 100 may be in communication with each other and configured to share information associated with the at least one person suffered from the transmissible disease with each other. Constructional and operational details of the system 100-1 are explained in the subsequent sections of the present disclosure.

In an embodiment, the system 100-1 may include, but is not limited to, at least one electronic device 102, a controlling unit 104 in communication with the at least one electronic device 102, and a plurality of audio sensors 105 in communication with the controlling unit 104. The electronic device 102 may be configured to capture at least one video stream associated with the environment having a plurality of persons. In the illustrated embodiment, the electronic device 102 may include, but is not limited to, a visible light camera 102-1 and an infrared camera 102-2. The visible light camera 102-1 and the infrared camera 102-2 may be configured to capture a first video stream and a second video stream associated with at least one region in the environment.

Further, the controlling unit 106 may include, but is not limited to, a processor 106, memory, module(s) 108, and data 110. The module(s) 108 and the memory are coupled to the processor 106. The processor 106 can be a single processing unit or a number of units, all of which could include multiple computing units. The processor 106 may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, state machines, logic circuitries, and/or any devices that manipulate signals based on operational instructions. Among other capabilities, the processor 106 is configured to fetch and execute computer-readable instructions and data stored in the memory.

The memory may include any non-transitory computer-readable medium known in the art including, for example, volatile memory, such as static random access memory (SRAM) and dynamic random access memory (DRAM), and/or non-volatile memory, such as read-only memory (ROM), erasable programmable ROM, flash memories, hard disks, optical disks, and magnetic tapes.

The module(s) 108, amongst other things, include routines, programs, objects, components, data structures, etc., which perform particular tasks or implement data types. The module(s) 108 may also be implemented as, signal processor(s), state machine(s), logic circuitries, and/or any other device or component that manipulate signals based on operational instructions.

Further, the module(s) 108 may be implemented in hardware, instructions executed by at least one processing unit, for e.g., the processor 106 or by a combination thereof. The processing unit may comprise a computer, a processor, a state machine, a logic array and/or any other suitable devices capable of processing instructions. The processing unit may be a general-purpose processor which executes instructions to cause the general-purpose processor to perform operations or, the processing unit may be dedicated to perform the required functions. In some example embodiments, the module(s) 108 may be machine-readable instructions (software, such as web-application, mobile application, program, etc.) which, when executed by a processor/processing unit, perform any of the described functionalities.

In an implementation, the module(s) 108 may include a data receiving module 110, an image processing module 112, an object tracking module 114, an interaction monitoring module 116, a data transmitting module 118. The data receiving module 110, the image processing module 112, the object tracking module 114, the interaction monitoring module 116, and the data transmitting module 118 are in communication with each other. The data 112 serves, amongst other things, as a repository for storing data processed, received, and generated by one or more of the modules 110.

In an embodiment of the present disclosure, the module(s) 108 may be implemented as part of the processor 106. In another embodiment of the present disclosure, the module(s) 108 may be external to the processor 106. In yet another embodiment of the present disclosure, the module(s) 108 may be part of the memory. In another embodiment of the present disclosure, the module(s) 108 may be part of hardware, separate from the processor 106.

The processor 106 may be configured to receive at least one video stream associated with the environment having the plurality of persons. In an embodiment, the data receiving module 110 may be configured to receive the first video stream and the second video stream from the visible light camera 102-1 and the infrared camera 102-2, respectively. In an embodiment, the visible light camera 102-1 may be configured to capture a spectrum of light belonging in a visible range of electromagnetic spectrum of light, i.e., a wavelength of 400-700 nm or 4*10-7 7*10-7 m. The infrared camera 102-2 may be configured to capture a spectrum of light belonging in a range of infrared light, i.e., 700 nm to 1mm or 7*10-7 to 10-3m.

Further, the data receiving module 110 may be configured to obtain data indicative of a plurality of operational parameters associated with each of the visible light camera 102-1 and the infrared camera 102-2. In an embodiment, the plurality of operational parameters may include, but is not limited to, a focal length, a camera view angle, resolution, and an angle of camera with respect to a reference axis. Further, the processor 106 may be configured to obtain a distance between the visible light camera 102-1 and the infrared camera 102-2 deployed in the system 100.

Figures 2a, 2b, and 2c illustrate an operation of the system 100 to identify at least one object in the environment, according to an embodiment of the present disclosure. Referring to Figure 1 and Figure 2a, the processor 106 may be configured to identify at least one person from among the plurality of persons. The at least one person may demonstrate at least one symptom associated with the transmissible disease. In an embodiment, the at least one symptom may include, but is not limited to, a body temperature, coughing, and sneezing, without departing from the scope of the present disclosure.

The data receiving module 110 may be configured to transmit video streams, such as the first video stream and the second video stream, and data indicative of the plurality of operation parameters to the image processing module 112. Referring to Figure 2a, at block 202, the image processing module 112 may be configured to extract frame from each of the first video stream and the second video stream at a timestamp. For instance, the frame extracted from the first video stream may be referred to as the visible image frame and the frame extracted from the second video stream may be referred to as the infrared image frame. Subsequently, each of the visible image frame and the infrared image frame may be converted to an 8-bit RGB colour model. The RGB colour model associated with the visible image frame may provide RGB values associated with the visible image frame. Similarly, the RGB colour model associated with the infrared image frame may represent values associated with the infrared image frame in the form of the RGB visible image frame.

Further, at block 204, the image processing module 112 may be configured to adjust resolution of one of the visible image frame and the infrared image frame based on the operational parameters of cameras, such as the visible light camera 102-1 and the infrared camera 102-2. For instance, if the resolution of the visible light camera 102-1 is different from the resolution of the infrared camera 102-2, then the image processing module 112 may adjust the resolution of one of the visible image frame and the infrared image frame to the same resolution.

Referring to Figure 2a, the processor 106 may be configured to identify the at least one person demonstrating at least one symptom based on the extracted frames, such as the visible image frame and the infrared image frame. At block 206, the image processing module 112 may be configured to identify static objects, such as non-living entities, and moving objects, such as, persons, captured in the visible image frame and the infrared image frame. In an embodiment, the image processing module 112 may be configured to implement a specific initial image or background subtraction algorithm to identify the static objects and the moving objects. For instance, multiple previous frames may be received from the first video stream and the second video stream for each pixel mode. Subsequently, the image processing module 112 may be configured to compile the multiple previous frames as background and then current frames, i.e., the visible image frame and the infrared image frame, may be subtracted from the background to identify the static objects and the moving objects.

Further, at block 208, the image processing module 112 may be configured to perform image smoothening by removing extra noise from the visible image frame and the infrared image frame. In order to remove the extra noise, the image processing module 112 may be configured to pass the visible image frame and the infrared image frame, through low pass filters including, but not limited to, averaging, bilateral filtering (or smoothening of edges), morphological transformation by erosion followed by dilation (to remove small noise particles), and again dilation followed by erosion (to remove small noise of 0 inside bigger particle).

Referring to Figure 2a, at block 210, the image processing module 112 may be configured to convert the frames, such as the visible image frame and the infrared image frame, into frames with a black and white colour model (digital model) for further processing. Referring to Figure 2a, 2b, and 2c, the image processing module 112 may assign black colour to pixels carrying subtracted portions, i.e., the background and assign white colour to pixels representing the moving objects, i.e., the persons, in the environment. For instance, referring to Figure 2b, the pixels representing the background and the pixels representing the moving objects in the visible image frame may be assigned with pixel value equivalent to 0 and pixel value equivalent to 1 (or 255 in 8-bit system representation). Similarly, referring to Figure 2c, the pixels representing the background and the pixels representing the moving objects in the infrared image frame may be assigned with pixel value equivalent to 0 and pixel value equivalent to 1 (or 255 in 8-bit system representation).

Further, the image processing module 112 may be configured to generate contour around the objects, i.e., the persons in each of the visible image frame and the infrared image frame. The image processing module 112 may transmit the visible image frame and the infrared image frame indicating the plurality of persons to the object tracking module 114.

Figures 3a, 3b, and 3c illustrate an operation of the system 100 to determine the location of the at least one object in the environment, according to an embodiment of the present disclosure. The processor 106 may be configured to determine a location of the identified object based on the extracted frames and the plurality of operational parameters associated with the visual light camera 102-1 and the infrared camera 102-2. In an embodiment, the object tracking module 114 may be configured to determine the location of the identified object, i.e., a person, based on the frames received from the image processing module 112 and the plurality of operation parameters. Initially, the object tracking module 114 may determine a centre of mass of each of the plurality of persons in the frames, i.e., the visible image frame and the infrared image frame. The object tracking module 114 may be configured to represent each of the frames in a coordinate system and assign a left bottom corner of each of the frames as a point of origin O.

Further, the object tracking module 114 may be configured to determine coordinates associated with the centre of mass of each of the plurality of persons in the frames with respect to the point of origin O. For instance, referring to Figure 2b, the object tracking module 114 may assign coordinates, such as (Cx1, Cy1), to the centre of mass of a person P1 from among the plurality of persons in the visible image frame. Similarly, referring to Figure 2c, the object tracking module 114 may assign coordinates, such as (Cx2, Cy2), to the centre of mass of the person P1 in the infrared image frame.

The processor 106 may be configured to determine a distance between the system 100-1 and the person P1 based on the coordinates indicative of centre of mass, the plurality of operational parameters, such as the focal length, and the distance between both the cameras 102. In an embodiment, the object tracking module 114 may be configured to determine a perpendicular distance between the system 100-1 and the person P1 by implementing an equation (1) as mentioned below:

$$D= (B*f)/ (C_{y1}- C_{y2}) \qquad (1)$$

Wherein,

D=Perpendicular distance of the person P1 from the system 100-1

B=Distance between both the cameras, such as the visible light camera and the infrared camera f= Focal length of the cameras

Further, the object tracking module 114 may be configured to adjust a value of the perpendicular distance, if the resolution of the visible light camera 102-1 is different from the resolution of the infrared camera 102-2 by implementing an equation (2) as mentioned below:

$$D' = D*(H1)/(H2) \qquad (2)$$

Wherein,

D'= Adjusted Perpendicular distance of the person P1 from the system 100-1

H1= original height of frame

H2= current height of frame

Referring to Figure 3a, in an embodiment, the object tracking module 114 may be configured to project the coordinates associated with the person P1 on a XZ plane in a three-dimensional coordinate system based on the perpendicular distance of the person P1 from the system 100-1. The person P1 may be indicated by coordinates P1 (P1X,P1Y) on the XZ plane in the three-dimensional coordinate system. In order to plot the coordinates on the XZ plane, curved parameters may be converted into plane parameters by considering θ which is represented by the equation (3) as mentioned below:

$$\theta = (180^\circ * Cy1) / (\text{View Angle of Camera}) * (\text{original height of frame}) \qquad (3)$$

As mentioned above, the angle θ may be determined to plot the coordinates associated with each of the persons in the frames on the XZ plane. Further, in the present embodiment, projection of the coordinates on the XZ plane may be indicated by the equation (4) as mentioned below:

$$D_1 = D*\cos(\phi) \qquad (4)$$

Wherein,

ϕ= Angle of the cameras with respect to a surface of earth (as shown in Figure 3c)

D = Perpendicular distance of the person P1 from the system 100-1. However, D' may be used instead of D in the equation (4), if the resolution of the visible light camera 102-1 is different from the resolution of the infrared camera 102-2

Referring to Figure 3c, in an embodiment, the angle ϕ may be determined by implementing sensors including, but not limited to, a gyroscope in the system 100-1. In another embodiment, the angle ϕ may be pre-stored in the system 100-1 for further processing. Referring to Figure 3b, the object tracking module 114 may be configured to project the coordinates associated with the person P1 on a XY plane in the three-dimensional coordinate system based on the based on the perpendicular distance of the person P1 from the system 100-1. The person P1 may be indicated by coordinates P1 (P1X, P1Y) on the XY plane in the three-dimensional coordinate system. In order to plot the coordinates on the XY plane, curved parameters may be converted into plane parameters by considering θ1 which is represented by the equation (5) as mentioned below:

$$\theta 1 = (180^\circ * Cy1) / (\text{View Angle of Camera}) * (\text{original height of frame}) \qquad (5)$$

As mentioned above, the angle θ1 may be determined to plot the coordinates associated with each of the persons in the frames on the XY plane. Further, in the present embodiment, projection of the coordinates on the XY plane may be indicated by the equation (6) as mentioned below:

$$D_2 = D * \sin(\phi) \qquad (6)$$

Wherein,

ϕ= Angle of the cameras with respect to a surface of earth

D = Perpendicular distance of the person P1 from the system 100-1. However, D’ may be used instead of D in the equation (6), if the resolution of the visible light camera 102-1 is different from the resolution of the infrared camera 102-2

Further, the processor 106 may be configured to ascertain a set of physical characteristics associated with the identified object based on the extracted frames. In an embodiment, the set of physical characteristics may include, but is not limited to, a height of the person and an age of the person. In an embodiment, the object tracking module 114 may be configured to determine the height of the person based on representation of the person in the XY plane of the three-dimensional coordinate system. The object tracking module 114 may determine a coordinate, such as (P1X’, P1Y’) associated with a topmost pixel of the contour of the person in the XY plane. Further, the object tracking module 114 may determine a coordinate (PIX’’, P1Y’’) associated with a bottommost pixel of the contour of the person in the XY plane. Subsequently, the object tracking module 114 may determine the height of the person by subtracting Y coordinates, such as P1Y’ and P1Y’’, corresponding to the topmost pixel and the bottommost pixel.

Based on the height of the person, the processor 106 may be configured to determine the age of the person. In an embodiment, based on the determined age of the person, the processor 106 may be configured to determine approximate life expectancy of the person and extent of effect of the transmissible disease on the person. Further, based on the infrared image frame, the processor 106 may be configured to determine the body temperature associated with each of the persons in the corresponding image frame. In an embodiment, the object tracking module 114 may be configured to correlate the body temperature of the persons with the coordinates associated with each of the persons. Further, based on the correlation, the object tracking module 114 may assign values of the body temperature to each of the coordinates associated with each of the persons. If a value of the body temperature of a person is higher than a threshold value of the body temperature, the object tracking module 114 may identify the person as infected with the transmissible disease.

Figure 4 illustrates a flowchart depicting operation of the system 100 to identify a source associated with at least one voice input and to determine a location of the at least one object, according to an embodiment of the present disclosure. As mentioned earlier, the processor 106 may be configured to identify at least one person demonstrating the at least one symptom, such as sneezing and coughing, associated with the transmissible disease. The system 100-1 may include the plurality of audio sensors

105 configured to detect audio inputs in the environment. In an embodiment, the plurality of audio sensors 105 may interchangeably be referred to as the audio sensors 105, without departing from the scope of the present disclosure.

Referring to Figure 4, at block 402, the processor 106 may be configured to receive at least one voice input from the audio sensors 105. In an embodiment, the object tracking module 114 may be configured to receive data associated with a plurality of voice inputs from the audio sensors 105. Further, at block 404, the object tracking module 114 may be configured to separate each of the voice inputs from the plurality of voice inputs. The object tracking module 114 may be configured to identify at least one source, such as a person from among the plurality of persons, associated with each of the voice inputs in the environment.

The object tracking module 114 may be configured to determine information associated with the identified source. In an embodiment, the information may be indicative of physiological characteristics of the identified source. The physiological characteristics may include, but is not limited to, sick and healthy, without departing from the scope of the present disclosure. At block 406, in an embodiment, the object tracking module 114 may be configured to compare each of the voice inputs with a plurality of pre-stored audio patterns indicative of sneezing or coughing. Based on the comparison, the object tracking module 114 may be configured to determine the information associated with the source and determine the presence of at least one source, i.e., a person, demonstrating the at least one symptom of the transmissible disease.

Further, at block 408, the object tracking module 114 may be configured to ascertain a location of the identified source based on the received voice input. **Figure 5** illustrates operation of the system 100-1 to identify the source associated with at least one voice input in the environment, according to an embodiment of the present disclosure. Referring to Figure 4 and Figure 5, in an embodiment, the object tracking module 114 may be configured to receive data associated with a value of intensity of the voice inputs from the sensors. As mentioned earlier, the plurality of systems may be deployed in the environment for monitoring spread of transmissible disease. Each of the systems may be positioned adjacent to each other at the pre-defined distance D’ in the environment.

Referring to Figure 5, in the illustrated embodiment, the system 100-1 and the system 100-2 may be configured to collectively determine the location of the source, i.e., a person, associated with the at least one voice input. The system 100-2 may be positioned adjacent to the system 100-1 at the pre-defined distance D’ in the environment. The system 100-1 may include the audio sensors 105, such as the first pair of audio sensors S1, S2, and the system 100-2 may include the audio sensors 105, such as a second pair of audio sensors S3, S4. The object tracking module 114 may obtain a distance of each of the first pair of audio sensors S1, S2 of the system 100-1 from the point of origin O in the three-dimensional coordinate system (as explained earlier).

In the illustrated embodiment, the distance of one of the first pair of audio sensors S1, S2 from the point of origin O may be referred to as X1. Similarly, the distance of another audio sensor from among the first pair of audio sensors S1, S2 from the point of origin O may be referred to as X2. Further, the distance of one of the second pair of audio sensors S3, S4 from the point of origin O may be referred to as X3. Similarly, the distance of another audio sensor from among the second pair of audio sensors S3, S4 from the point of origin O may be referred to as X4.

Further, the processor 106 may be configured to receive analogue values indicative of the intensity of the voice inputs from each of the first pair of audio sensors S1, S2 and the second pair of audio sensors. In an embodiment, the object tracking module 114 may be configured receive analogue values indicative of intensity of the voice inputs from each of the first pair of audio sensors and the second pair of audio sensors S3, S4. In the illustrated embodiment, the object tracking module 114 may receive an analogue value, i.e., As1, from one of the first pair of audio sensors S1, S2. Similarly, the object tracking module 114 may receive an analogue value, i.e., As2, from another audio sensor from among the first pair of audio sensors S1, S2. Further, the object tracking module 114 may receive an analogue value, i.e., As3, from one of the second pair of audio sensors S3, S4. Similarly, the object tracking module 114 may receive an analogue value, i.e., As4, from another audio sensor from among the second pair of audio sensors S3, S4.

Further, the object tracking module 114 may determine the location of the source, i.e., the person based on the analogue values received from the audio sensors 105, such as the first pair of audio sensors S1, S2 and the second pair of audio sensors S3, S4, and the distance of each of the audio sensors 105 from the point of origin O. In an embodiment, the object tracking module 114 may implement an equation (5) as mentioned below to determine a distance of the source from the point of origin O in the three-dimensional coordinate system.

$$Xp = (As1*X1 + As2*X2 + As3*X3 + As4*X4) / (As1 + As2 + As3 + As4) \quad (5)$$

Wherein,

As1=Analogue value by sensor S1 from among the first pair of audio sensors

As2=Analogue value by sensor S2 from among the first pair of audio sensors

As3=Analogue value by sensor S3 from among the second pair of audio sensors

As4=Analogue value by sensor S4 from among the second pair of audio sensors

X1, X2, X3, X4 = Distance of the sensors S1, S2, S3, S4, respectively, from the point of origin O

Further, the processor 106 may be configured to correlate the location of the identified object with the location of the identified sources of the at least one voice input. In an embodiment, the object tracking module 114 may be configured to correlate the location of the person determined based on the visible image frame and the infrared image frame with the location, i.e., X_p, of the identified source of the at least one voice input. Further, the object tracking module 114 may correlate the body temperature assigned to each of the persons in the frames with the physiological characteristics of each of the persons.

Based on the correlation, the object tracking module 114 may identify the at least one person demonstrating at least one symptom associated with a transmissible disease in the environment.

Referring to Figure 4, at block 410, the processor 106 may be configured to plot locations of the persons in the environment in the three-dimensional coordinate system indicating information associated with each of the persons. **Figure 6** illustrates an exemplary three-dimensional map of the environment depicting at least one system 100 for monitoring spread of transmissible disease in the environment, according to an embodiment of the present disclosure. The processor 106 may be configured to track movement of the identified object based on the captured video streams, i.e., the first video stream and the second video stream. In an embodiment, the object tracking module 114 may be configured to track the movement of the identified object based on the captured video streams.

Referring to Figure 6, the object tracking module 114 may be configured to plot a three-dimensional map of the environment indicating the location of the identified object based on the correlation and the set of physical characteristics of each of the visible light camera 102-1 and the infrared camera 102-2. The three-dimensional map may also indicate a plurality of regions in the environment monitored by each of the systems 100. For instance, the system 100-1 may be configured to monitor a region, i.e., ABEF, in the three-dimensional map. Similarly, the system 100-2 may be configured to monitor a region, i.e., BCDE, in the three-dimensional map.

Further, the object tracking module 114 may be configured to update coordinates associated with each of the persons based on the video stream received from the cameras 102. The object tracking module 114 may be configured to receive image frames from the video stream in a real-time. Subsequently, the object tracking module 114 may update the coordinates associated with each of the persons based on position of the corresponding person in the image frames. The object tracking module 114 may be configured to mark the person demonstrating at least one symptom of the transmissible disease in the three-dimensional map. As shown in Figure 6, the object tracking module 114 may mark the person P2 as infected with the transmissible disease.

The processor 106 may be configured to determine a speed of movement of each of the persons in the environment based on the extracted frames associated with the first video stream and the second video stream. In an embodiment, the object tracking module 114 may be configured to determine the speed of movement of the persons, based on the extracted frames. The object tracking module 114 may determine the speed of the person based on a change in the distance of the person from the point of origin O with respect to a time period. Further, the processor 106 may be configured to track the movement of the identified object in the environment based on the speed of movement. In an embodiment, the object tracking module 114 may be configured to track the movement of the person in the environment. The object tracking module 114 may be configured to update the three-dimensional map based on movement tracking of the identified object, i.e., the person.

Further, the processor 106 may be configured monitor interaction of the person, with at least another person from among the plurality of based on the movement of the person. In an embodiment, the interaction monitoring module 116 may be configured to monitor interaction between the plurality of persons in the environment based on the movement of each of the persons. The interaction monitoring module 116 may be configured to define a zone 602 around each of the persons in the three-dimensional coordinate system. Based on a change in coordinates associated with each of the persons, the interaction monitoring module 116 monitor proximity between each of the persons in the environment.

In an embodiment, the interaction monitoring module 116 may be configured to define a contagious zone 602-1 around the identified object, i.e., the person demonstrating the at least one symptom of the transmissible disease and having the body temperature higher than the threshold temperature. The contagious zone 602-1 may be defined as a circular area having a radius, without departing from the scope of the present disclosure. The radius of the contagious zone 602-1 can be varies based on various parameters, such as type of transmissible disease. In an embodiment, the radius may be selected based on a set of guidelines established by government authorities. Further, the interaction monitoring module 116 may also be configured to define the zone, such as the zone 602-2, around the persons not demonstrating any symptom of the transmissible disease.

The person demonstrating the at least one symptom and having the body temperature higher than the threshold temperature may be referred to as the infected person. Further, the interaction monitoring module 116 may be configured to determine proximity of the at least another person with respect to the contagious zone. The interaction monitoring module 116 may be configured to monitor interaction of the infected person with the at least another person based on the determined proximity and the movement of the infected person.

Figure 7 illustrates an exemplary operation of the system 100 to categorize at least one object in at least one of a plurality of categories, according to an embodiment of the present disclosure. The processor 106 may be configured to categorize each of the persons in at least one of a plurality of categories based on monitored interaction of the infected person with each of the person. In an embodiment, the plurality of categories may include, but is not limited to, infected, potentially-infected, sub-potentially infected, and normal. Referring to Figure 7, a first category, i.e., normal, a second category, i.e., infected, a third category, i.e., potentially-infected, and a fourth category, i.e., sub-potentially infected may be indicated by A1, A2, B1, and C1/C2, respectively. The plurality of categories may be further categorized within a plurality of stages, such as a first stage, a second stage, and a third stage. The second category, i.e., A2 and the third category, i.e., B1 may be categorized in the first stage and the second stage, respectively. Further, the fourth category, i.e., C1/C2 may be categorized in the third stage.

Based on the interaction between the persons, the interaction monitoring module 116 may categorize each of the persons in categories A1, A2, B1, and C1/C2. For instance, if a person comes in contact with the infected person categorized in the second category A2, then the interaction monitoring module 116 may categorize such person in the third category B2. The person categorized to the second stage in the third category, i.e., B1 may require a medical test for confirming whether the person is suffered from the transmissible disease. If the medical test indicates a positive test, then the person may be shifted to the first stage in the second category, i.e., A2. However, if the medical test indicates a negative test, then the person may be shifted to the first category, i.e., A1.

Further, if a person comes in contact with the person categorized in the second stage in the third category, i.e., B1, then the interaction monitoring module 116 may categorize such person in the fourth category, i.e., C2. If a person comes in contact with the person categorized in the third category, i.e., B1 and demonstrates at least one symptoms of the transmissible disease, then the interaction monitoring module 116 may categorize such person in the fourth category, i.e., C1. Further, the person categorized in the fourth category, i.e., C1 may require a medical test for confirming whether the person is suffered from the transmissible disease. If the medical test indicates a positive test, then the person may be shifted to the first stage in the second category, i.e., A2. However, if the medical test indicates a negative test, then the person may be shifted to the first category, i.e., A1.

In an embodiment, the processor 106 may be configured to identify at least one electronic device associated with the persons in the environment. The at least one electronic device may include, but is not limited to, a smartphone and tablet, without departing from the scope of the present disclosure. The processor 106 may be configured to establish communication with the at least one electronic device via network, such as wireless network. The processor 106 may be configured to identify a location of the at least one electronic device in the environment. Further, the processor 106 may be configured to correlate the location of the at least one electronic device with the location of the persons in the environment. Based on the correlation, the processor 106 may assign the at least one electronic device to each of the persons in the environment.

In an embodiment, the object tracking module 114 may monitor the movement of the person in the environment based on the location of the at least one electronic device assigned to such person. Further, in the present embodiment, the object tracking module 114 may determine the speed of the person based on the movement of the at least one electronic device assigned to such person in the environment. The object tracking module 114 may identify movement of the person from one region in the environment to another region in the environment. For instance, if the person moves from a region monitored by the system 100-1 to another region monitored by the system 100-2, then the object tracking module 114 and the interaction monitoring module 116 of the system 100-1 may transmit information associated with the person to the data transmitting module. Subsequently, the data transmitting may be configured to transmit the information to the processor 106 of the system 100-2.

In an embodiment, the processor 106 may be configured to update information in application, such as medical monitoring application, deployed in the at least one electronic device. Based on the category of the person, the processor 106 may update the information in the application deployed in the at least one electronic device assigned to such person. In an embodiment, the data transmitting module may update the information in the application deployed in the at least one electronic device. Further, the processor 106 may be configured to assign a unique ID to at least one electronic device assigned to at least one of the persons. If no electronic device is identified for a person in the environment, then the processor 106 may store the visible spectrum image of the person and assign the information of the person, such as the infected person, corresponding to the visible spectrum image. Further, in an embodiment, the processor 106 may transmit the visible spectrum image along with the information of the person, such as the infected person, to the server for further processing by government authorities.

Figure 8 illustrates a flowchart depicting a method 800 for monitoring spread of transmissible diseases in the environment, according to an embodiment of the present disclosure. The method 800 may be implemented by the systems 100 using components thereof, as described above. In an embodiment, the method 800 may be executed by the visible light camera 102-1, the infrared camera 102-2, the audio sensors 105, the processor 106, the memory, data 120, and the module(s) 108. For the sake of brevity, details of the present disclosure that are explained in details in the description of Figure 1, Figure 2a, Figure 2b, Figure 2c, Figure 3a, Figure 3b, Figure 4, Figure 5, Figure 6, and Figure 7 are not explained in detail in the description of Figure 8.

At block 802, the method 800 includes receiving at least one video stream associated with an environment having the plurality of objects from at least one electronic device. In an embodiment, the method 800 includes receiving a first video stream from the visible light camera 102-1 and a second video stream from the infrared camera 102-2. Further, the method 800 includes obtaining data indicative of the plurality of operational parameters associated with each of the visible light camera 102-1 and the infrared camera 102-2.

At block 804, the method 800 includes identifying at least one object from among the plurality of objects, wherein the at least one object demonstrates at least one symptom associated with a transmissible disease. In an embodiment, the method 800 includes extracting a frame from each of the first video stream and the second video stream at a timestamp. The method 800 includes identifying the at least one object demonstrating the at least one symptom based on the extracted frames. Further, the method 800 includes determining the location of the identified object based on the extracted frames and the plurality of operational parameters associated with the visual light camera 102-1 and the infrared camera 102-2. The method 800 includes correlating the location of the identified object with the location of the identified sources of the at least one voice input. Further, the method 800 includes ascertaining the set of physical characteristics associated with the identified object based on the extracted frames.

At block 806, the method 800 includes tracking movement of the identified object based on the captured video stream. In an embodiment, the method 800 includes plotting the three-dimensional map of the environment indicating the location of the identified object based on the correlation and the set of physical characteristics. Further, the method 800 includes determining the speed of movement of the identified object based on the extracted frames associated with the first video stream and the second video stream. The method 800 includes tracking the movement of the identified object in the environment based on the speed of movement. Further, the method 800 includes updating the three-dimensional map based on movement tracking of the identified object.

At block 808, the method 800 includes monitoring interaction of the identified object with at least another object from among the plurality of objects based on the movement of the identified object. In an embodiment, the method 800 includes defining the contagious zone around the identified object in the environment. Further, the method 800 includes determining proximity of the at least another object with respect to the contagious zone. Furthermore, the method includes monitoring interaction of the identified object with the at least another object based on the determined proximity and the movement of the identified object.

At least by virtue of aforesaid embodiment, the present disclosure at least leads to the following advantages:

- The concept of inter-individual human distance is introduced in the system 100 having self-measuring technology, which can be modified as per the guidelines issued by the Government authorities.
- The system 100 and method 800 are provided to pinpoint the infected individual and extract the unique ID or image of the infected person.
- The system 100 and the method 800 are provided to determine the location of each of the persons in the environment based on the video stream captured by each of the visible light camera 102-1 and the infrared camera 102-2. Further, the system 100 and the method 800 are provided to determine the location of each of the persons in the environment based on the voice inputs captured by the audios sensors. The system 100 and the method 800 are provided to correlate the location of each of the persons determined based on the video streams with the location of each of the person determined based on the voice inputs in the environment. This substantially increases overall accuracy and effectiveness associated with determination of the location of each of the persons in the environment.
- The system 100 and the method 800 are provided to generate the three-dimensional map of the environment indicating the infected persons and tracking movement of each of the persons in the environment.
- The system 100 and the method 800 are provided to determine the set of physical characterises such as the height, the age, and the speed, of each of the persons in the environment. Further, the system 100 and the method 800 may be provided to determine approximate life expectancy of the person and extent of effect of the transmissible disease on the person based on the age of the person.

- The system 100 and the method 800 are configured to categorize each of the persons different categories, such as infected, potential-infected, sub-potential infected, and normal based on the extent of the infection. Further, the system is configured to update the category of each of the person based on the interaction with other people in the environment and based on medical tests conducted on each of the person.
- Implementation of the system 100 and the method 800 for monitoring spread of the transmissible disease substantially eliminates involvement of human workforce, such as medical officers, to physically monitor each of the persons. This substantially reduces probability associated with spreading of the transmissible disease in the environment.

While specific language has been used to describe the present subject matter, any limitations arising on account thereto, are not intended. As would be apparent to a person in the art, various working modifications may be made to the method in order to implement the inventive concept as taught herein. The drawings and the foregoing description give examples of embodiments. Those skilled in the art will appreciate that one or more of the described elements may well be combined into a single functional element. Alternatively, certain elements may be split into multiple functional elements. Elements from one embodiment may be added to another embodiment.

[redacted]

[redacted]

[redacted]

[redacted]

ABSTRACT OF THE INVENTION

A METHOD AND A SYSTEM FOR MONITORING SPREAD OF TRANSMISSIBLE DISEASES

A method for monitoring spread of transmissible diseases is disclosed. The method includes receiving at least one video stream associated with an environment having a plurality of objects from at least one electronic device. Further, the method includes identifying at least one object from among the plurality of objects. The at least one object demonstrates at least one symptom associated with a transmissible disease. The method includes tracking movement of the identified object based on the captured video stream. Further, the method includes monitoring interaction of the identified object with at least another object from among the plurality of objects based on the movement of the identified object.

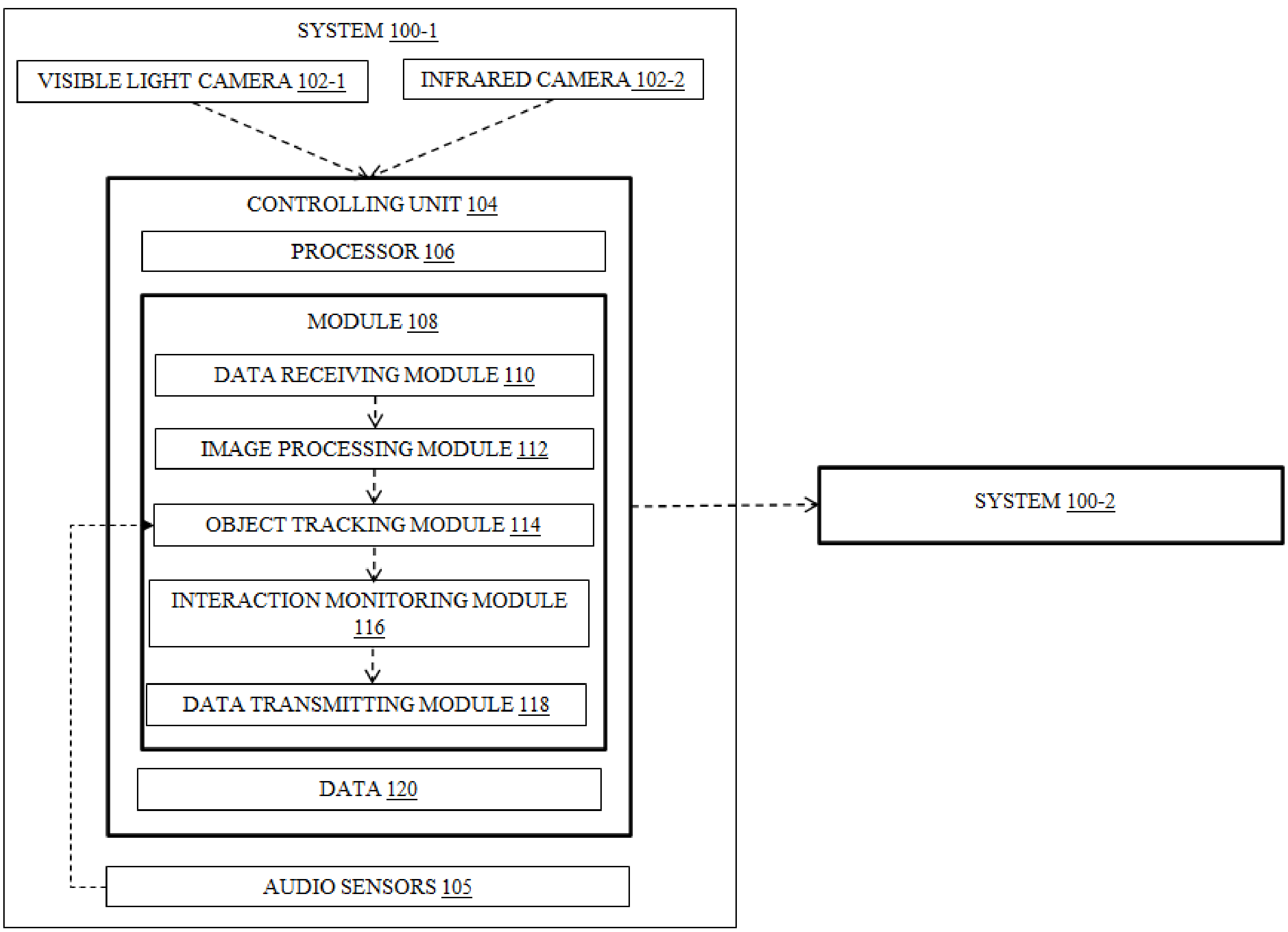

FIGURE 1

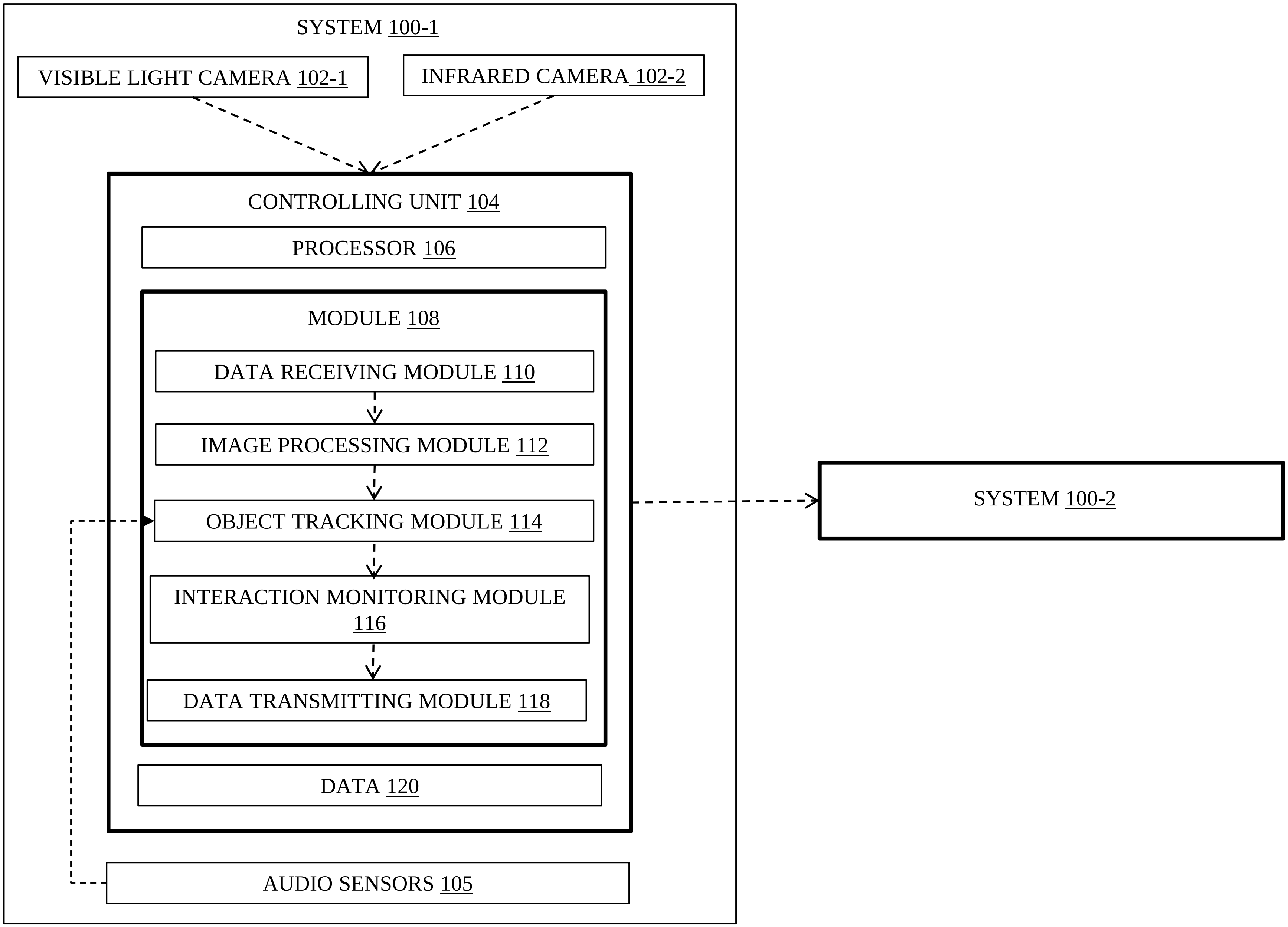
SYSTEM 100-1
VISIBLE LIGHT CAMERA 102-1
INFRARED CAMERA 102-2
CONTROLLING UNIT 104
PROCESSOR 106
MODULE 108
DATA RECEIVING MODULE 110
IMAGE PROCESSING MODULE 112
OBJECT TRACKING MODULE 114
INTERACTION MONITORING MODULE 116
DATA TRANSMITTING MODULE 118
DATA 120
AUDIO SENSORS 105
SYSTEM 100-2

FIGURE 1

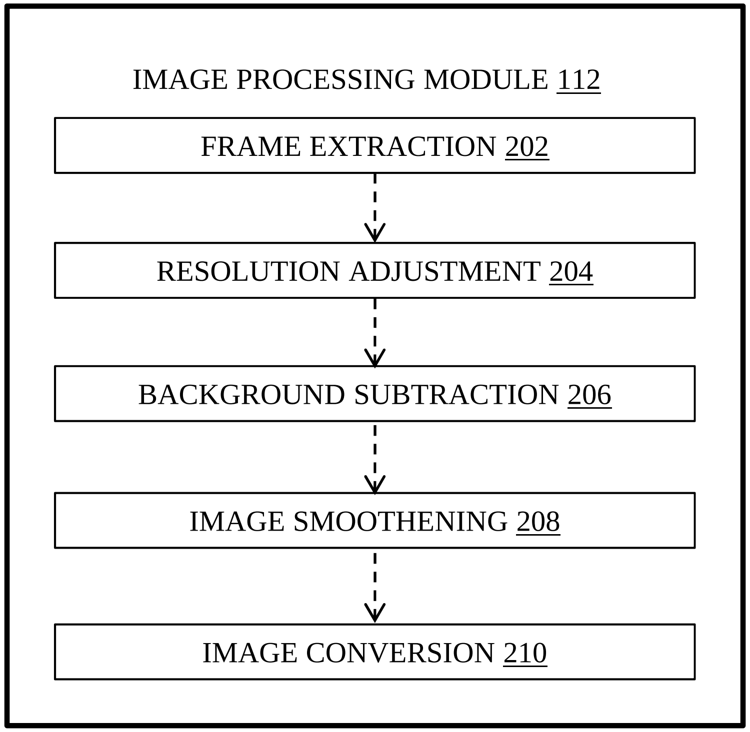

FIGURE 2a

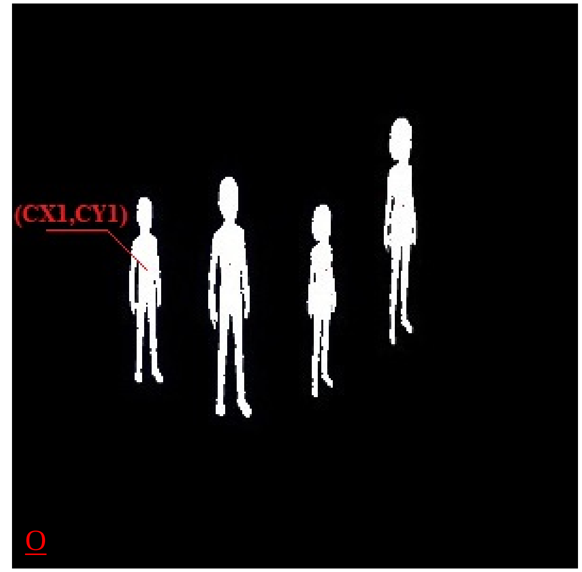

FIGURE 2b

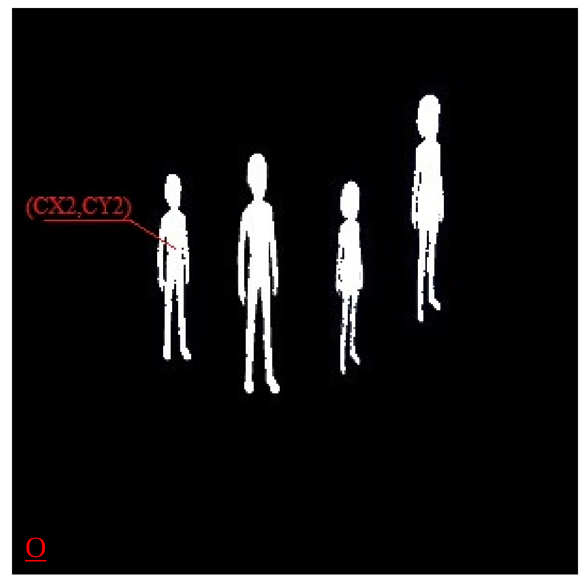

FIGURE 2c

Manisha Singh
Agent for the Applicant [IN/PA-740]
LEXORBIS

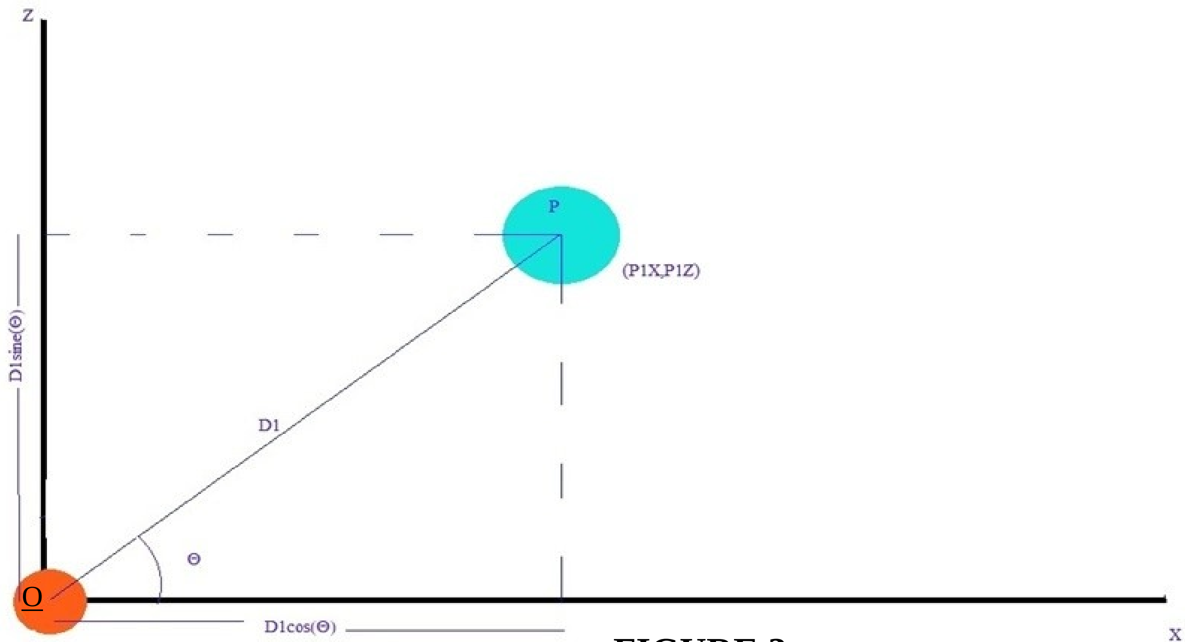

FIGURE 3a

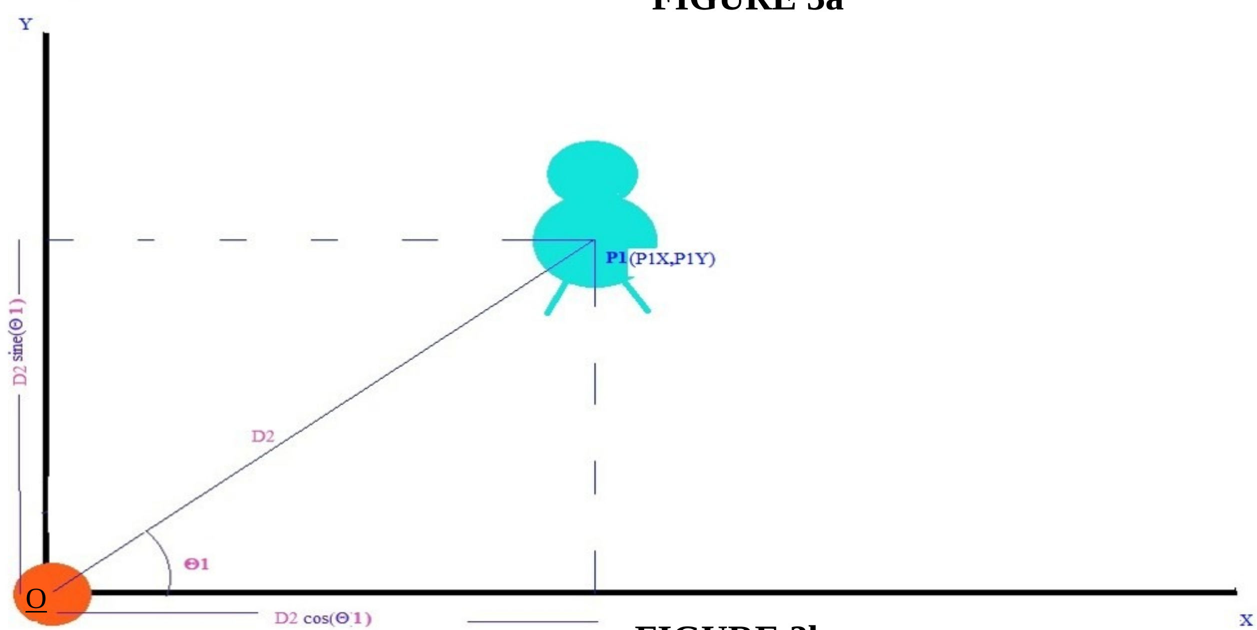

FIGURE 3b

Manisha Singh
Agent for the Applicant [IN/PA-740]
LEXORBIS

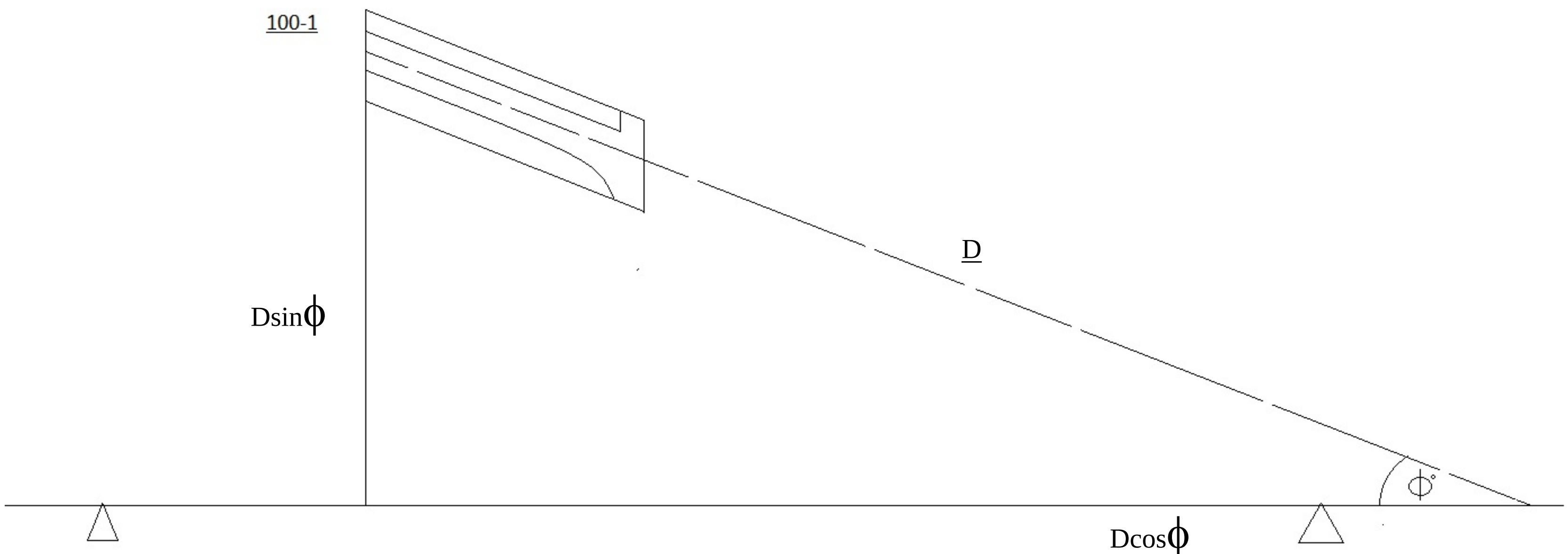

FIGURE 3c

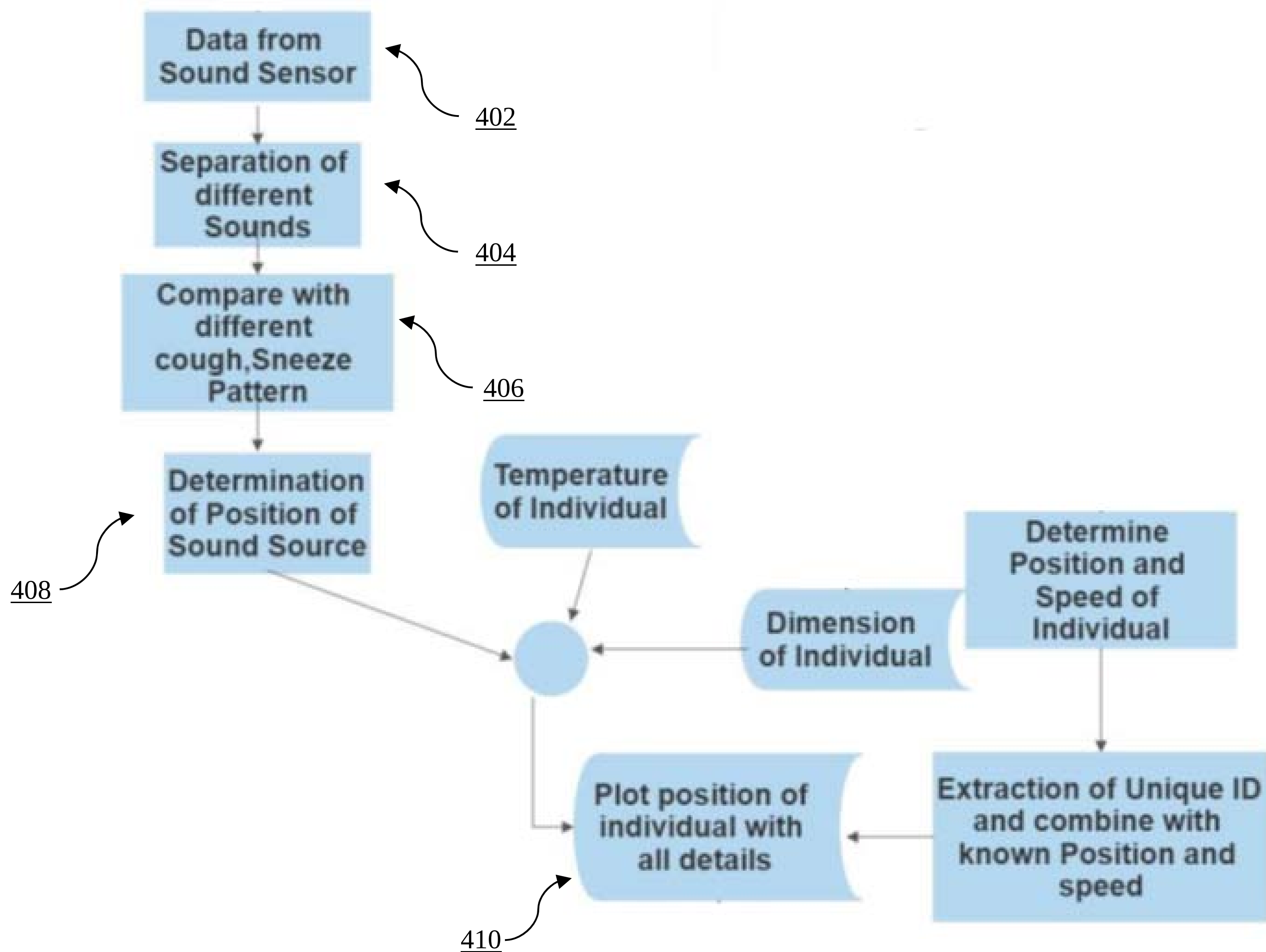
Data from Sound Sensor
402
Separation of different Sounds
404
Compare with different cough,Sneeze Pattern
406
Determination of Position of Sound Source
408
Temperature of Individual
Determine Position and Speed of Individual
Dimension of Individual
Plot position of individual with all details
410
Extraction of Unique ID and combine with known Position and speed

FIGURE 4

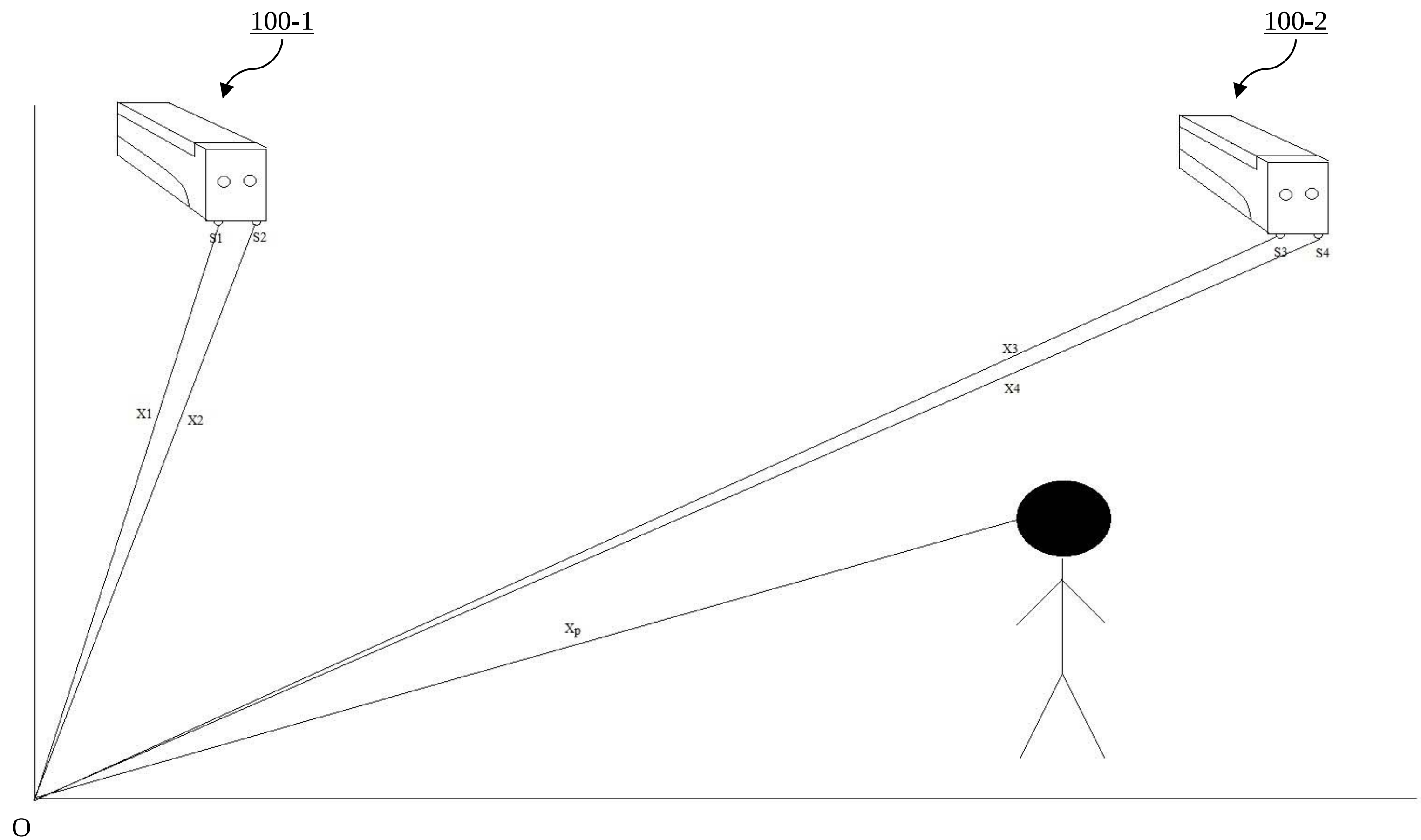

FIGURE 5

Manisha Singh
Agent for the Applicant [IN/PA-740]
LEXORBIS

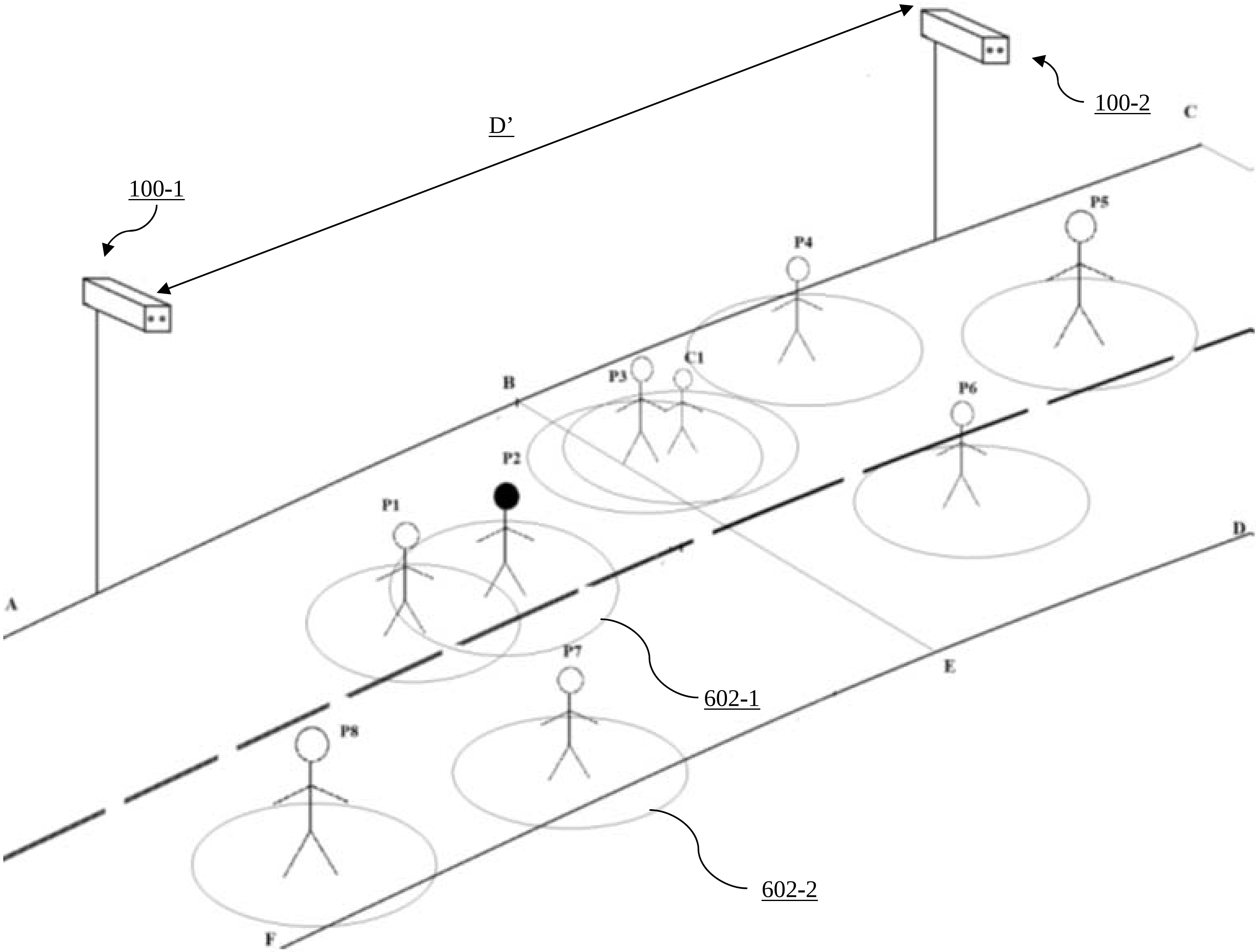

FIGURE 6

Manisha Singh
Agent for the Applicant [IN/PA-740]
LEXORBIS

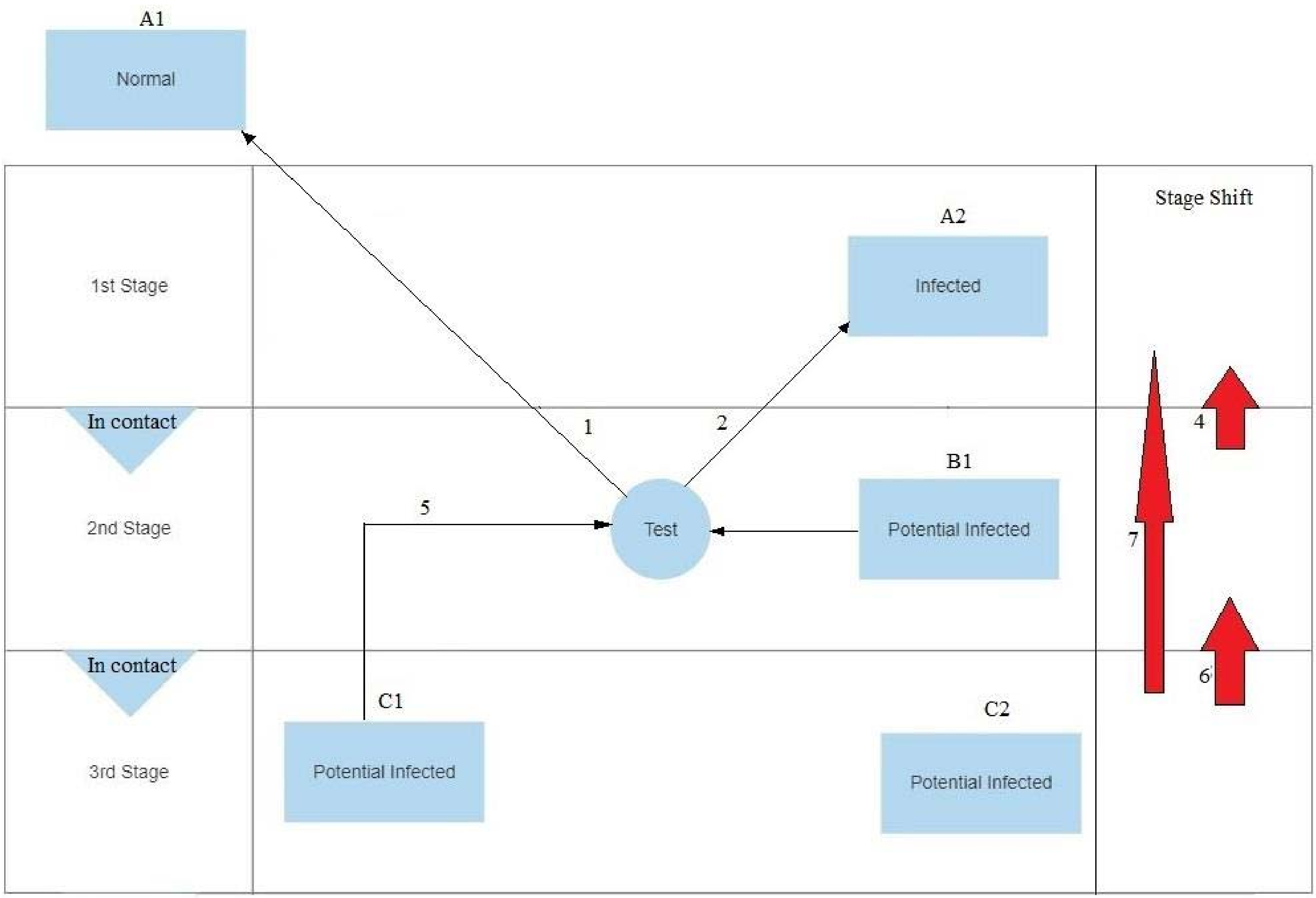
A1
Normal
Stage Shift
A2
Infected
1st Stage
In contact
1
2
4
B1
2nd Stage
5
Test
Potential Infected
7
In contact
6
C1
C2
3rd Stage
Potential Infected
Potential Infected

FIGURE 7

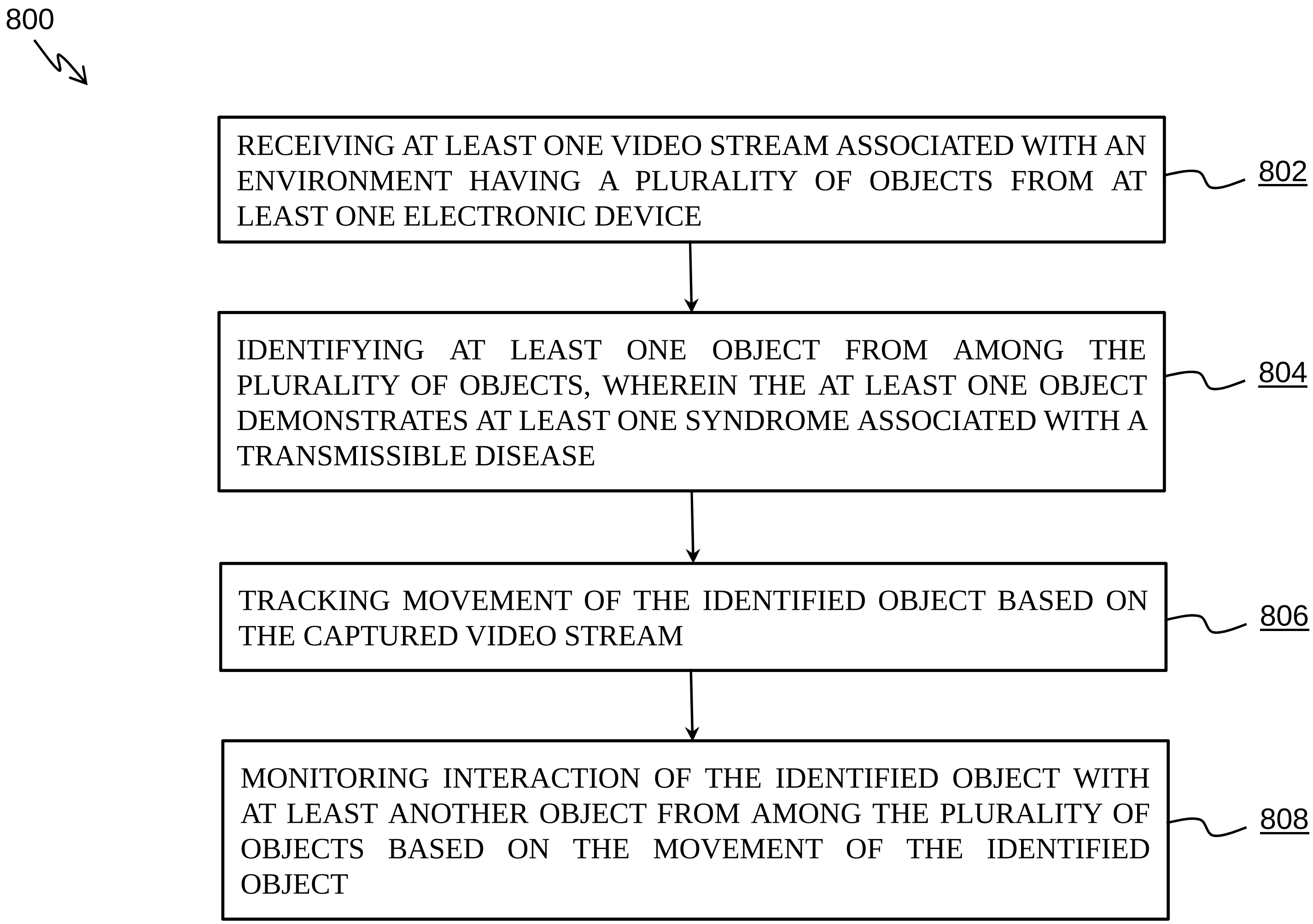

FIGURE 8

Manisha Singh
Agent for the Applicant [IN/PA-740]
LEXORBIS