

A METHOD FOR PROVIDING AN INSECT POPULATION GROWTH
FORECAST, A MONITORING DEVICE AND A SYSTEM

Technical Field

The invention generally relates to pest control. More particularly, it is related to methods for providing an insect population growth forecast, monitoring devices for
5 detecting insects and systems comprising such monitoring devices.

Background Art

It is well-known that insects cause severe damages, both directly and indirectly. For instance, cockroaches may leave an offensive odor in kitchens and homes.
10 Further, an indirect effect of having cockroaches in homes may be allergic reactions. The cockroaches may namely carry proteins, pathogens or other microbes on their body surfaces, which may trigger allergic reactions. Bed bugs, which is another insect causing severe damages, may cause bites, which is not only unpleasant, but can also result in allergic reactions.
15 Once cockroaches, bed bugs or other species of insects have found their way into a home, a hospital, a restaurant kitchen, etc it may be difficult to have these eradicated. For instance, in case bed bugs are found in a bed in a hotel room, the mattress is most often discarded and the room is often closed for a period of time such that the bed bugs can be eliminated. Since bed bugs, and also cockroaches, may
20 survive weeks without food, it is difficult to eliminate these insects quickly. Therefore, the hotel room may be closed for weeks before this can be used again, which cause and economic burden for the hotel owner. Another unwanted effect of bedbug infestations is that this may result in that the bed bugs could have been brought home by guests that have stayed in the room. As a result, for the hotel owner to have bed
25 bugs in one or several of the rooms does not only result in that the room has to be closed for some time, but also that the problem may be spread to the homes of the guests, which in turn results in that actions need to be taken in the homes of the guests as well. Thus, having hotel rooms infested by bed bugs may in addition cause severe long term reputational damage for hotel owners.
30 There are several techniques for trapping bed bugs, cockroaches and the like. For instance, it is commonly known to have a plate-like device placed under legs of beds to prevent bed bugs from crawling from the floor into the bed. It is also possible to use insecticides to kill off bed bugs and cockroaches. However, since using

insecticides comes with several unwanted side effects, this alternative is often avoided to the largest extent possible. Another option to kill off bed bugs is by using heat-treatment, such as a steamer.

The current solutions provide for that damages caused by insects can be prevented to some extent. As mentioned, there are different types of traps available that prevent bedbugs from reaching beds. It is also possible to detect bedbugs in various ways by using e.g. a dog with special training. Even though there are traps available and even though that there different ways to detect presence of different insects, there is a need to further reduce the damages caused by insects, such as bedbugs and cockroaches.

Summary

It is an object of the invention to at least partly overcome one or more of the above-identified limitations of the prior art. In particular, it is an object to provide a method and a system for providing an insect population growth forecast. Put differently, it is an object to provide the forecast such that different measures may be taken at an early stage such that damages caused by the insects can be reduced. The object can be achieved by having multiple monitoring devices that each can provide sensor data sets such that these data sets in combination can be used for making the forecast.

According to a first aspect it is provided a method for providing an insect population growth forecast in a monitored area, said method comprising obtaining sensor data sets from a plurality of monitoring devices placed in the monitored area for a sample time period, wherein each monitoring device comprises at least one sensor, wherein the sensor data sets comprises for each sensor detection a detection time point,

determining a number of individuals detected in the monitoring devices during the sample time period based on the sensor data sets,

obtaining respective location data sets for the plurality of monitoring devices, wherein each location data set at least provides a distance to another monitoring device among the plurality of monitoring devices, and

determining the insect population growth forecast by combining the number of individuals detected in the monitoring devices, the detection time points registered by the monitoring devices, and the location data sets of the monitoring devices.

An advantage with this is that by being able to combine detections made by the plurality of monitoring devices, the detection time points and the locations of the

detections, it is made possible to provide a reliable forecast regarding the insect population growth. As an effect, by being able to e.g. predict bedbug outbreaks, it is possible to take action at an early stage such that damages caused by the bedbug outbreak can be avoided or at least reduced.

5 The monitored area may be one or several rooms in a building.

 The monitoring devices may be arranged to communicate with one another via wireless data transmission, wherein the obtaining the respective location data sets comprises

 for each of the monitoring devices,
10 obtaining information about at least one data communication path with at least one other monitoring device, and
 for each of the at least one data communication paths,
 identifying the other monitoring device linked to the data communication path such that the distance to the other monitoring device can be set to be less or equal to a
15 maximum wireless data communication range.

 By having the monitoring devices communicating with each other by wireless transmission, it is possible to use data communication paths, that is, information between which monitoring devices there is data communication, to determine the distance between the different monitoring devices. The distance may be set to
20 correspond to a signal strength measure linked to the data communication path between two monitoring devices, that is, the higher signal strength, the shorter distance. Further, if not the signal strength is available, the distance could at least be set to be less or equal to the maximum wireless communication range. An advantage of using information made available as an effect of using wireless data communication
25 between the monitoring devices is that the locations can be estimated without direct involvement of an operator. As an effect, the risk of human errors can be reduced.

 The location data sets may comprise coordinates reflecting positions of the monitoring devices in the monitored area.

 The method may further comprising
30 determining a species and/or life cycle stages of the individuals detected in the monitoring devices based on the sensor data sets,
 wherein the insect population growth forecast comprises a population growth forecast per species.

 The at least one monitoring device may comprise a plurality of sensors placed
35 at different positions inside a housing of the monitoring device, wherein at least two of

the plurality of sensors can be placed such that an individual can be detected by multiple sensors at the same time such that a size of the individual can be determined.

A first and a second sub-set of the plurality of sensors may be placed in or at a first and a second passageway, respectively, such that different routes chosen by the individual inside the housing can be determined.

Different species or individuals of different stages may be more or less inclined to choose a certain route. By arranging the monitoring devices such that, by way of example, both narrow passageways and wide passageways are provided, it may be that smaller insects are feeling more safe in the narrow passageways and hence choose these passageways instead of the wide passageways. On the other hands, larger insects may be too large for the narrow passageways and may therefore choose the wide passageways. As an effect, by having passageways of different sizes, individuals of different sizes can be determined in a more reliable manner.

The first and second passageway differ in size.

Since bedbugs of different stages differ in size, the passageways of different size also provide for that the stage of a particular individual can be determined. With this information at hand, the insect population growth forecast can be determined more accurately.

The at least one sensor may comprise at least one microphone arranged to register sound directly or indirectly pertaining to the individual within the housing.

Using the microphone comes with the benefit that sounds generated by the individuals in the monitoring device can be used for determining the species of these individuals. Further, by also registering indirect sounds generated by the individuals, e.g. sounds originating from the individuals walking inside the monitoring device, a combination of the direct and indirect sounds originating from the individuals may be used for determining the species or stages of the individuals. Further, by also taking into account the sounds, the number of individuals can be determined by improved accuracy.

The method further comprising obtaining ventilation data, temperature data and/or humidity data pertaining to the monitored area,

wherein determining the insect population growth forecast is performed by combining the number of individuals detected in the monitoring devices, the detection time points registered by the monitoring devices, the location data sets of the

monitoring devices and also the ventilation data, the temperature data and/or the humidity data pertaining to the monitored area.

An advantage by also incorporating external data, such as the ventilation data, the temperature data and/or the humidity data, is that the insect population growth
5 forecast can be made with improved accuracy. One reason for this is that different species may be more or less common at different temperatures, different humidity etc. Thus, by taking this information into account, the species of the individuals in the monitoring devices can be determined with improved accuracy, which in turn provides for that the insect population growth forecast can be made more accurate.

10 According to a second aspect it is provided a monitoring device for detecting insects, said device comprising
a housing,
a processor,
a memory,
15 a data communication device,
at least one sensor for detecting the insects inside the housing,
wherein the processor in combination with the memory is arranged to receive signals from the at least one sensor, to link the signals to detection time points and to process the signals and the detection time points into sensor data sets,
20 wherein the data communication device is arranged to transmit the sensor data sets to a gateway either directly or indirectly via another monitoring device.

The same features and advantages as presented with respect to the first aspect also apply to this second aspect.

The monitoring device may comprise a plurality of sensors placed at different
25 positions inside the housing, wherein at least two of the plurality of sensors are placed such that an individual can be detected by multiple sensors at the same time such that a size of the individual can be determined.

A first and a second sub-set of the plurality of sensors may be placed in or at a first and a second passageway, respectively, such that different routes chosen by the
30 individual inside the housing can be determined.

The first and second passageway may differ in size.

The at least one sensor may comprise at least one microphone arranged to register sound directly or indirectly pertaining to the individual within the housing.

According to a third aspect it is provided a system comprising a plurality of
35 monitoring devices according to the second aspect and a gateway communicatively

connected directly or indirectly to the monitoring devices and to a data processing apparatus, said gateway being configured to obtain the sensor data sets from the monitoring devices and to transmit the sensor data sets to the data processing apparatus, wherein the data processing apparatus being configured to determine an insect population growth forecast according to the first aspect.

The same advantages and features as presented above with respect to the other aspects also apply to this aspect.

Still other objectives, features, aspects and advantages of the invention will appear from the following detailed description as well as from the drawings.

Brief Description of the Drawings

Embodiments of the invention will now be described, by way of example, with reference to the accompanying schematic drawings, in which

Fig. 1 illustrates an overview of two rooms provided with monitoring devices.

Fig. 2 illustrates a user device having a user interface in which location data for the monitoring devices may be entered and amended.

Fig. 3A illustrates a first example of how sensor data sets and location data sets can be used for determining an insect population growth forecast.

Fig. 3B illustrates a second example of how sensor data sets and location data sets can be used for determining the insect population growth forecast.

Fig. 4 illustrates by way of example a monitoring device in further detail seen from above with a top portion removed.

Fig. 5 is a flowchart illustrating a method for providing an insect population growth forecast.

Detailed Description

With reference to Fig. 1 an overview of two rooms is illustrated. The first and second room are herein referred to as a first and a second monitored area 100, 102, respectively. In this particular example, the first monitored area 100 covers a kitchen, and the second monitored area 102 covers a storage room accessible via the kitchen. Even though the illustrated example provides for that each room is covered by a monitored area, it is also possible to have several rooms covered by one monitored area or, conversely, different parts of a room may each be covered by a monitored area.

As illustrated, in the first monitored area 100, first monitoring devices 104a-h can be placed, and in the second monitored area 102, second monitoring devices 106a-i can be placed. The monitoring devices 104a-h, 106a-i may be arranged with data communication modules such that they can communicate with each other via wireless data transmission. By way of example, the monitoring devices 104a-h, 106a-i may be configured to communicate with each other in the form of a mesh network, i.e. each monitoring device may function both as a device for capturing sensor data as well as a data communication bridge. Having the data communication set up in this form, or other arrangement providing for that communication between a gateway 108 and the different monitoring devices 104a-h, 106a-i can be made directly as well as indirectly via one or several of the other monitoring devices, comes with the benefit that set up can be facilitated and also that reliability can be assured. By having the different monitoring devices, it is namely possible to find new communication paths if one of the devices are lost or inactive due to e.g. power failure. In case the monitoring devices are battery-powered, sleep signals may be used to inactivate the data communication between the different monitoring devices such that the data communication can be limited to certain time periods. By having the data communication limited to e.g. 30 seconds every ten minutes, it is made possible to use dynamical and non-hierarchical data communication approaches, such as mesh networks, and at the same time offer extensive battery life times. For instance, by restricting the data communication as presented above, the battery lifetime may be extended up to five times compared to using standard mesh network protocols.

The gateway 108, sometimes also referred to as a hub, may be connected to a data communications network 110, such as Internet or a cellular network, such that data sets captured by the monitoring devices and communicated to the gateway 108 can be transferred to a data processing apparatus 112 and a database 114. The data processing apparatus 112 may be a remote server and several gateways may transfer data to this. As an effect, with vast amount of data at hand, different prediction and/or decision models may be trained, e.g. neural networks may be trained to forecast insects population outbreaks. Even though there are clear advantages with having the data processing apparatus 112 arranged as the remote server, it is also possible to have the data processing apparatus 112 configured to handle data from one specific site, such as the first and second monitored area 100, 102 depicted. In case the data processing apparatus 112 is only to communicate with one gateway 108, this may in such situation be integrated in the gateway 108. It is also possible to use a distributed

approach with part of the data processing performed in the monitoring devices, part of the data processing in the gateway 108 and part of the data processing in the data processing apparatus 112. The monitoring devices, the gateway, the data processing apparatus and, optionally, the database are herein referred to as a system 116.

5 As illustrated, some of the monitoring devices are placed such that these can be communicatively connected to multiple monitoring devices, while others are placed such that they are only communicatively connected to a single monitoring device. Since having only one single data communication path leaves no redundancy, such monitoring devices may be identified by the data processing apparatus 112, provided
10 that information about the data communication paths are communicated to the data processing apparatus, and a notification to add further monitoring devices in certain locations of the monitored areas may be transmitted to an operator. In this way, a more reliable system may be achieved.

 By having the monitoring devices 104a-h, 106a-i, it is made possible to detect
15 presence of insects in different locations within the monitored areas 100, 102. Linking the different monitoring devices to locations can be made by using a user device 200, such as a tablet, a mobile phone, a laptop or any other suitable device for interacting with a user, e.g. an operator. As illustrated in fig. 2, a drawing of the monitored areas 100, 102 can be displayed on a display of the user device 200. The drawing may be
20 retrieved from the database 114 via the data processing apparatus 112 or it may be made by the user himself via a user interface of the user device 200.

 As illustrated, the user device 200 may comprise a touch screen 202 such that the locations of the different depicted monitoring devices can be set by using drag and drop operations. As illustrated, in addition to providing possibility to place the depicted
25 monitoring devices such that actual locations of the monitoring devices are reflected in the user interface, it is also possible to set coordinate data for the different depicted monitoring devices. If choosing the option to set the location by inputting the coordinate data, a coordinates textbox 204 may be made available via the user interface.

 By having the monitoring devices 104a-h, 106a-i arranged to communicate via
30 wireless data transmission, e.g. by using the mesh network approach as described above, it is possible to use information about the data communication paths to estimate the location data for the different monitoring devices. In case there are multiple communication paths, the estimate may be more accurate compared to if only one data communication path is available. The estimates achieved based on the data
35 communication paths may be presented as a starting point in the user interface such

that setting the location data for the monitoring devices can be made more efficient by the user. Further, to be able to link the depicted monitoring devices in the user interface with the monitoring devices placed in the monitored areas, the different monitoring devices can be provided with identification tags and the depicted monitoring devices in the user interface may also be presented with identification data. As an effect, for the user, linking the depicted monitoring devices in the user interface to the monitoring devices in the monitored areas 100, 102 is facilitated.

As described above, to improve the redundancy, a notification can be transmitted to the user device saying that monitoring devices are to be added in certain sub-areas of the monitored areas to provide for that single communication paths can be replaced by multiple communication paths. Another effect of adding monitoring devices is that the locations of the monitoring devices can be estimated with greater accuracy.

Further, if using wireless data communication between the monitoring devices and the communication paths are known, a maximum distance between two communicatively connected monitoring devices is a maximum wireless communication range. By using this information, it is made possible, from the data communication paths alone in combination with information about the maximum wireless communication range, to estimate the location data for the different monitoring devices. Since the communication paths may be hindered by stone walls, other equipment transmitting electromagnetic waves, etc, the estimated location data may in some situations differ significantly from actual location data of the monitoring devices, but even so, the estimated location data, derived from the communication paths, may be sufficient information for estimating an insect population growth. Since the uncertainty linked to the location data derived from the communication paths can be reduced by having multiple communication paths between the monitoring devices, the data processing apparatus may be arranged to transmit a notification to the user that additional monitoring devices can be added to improve the insect population growth forecast.

As illustrated, objects in the monitored areas 100, 102 may in the user interface be linked with different properties. For instance, via the user interface, it can be possible to add objects in the form of doors, windows, shelves, stove, tables, kitchen sink, etc. Further, even though not illustrated, the different communication paths may also be depicted in the user interface.

Fig. 3A illustrates a first example of how sensor data sets 300a-h, captured via sensors in the monitoring devices 104a-h placed in the first monitored area 100, and location data sets 302a-h, reflecting positions of the monitoring devices, can be combined into an insect population growth forecast 304. As illustrated, the location data sets 302a-h can be determined by using the user device 200, herein exemplified by a table-top computer. The data processing apparatus 112 may be used for performing the data processing, i.e. determining the insect population growth forecast 304 by combining the sensor data sets 300a-h and the location data sets 302a-h. A memory or the database 114 may be used by the data processing apparatus 112 during the data processing. The data processing apparatus 112 may use a neural network or any other artificial intelligence (AI) based model for determining the insect population growth forecast 304. It is also possible to use non-AI based models, e.g. statistical models.

The sensor data sets 300a-h provide indications of insect presence in the different monitoring devices 104a-h. This may in itself prove sufficient for providing the insect population growth forecast 304 in a reliable manner, but to further improve the reliability additional data may be added. An example of such data is ventilation data 308. The ventilation data 308 may comprise information captured by sensors in a ventilation system linked to the first monitored area 100, such data may for instance comprise air flow in the ventilation system, oxygen content, etc. The ventilation data 308 may also comprise control data for the ventilation system, e.g. activation and/or deactivation control data transmitted to supply fans and/or exhaust fans. Since air quality may be linked to the risk of an insect outbreak and since the air quality also may be used as input by the ventilation system, using the ventilation data 308 for determining the insect population growth forecast 304 can improve reliability.

By having the ventilation data, information about air exchange between different rooms, and also different monitored areas, at different time points may be taken into account when determining the insect population growth forecast. In this way, it is made possible to provide a more reliable forecast.

Similar to the ventilation data 308, temperature data 310 may also be used as input for determining the insect population growth forecast 304. The temperature data 310 may be captured by temperature sensors included in the monitoring devices 104a-h and/or the temperature sensors may be stand alone. Still a possibility is to have the temperature sensors forming part of the ventilation system.

Another type of data that may be beneficial to include to improve the reliability of the insect population growth forecast 304 is humidity data 312. As for the

temperature data 310, the humidity data 312 may be captured by using sensors included in the monitoring devices 104a-h, stand-alone sensors and/or sensors included in the ventilation system.

5 Since there are different species of insects, and also different sub-species, in different parts of the world, geographical position of the monitored areas 100, 102 may also be input to the data processing apparatus 112 to provide for that the insect population growth forecast 304 can be made reliably.

Even though reference herein is made to the monitoring devices 104a-h, 106a-i, these devices should not be understood to be devices solely configured for monitoring, but it is equally possible to have devices arranged for monitoring and trapping. In case 10 the monitoring devices 104a-h are arranged for trapping, the user may be requested to provide input to the data processing apparatus 112 about insects being trapped. For instance, the user can be requested to input information about number of insects trapped and/or species of the insects trapped. This information may be input as text 15 into the system. Another option is however that the information is input as image data. In this latter case, instead of requesting this information from the user, all or a sub-set of the monitoring devices may be equipped with image sensors such that this information can be achieved without involving the user, e.g. by using vision technology for determining the species of the individuals registered in the monitoring devices.

20 Fig. 3B illustrates a second example of how the sensor data sets 300a-h and the location data sets 302a-h can be used for determining the insect population growth forecast 304. Unlike the first example illustrated in fig. 3A, the location data sets 302a-h are determined without the direct involvement of the user. For instance, as described above, by having the monitoring devices 104a-h communicating with each other using 25 wireless data transmission, the location data sets 302a-h may be estimated by making use of the data communication paths. Put differently, by having information about which monitoring devices each monitoring device is communicating with and also the maximum communication range, it is made possible to estimate the location data sets 302a-h for the different monitoring devices 104a-h.

30 Even though not illustrated, it is also possible to use the user device 200 as a component in determining the location data sets 302a-h. By moving the user device 200 within the monitored area 100 and for the different locations determine with which of the monitoring devices 104a-h there is wireless data communication, the location data sets 302a-h can be determined with improved accuracy. If the user device 200 is 35 provided with a gyroscope and/or an accelerometer and it is assumed that the user is

walking with the user device within the monitored area 100, a number of steps between the different distances can be estimated, which in turn provides for that the distances between the different locations can be estimated.

Even though the first and second example is illustrated as two different approaches, these may be used in combination, e.g. the location data sets 302a-h input by the user device 200 may be used as starting location data sets that are fine-tuned by the approach illustrated in fig. 3B. Further, still an option is that the location data sets 302a-h are only requested from the user via the user device 200 in case there are one or two data communication paths such that the location data sets cannot be determined reliably only by considering the data communication paths.

Fig. 4 illustrates the monitoring device 104a-h, 106a-i in further detail by way of example. As illustrated, the monitoring device may comprise a processor 400, a memory 402, a data communication device 404 and a battery 406. These may be comprised within a housing 407. The processor 400 and memory 402 may be arranged to capture signals from one or several sensors 408a-f placed inside the housing 407. Even though not illustrated, the sensors 408a-f may also be placed outside the housing 407 such that insects outside the housing can be detected. The data communication device 404 may be arranged to communicate with the gateway 108 directly or indirectly via other monitoring devices as illustrated in fig. 1.

The monitoring devices may be arranged in a number of different ways. By way of example, as illustrated, the monitoring devices may comprise a first and a second passageway 409a-b having different widths. By having different widths, or in other way differ in size, insects of larger size may choose a route from an entrance 409 of the monitoring device to an exit 412 via a second passageway 409b instead of a first passageway 412a, while insects of smaller size may choose the first passageway 409a, wherein the second passageway 409b is greater in size compared to the first passageway 409a. By having a first sensor 408a placed between the passageways 409a-b and the entrance 410 and a second sensor 408b placed in the first passageway 409a and a third sensor 408c placed in the second passageway 409b, it is made possible to register whether an incoming insect is choosing the first passageway 409a or the second passageway 409b and also by which speed the insect is moving. As illustrated, the first passageway 409a comprises a section having a first width D1 and the second passageway 409b has a uniform width, D2, wherein D2 is greater than D1.

A size of the insect may also be estimated by having the two sensors placed after one another such that the larger insects can be registered by both sensors at the

same time, while the smaller insects will only be registered by one of the sensors at a time. By way of example, a fourth sensor 408d and a fifth sensor 408e may be placed after one another, as illustrated. Even though not illustrated, instead of having the sensors placed after one another, that is, on the same height, the sensors may be placed on different heights such that a height of the insects passing can be estimated. Further, the two concepts can also be combined, that is, sensors placed after one another and sensors placed at different heights. By having both, insects of both different height and length could be identified.

The insect population growth forecast 304 can be linked to insects in general, but by using several sensors placed in the monitoring devices, it is possible also to determine the insect population growth forecast for a particular species, e.g. bedbug. As described above, the sensors may be arranged such that insects of different length and height may be identified. In addition, the speed with which the insects move may also be identified. It should however be noted that a species may have different stages. For instance, the bed bugs are generally considered to have seven stages; egg, first stage larval, second stage larva, third stage larva, fourth stage larva, fifth stage larva and adult. In fig. 4, two bed bug adults 414a-b are illustrated, measuring approximately 5.5 mm, and a second stage larva bed bug 416, measuring approximately 2 mm.

The first to fifth sensors 408a-e illustrated in fig. 4 can be light-based presence sensors that can be used to register whether or not a light beam is interrupted by one or several insects. Even though this form of presence sensors may in some situations, e.g. when there is only one type of species present, serve as the sole type of sensor needed for making a reliable forecast of the insect population growth, there may be situations with several different species present and potentially also individuals from different stages when sensors of different types are beneficial in order to make a reliable forecast. One such sensor-type that can be combined with the light-based presence sensors 408a-e is a microphone 408f. Different species of insects communicate by sound and by being able to register sound by using the microphone 408f it is made possible more reliably determine the species of the insects present in the housing 407. The processor 400 and the memory 402 may be configured such that background noise can be eliminated, thereby providing for that sounds not originating from the insects can be removed. The microphone 408f can also be configured to register sounds indirectly generated by the insects. For instance, echo inside the housing 407 generated when feet of the insects hit a floor of the monitoring device may

be registered and used as one component of the sensor data sets 300a-h used for determining the insect population growth forecast 304.

Fig. 5 is a flowchart illustrating a method 500 for determining the insect population growth forecast in the monitored area. The method can comprise obtaining
5 502 the sensor data sets 300a-h from the plurality of monitoring devices 104a-h placed in the monitored area 100 for a sample time period, wherein each monitoring device 104a-h can comprise at least one sensor 408a-f, wherein the sensor data sets 300a-h comprises for each sensor detection a detection time point, determining 504 a number of individuals detected in the monitoring devices 104a-h during the sample time period
10 based on the sensor data sets 300a-h, obtaining 506 respective location data sets 302a-h for the plurality of monitoring devices 104a-h, wherein each location data set 302a-h at least provides a distance to another monitoring device among the plurality of monitoring devices, and determining 508 the insect population growth forecast by combining the number of individuals detected in the monitoring devices 104a-h, the
15 detection time points registered by the monitoring devices 104a-h, and the location data sets 302a-h of the monitoring devices 104a-h.

Optionally, the monitoring devices 104a-h can be arranged to communicate with one another via wireless data transmission, wherein the obtaining 506 the respective location data sets 302a-h comprises, for each of the monitoring devices, obtaining 510
20 information about at least one data communication path with at least one other monitoring device, and, for each of the at least one data communication paths, identifying 512 the other monitoring device 104a-h linked to the data communication path such that the distance to the other monitoring device can be set to be less or equal to a maximum wireless data communication range.

25 Optionally, the method may also comprise determining 514 a species and/or life cycle stages of the individuals detected in the monitoring devices 104a-h based on the sensor data sets 300a-h, wherein the insect population growth forecast comprises a population growth forecast per species.

Optionally, the method may further comprise obtaining 516 the ventilation data
30 308, the temperature data 310 and/or the humidity data 312 pertaining to the monitored area 100, wherein determining 508 the insect population growth forecast is performed by combining the number of individuals detected in the monitoring devices 408a-f, the detection time points registered by the monitoring devices 104a-h, the location data sets 302a-h of the monitoring devices 104a-h and also the ventilation data 308, the

temperature data 310 and/or the humidity data 312 pertaining to the monitored area 100.

From the description above follows that, although various embodiments of the invention have been described and shown, the invention is not restricted thereto, but
5 may also be embodied in other ways within the scope of the subject-matter defined in the following claims.

CLAIMS

1. A method (500) for providing an insect population growth forecast in a monitored area (100), said method comprising
 - 5 obtaining (502) sensor data sets (300a-h) from a plurality of monitoring devices (104a-h) placed in the monitored area (100) for a sample time period, wherein each monitoring device (104a-h) comprises at least one sensor (408a-f), wherein the sensor data sets (300a-h) comprises for each sensor detection a detection time point, determining (504) a number of individuals detected in the monitoring devices
 - 10 (104a-h) during the sample time period based on the sensor data sets (300a-h), obtaining (506) respective location data sets (302a-h) for the plurality of monitoring devices (104a-h), wherein each location data set (302a-h) at least provides a distance to another monitoring device among the plurality of monitoring devices, and determining (508) the insect population growth forecast by combining the
 - 15 number of individuals detected in the monitoring devices (104a-h), the detection time points registered by the monitoring devices (104a-h), and the location data sets (302a-h) of the monitoring devices (104a-h).
2. The method according to claim 1, wherein the monitoring devices (104a-h)
 - 20 are arranged to communicate with one another via wireless data transmission, wherein the obtaining (506) the respective location data sets (302a-h) comprises for each of the monitoring devices, obtaining (510) information about at least one data communication path with at least one other monitoring device, and
 - 25 for each of the at least one data communication paths, identifying (512) the other monitoring device (104a-h) linked to the data communication path such that the distance to the other monitoring device can be set to be less or equal to a maximum wireless data communication range.
3. The method according to any one of the preceding claims, wherein the
 - 30 location data sets (302a-h) comprise coordinates reflecting positions of the monitoring devices (104a-h) in the monitored area (100).
4. The method according to any one of the preceding claims, further
 - 35 comprising

determining (514) a species and/or life cycle stages of the individuals detected in the monitoring devices (104a-h) based on the sensor data sets (300a-h), wherein the insect population growth forecast comprises a population growth forecast per species.

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5. The method according to any one of the preceding claims, wherein the at least one monitoring device (104a-h) comprises a plurality of sensors (408a-f) placed at different positions inside a housing (407) of the monitoring device (104a-h), wherein at least two of the plurality of sensors (408a-f) are placed such that an individual can be detected by multiple sensors at the same time such that a size of the individual can be determined.

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6. The method according to any one of the preceding claims, wherein a first and a second sub-set (408b, 408c) of the plurality of sensors are placed in or at a first and a second passageway (409a, 409b), respectively, such that different routes chosen by the individual inside the housing (407) can be determined.

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7. The method according to claim 6, wherein the first and second passageway (409a, 409b) differ in size.

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8. The method according to any one of the preceding claims, wherein the at least one sensor (408a-f) comprises at least one microphone (408f) arranged to register sound directly or indirectly pertaining to the individual within the housing (407).

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9. The method according to any one of the preceding claims, said method further comprising

obtaining (516) ventilation data (308), temperature data (310) and/or humidity data (312) pertaining to the monitored area (100),

wherein determining (508) the insect population growth forecast is performed by combining the number of individuals detected in the monitoring devices (408a-f), the detection time points registered by the monitoring devices (104a-h), the location data sets (302a-h) of the monitoring devices (104a-h) and also the ventilation data (308), the temperature data (310) and/or the humidity data (312) pertaining to the monitored area (100).

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10. A monitoring device (104a-h, 106a-i) for detecting insects, said device comprising
- a housing (407)
 - a processor (400),
 - 5 a memory (402),
 - a data communication device (404),
 - at least one sensor (408a-f) for detecting the insects inside the housing (407),
 - wherein the processor (400) in combination with the memory (402) is arranged to receive signals from the at least one sensor (408a-f), to link the signals to detection
 - 10 time points and to process the signals and the detection time points into sensor data sets (300a-h),
 - wherein the data communication device (404) is arranged to transmit the sensor data sets (300a-h) to a gateway (108) either directly or indirectly via another monitoring device (104a-h, 106a-i).
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11. The monitoring device according to claim 10, said monitoring device (104a-h) comprising a plurality of sensors (408a-f) placed at different positions inside the housing (407), wherein at least two of the plurality of sensors (408a-f) are placed such that an individual can be detected by multiple sensors at the same time such that a size
- 20 of the individual can be determined.
12. The monitoring device according to claim 10 or 11, wherein a first and a second sub-set (408b, 408c) of the plurality of sensors are placed in or at a first and a second passageway (409a, 409b), respectively, such that different routes chosen by
- 25 the individual inside the housing (407) can be determined.
13. The monitoring device according to claim 12, wherein the first and second passageway (409a, 409b) differ in size.
14. The monitoring device according to any one of the claims 10 to 13, wherein
- 30 the at least one sensor (408a-f) comprises at least one microphone (408f) arranged to register sound directly or indirectly pertaining to the individual within the housing (407).
15. A system (116) comprising a plurality of monitoring devices (104a-h)
- 35 according to any one of the claims 10 to 14 and a gateway (108) communicatively

- connected directly or indirectly to the monitoring devices (104a-h) and to a data processing apparatus (112), said gateway (108) being configured to obtain the sensor data sets (300a-h) from the monitoring devices (104a-h) and to transmit the sensor data sets (300a-h) to the data processing apparatus (112), wherein the data processing
- 5 apparatus being configured to determine an insect population growth forecast according to any one of the claims 1 to 9.