DESCRIPTION

IMAGING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001]

This application claims priority to Japanese Patent Application No. 2022-121789, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002]

The present invention relates to an imaging system for capturing an image of an insect trapping surface of an insect trapping sheet.

BACKGROUND

[0003]

A system described in Patent Literature 1 is conventionally known as a trapped insect identification system for identifying trapped insects. The trapped insect identification system includes an image reading device configured to read an image of an adhesive sheet with an insect adhering thereto using an image reader, and an analysis apparatus for analyzing the read image to identify the trapped insect. The analysis apparatus includes: a pre-processing device configured to process the read image to distinguish an insect area of the image in which the insect is present from a background area; a characteristic extracting device configured to acquire merkmal data of the insect from the pre-processed image; a data storage device configured to store standard merkmal data obtained by standardizing merkmals of morphological characteristics of the insect; an identifying device configured to identify the insect through comparison between the merkmal data extracted by the characteristic extracting device and the standard merkmal data stored in the data storage device.

[0004]

The trapped insect identification system as described above is deemed to be

capable of obtaining more objective and more consistent identification results than in the case where insects are manually identified.

CITATION LIST

Patent Literature

[0005]

Patent Literature 1: JP 2014-142833 A

SUMMARY

Technical Problem

[0006]

When identifying insects using the trapped insect identification system as described above, the morphological characteristics or the like of the insects need to be recognized from the image read by the image reading apparatus. However, the insect trapping sheet (adhesive sheet) sometimes warps due to, for example, moisture absorption in an environment in which the insect trapping sheet is placed for trapping insects. Reading the insect trapping sheet in a warping state with the image reader may result in, for example, an image out of focus, from which the morphological characteristics of the trapped insects are hardly recognizable.

[0007]

Such a problem could occur not only in mechanically identifying the trapped insects but also in manual identification based on the captured image of the insect trapping sheet.

[0008]

It is therefore an object of the present invention to provide an imaging system capable of appropriately capturing an image of the insect trapping surface of the insect trapping sheet even when the insect trapping sheet warps.

Solution to Problem

[0009]

An imaging system of the present invention is an imaging system for capturing

an image of an insect trapping surface disposed on at least one side of an insect trapping sheet and configured to be capable of trapping an insect, the imaging system including: a holding part for holding the insect trapping sheet under tension in a tensioning direction along a plane direction of the insect trapping surface; and an imaging device for capturing the image of the insect trapping surface of the insect trapping sheet held by the holding part.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

Fig. 1 is a block diagram of an imaging system according to one embodiment of the present invention.

Fig. 2 is a perspective view of an imaging apparatus of the imaging system.

Fig. 3 is a view showing an inside of the imaging apparatus.

Fig. 4 is a view showing a holding part of the imaging system.

Fig. 5A is a view showing a state in which one end of an insect trapping sheet is fixed to the holding part of the imaging system.

Fig. 5B is a view showing a state in which the insect trapping sheet in the state shown in Fig. 5A is pulled in a right-left direction.

Fig. 5C is a view showing a state in which both ends of the insect trapping sheet are fixed to the holding part of the imaging system.

Fig. 6 is a cross-sectional view taken along line VI-VI in Fig. 5C.

Fig. 7 is a cross-sectional view taken along line VII-VII in Fig. 3.

Fig. 8 is a schematic view of images to be captured by the imaging device of the imaging system.

Fig. 9 is a schematic view of image processing in an image processing part of the imaging system.

Fig. 10 is a schematic view of the insect trapping sheet whose image is to be captured by the imaging system.

DESCRIPTION OF EMBODIMENTS

[0011]

A description will be hereinafter given on an imaging system 1 according to one embodiment of the present invention with reference to Fig. 1 to Fig. 10. For convenience of explanation, the description will be given on a basis of a vertical direction, a right-left direction, and a front-back direction, which are as shown in Fig. 2.

[0012]

First, a description will be given on an insect trapping sheet 9 of which an image is to be captured by the imaging system 1 according to the present invention, with reference to Fig. 10.

[0013]

As shown in Fig. 10, the insect trapping sheet 9 has a substantially rectangular sheet shape in plan view. Specifically, the insect trapping sheet 9 includes an insect trapping part 91 extending in the right-left direction, and a pair of sheet end parts 92 respectively connected to both ends in the right-left direction of the insect trapping part 91.

[0014]

The insect trapping part 91 is configured to have insect trapping surfaces 91a capable of trapping insects on both an upper side and a lower side of the insect trapping part 91. Specifically, the insect trapping part 91 includes a base member having a sheet shape and a rectangular shape in plan view and elongated in the right-left direction, and the insect trapping surfaces 91a present on the upper side and the lower side of the base member, and each of the insect trapping surfaces 91a is formed as an adhesive surface to which insects can adhere. The insect trapping part 91 of this embodiment is configured to allow a flying insect that has come into contact with the insect trapping surface 91a to adhere to the insect trapping surface 91a so that the insect can be trapped.

[0015]

The sheet end parts 92 are plate-shaped bodies respectively connected to the both end parts in the right-left direction of the insect trapping part 91. Specifically, the sheet end parts 92 include a first sheet end part 921 having a plate shape and disposed in an end part on one side (left side) in the right-left direction of the insect trapping part 91, and a second sheet end part 922 having a plate shape and disposed in an end part on an other side (right side) in the right-left direction of the insect trapping part 91. The first

sheet end part 921 has a hook hole 921a penetrating therethrough in a thickness direction, and a writing part 921b for writing information on insect trapping (e.g., location in which or time at which insects are trapped) thereon. The insect trapping part 91 is connected to an intermediate portion in the right-left direction of the second sheet end part 922 in the state where the second sheet end part 922 has its plane direction extending along the upper side and the lower side of the insect trapping part 91. The second sheet end part 922 includes an inward portion 922a disposed on one side (left side) in the right-left direction of the connected portion to the insect trapping part 91 and overlapping the insect trapping part 91 in the vertical direction in the state where the inward portion 922a has its plane direction extending along the upper side and the lower side of the insect trapping part 91, and an outward portion 922b on an other side (right side) in the right-left direction of the connected portion to the insect trapping part 91. In this embodiment, each of the first sheet end part 921 and the second sheet end part 922 has a length in the front-back direction (width direction) greater than the length in the front-back direction (width direction) of the insect trapping part 91.

[0016]

Such an insect trapping sheet 9 is placed at a location of insect trapping (e.g., location to be inspected as to whether insects live) for a certain period of time. For example, the insect trapping sheet 9 is placed at the location of placement with a hook at the location inserted into the hook hole 921a, and then collected after several days to several months during which the insect trapping sheet 9 is kept being placed. The insect trapping sheet 9 may warp due to moisture absorption in the environment where it is placed, in which case the insect trapping sheet 9 may, for example, entirely or locally expand or contract in the right-left direction.

[0017]

As shown in Fig. 1, the imaging system 1 includes an imaging apparatus 2 configured to capture an image of the insect trapping sheet 9, and a determination processing part 3 configured to determine the insect trapped by the insect trapping sheet 9 based on the resulting image captured by the imaging apparatus 2. The determination processing part 3 of this embodiment is a server external to the imaging apparatus 2, and is configured to enable wired or wireless communication with the imaging apparatus 2.

Such an imaging system 1 is a system for capturing an image of the insect trapping surface 91a of the insect trapping sheet 9 that is collected after being placed at the location of insect trapping for a certain period of time as described above.

[0018]

As shown in Fig. 1 to Fig. 3, the imaging apparatus 2 includes: a housing 21 having a box shape; a holding part 4 for holding the insect trapping sheet 9 of which the image is to be captured; a control part 23 for controlling the entire apparatus; an imaging device 5 for capturing an image of the insect trapping sheet 9 held by the holding part 4; an illuminating apparatus 6 for illuminating the insect trapping sheet 9 held by the holding part 4 with light; an operating part 7 for receiving external inputs; and an image processing part 8 for processing the image captured by the imaging device 5. The holding part 4, the control part 23, the imaging device 5, and the illuminating apparatus 6 are disposed inside the housing 21. The housing 21 includes an openable and closable door 22 on its front side, and is configured to allow the holding part 4 to be drawn forward when the door 22 is opened. Further, the housing 21 is made of a material including a magnetic metal (e.g., iron).

[0019]

As shown in Fig. 3 and Fig. 4, the holding part 4 is a portion having a frame shape and a rectangular shape in plan view and connected to the housing 21. Specifically, the holding part 4 includes a holding frame part 41 for holding the insect trapping sheet 9, and a holding base part 46 for connecting the holding frame part 41 to the housing 21. The holding frame part 41 of this embodiment is configured to be detachably attached to the housing 21 via the holding base part 46. Such a holding part 4 is disposed at a position upwardly away from a lower side of the housing 21 to have its longitudinal direction corresponding to the right-left direction, and is configured to hold the insect trapping sheet 9 to extend in a horizontal direction.

[0020]

As shown in Fig. 4, the holding frame part 41 is a frame-shaped body having a rectangular shape in plan view, and is capable of holding the insect trapping sheet 9 therewithin. Specifically, the holding frame part 41 includes: a frame body 42 having a rectangular shape in plan view extending in its longitudinal direction (right-left direction)

and its short-side direction (front-back direction); a first fixing device 43 disposed at one end part in the longitudinal direction of the frame body 42; a second fixing device 44 disposed at an other end part in the longitudinal direction of the frame body 42; and a tension applying device 45 for applying tension in the longitudinal direction to the held insect trapping sheet 9. The frame body 42 is a frame made in combination of a pair of rod bodies extending in the longitudinal direction and a pair of rod bodies extending in the short-side direction, and has a plurality of connecting holes 41a with which holding projections of the holding base part 46 to be described later can be engaged.

[0021]

The first fixing device 43 is a portion for fixing an end part on the one side (left side) in the right-left direction of the insect trapping sheet 9. Specifically, the first fixing device 43 includes a first fixing base 431 having a plate shape and connected to the frame body 42, and a hook part 432 connected to the first fixing base 431. The first fixing base 431 is immovably fixed to the frame body 42. The hook part 432 is a hook capable of being inserted into the hook hole 921a of the first sheet end part 921, and is disposed at a substantially central portion in the short-side direction to extend upward and leftward from the first fixing base 431.

[0022]

The second fixing device 44 is a portion for fixing an end part on the other side (right side) in the right-left direction of the insect trapping sheet 9. Specifically, the second fixing device 44 includes a second fixing base 441 having a plate shape and connected to the holding frame part 41 via the tension applying device 45, and a stopper 442 (see Fig. 6) having a plate shape and extending downward from the second fixing base 441. The stopper 442 is disposed to extend downward from an end part on one side in a longitudinal direction of the second fixing base 441, and is configured to restrict the inward portion 922a of the second sheet end part 922 from moving on one side in the longitudinal direction.

[0023]

The second fixing base 441 includes a fixing body part 443 having a plate shape and forming one end part in the longitudinal direction, and a positioning part 444 having a plate shape and connected to the fixing body part 443 and extending on the other end side

in the longitudinal direction. The positioning part 444 includes a pair of positioning parts 444 spaced away from each other in the short-side direction; specifically, the pair of positioning parts 444 are connected to one end and an other end in the short-side direction of the fixing body part 443. As shown in Fig. 5A, the pair of positioning parts 444 are disposed away from each other in the short-side direction with a distance substantially equal to the length in the short-side direction of the insect trapping part 91 of the insect trapping sheet 9 to be fixed.

[0024]

As shown in Fig. 4 and Fig. 6, the tension applying device 45 is configured to apply tension to the insect trapping sheet 9 fixed to the first fixing device 43 and the second fixing device 44. The tension applying device 45 applies tension in a direction in which the first fixing device 43 and the second fixing device 44 are away from each other; in this embodiment, the tension applying device 45 applies tension in the direction in which the first fixing device 43 and the second fixing device 44 are away from each other to the insect trapping sheet 9 fixed to the first fixing device 43 and the second fixing device 44, by biasing the second fixing device 44 in a direction away from the first fixing device 43. Specifically, the tension applying device 45 includes a guide part 451 connected to the frame body 42 and extending in the longitudinal direction, and a biasing device 452 disposed on the guide part 451.

[0025]

The guide part 451 is a portion having a rod shape and extending along the longitudinal direction. Specifically, the guide part 451 includes a guide body part 453 having a rod shape and extending along the longitudinal direction, a biasing connecting part 454 having a wall shape and disposed at one end in the longitudinal direction of the guide body part 453 and extending in the vertical direction, and a slide restricting part 455 having a wall shape and disposed at an other end in the longitudinal direction of the guide body part 453 and extending in the vertical direction. The second fixing base 441 can be attached to the guide body part 453, and the attached second fixing base 441 can move between the slide restricting part 455 and the biasing connecting part 454 along the guide body part 453.

[0026]

The second fixing device 44 has the second fixing base 441 moving in the longitudinal direction along the guide part 451 to be thereby movable in the direction toward and away from the first fixing device 43. Specifically, the second fixing device 44 is movable between the biasing connecting part 454 and the slide restricting part 455 along the guide body part 453. The guide part 451 is disposed to allow the second fixing device 44 to move between a position with a shorter distance from the first fixing device 43 (specifically hook part 432) and a position with a longer distance therefrom than the length in the longitudinal direction of the insect trapping sheet 9. Specifically, in the guide part 451, the biasing connecting part 454 at the one end in the longitudinal direction of the guide body part 453 is disposed at a position with a shorter distance from the first fixing device 43 than the length in the longitudinal direction of the insect trapping sheet 9, and the slide restricting part 455 at the other end of the guide body part 453 is disposed at a position with a longer distance from the first fixing device 43 than the length in the longitudinal direction of the insect trapping sheet 9. This configuration enables the second fixing device 44 to move between the position with a shorter distance from the first fixing device 43 and the position with a longer distance therefrom than the length in the longitudinal direction of the insect trapping sheet 9.

[0027]

The biasing device 452 is a portion for biasing the second fixing base 441 attached to the guide part 451 toward the other end side in the longitudinal direction. Specifically, the biasing device 452 is disposed on the guide part 451 to have one end part in the longitudinal direction connected to the biasing connecting part 454 and have an other end part in contact with the second fixing base 441. In this embodiment, the biasing device 452 is a coil spring disposed between the biasing connecting part 454 and the second fixing base 441. When not subjected to external force, the biasing device 452 biases the second fixing base 441 to locate the second fixing base 441 with a distance in the longitudinal direction from the first fixing device 43 longer than the length in the longitudinal direction of the insect trapping sheet 9.

[0028]

Such a tension applying device 45 includes a pair of tension applying devices 45 disposed away in the short-side direction from each other. Specifically, the tension

applying devices 45 are disposed respectively on one rod body and an other rod body both extending in the longitudinal direction of the frame body 42. The tension applying device 45 on one side in the short-side direction is connected to one end part in the short-side direction of the second fixing device 44 while the tension applying device 45 on an other side in the short-side direction is connected to an other end part in the short-side direction of the second fixing device 44. Further, a biasing part of the tension applying device 45 on the one side in the short-side direction is in contact with the one end part in the short-side direction of the second fixing device 44 to bias the second fixing device 44 while a biasing part of the tension applying device 45 on the other side in the short-side direction is in contact with the other end part in the short-side direction of the second fixing device 44 to bias the second fixing device 44.

[0029]

A description will be given on a method for attaching the insect trapping sheet 9 to the holding frame part 41 with reference to Fig. 5A to Fig. 5C. In this embodiment, the second sheet end part 922 is fixed to the second fixing device 44, and then the first sheet end part 921 is fixed to the first fixing device 43.

[0030]

As shown in Fig. 5A, when the second sheet end part 922 is fixed to the second fixing device 44, the second sheet end part 922 is engaged with the second fixing base 441. Specifically, the insect trapping part 91 is disposed on the fixing body part 443 and the inward portion 922a of the second sheet end part 922 is disposed under the fixing body part 443, to support the connected portion of the second sheet end part 922 and the insect trapping part 91 between an upper side and a lower side (i.e., thickness) of the fixing body part 443. Then, an upper side of the second sheet end part 922 is brought in abutting contact with the lower side of the fixing body part 443 to be thereby engaged with the second fixing base 441.

[0031]

The positioning parts 444 extending on the other end side in the longitudinal direction are connected to both ends in a width direction (i.e., short-side direction) of the fixing body part 443; thus, the positioning parts 444 can suppress the insect trapping part 91 from being displaced in the width direction. Since the second sheet end part 922 has a

length in the width direction longer than the length in the width direction of the insect trapping part 91, a portion of the second sheet end part 922 outside the insect trapping part 91 in the width direction can be securely engaged with lower sides of the positioning parts 444. This configuration can suppress the insect trapping sheet 9 fixed to the second fixing device 44 from being displaced or from falling off the second fixing device 44.

[0032]

Next, as shown in Fig. 5B and Fig. 5C, in the state where the second fixing device 44 fixes the second sheet end part 922, the second fixing base 441 is caused to move to one end side in the longitudinal direction (i.e., one side in a tensioning direction) against the biasing force of the biasing device 452 to bring the second fixing device 44 close to the first fixing device 43 and fix the first sheet end part 921 to the first fixing device 43. To fix the first sheet end part 921 to the first fixing device 43, the hook part 432 is inserted into the hook hole 921a of the first sheet end part 921.

[0033]

The insect trapping sheet 9 is attached to the holding frame part 41 by the above procedure. The insect trapping sheet 9 can be attached to the holding frame part 41 by other procedure than those above. For example, the configuration can be such that the first sheet end part 921 is first fixed to the first fixing device 43 and then the second fixing device 44 is brought close to the first fixing device 43 to fix the second sheet end part 922 to the second fixing device 44.

[0034]

As shown in Fig. 5C, the insect trapping sheet 9 attached to the holding frame part 41 is held pulled in the longitudinal direction by the tension applying devices 45. Specifically, the second fixing device 44 biased by the biasing part toward the other end side in the longitudinal direction biases the second sheet end part 922 fixed to the second fixing device 44 toward the other end side in the longitudinal direction, thereby applying tension in the longitudinal direction to the insect trapping sheet 9. The tension thus corrects warping of the insect trapping sheet 9. Further, as shown in Fig. 5C and Fig. 6, the second fixing device 44 supports the entire area in the width direction of the insect trapping sheet 9. The second fixing device 44 of this embodiment is brought into abutting contact with the entire area in the width direction of the connected portion

between the insect trapping part 91 of the insect trapping sheet 9 and the second sheet end part 922 from the one side in the longitudinal direction to thereby support the insect trapping sheet 9. This configuration suppresses tension from being applied to a partial area in the width direction of the insect trapping sheet 9, and thus suppresses the insect trapping sheet 9 from warping due to tension.

[0035]

As shown in Fig. 4, the holding base part 46 includes a frame receiving part 461 for receiving the frame body, and a pivoting mechanism K for connecting the frame receiving part 461 to the housing 21 and pivotally moving the frame receiving part 461 relative to the housing 21. The pivoting mechanism K includes a shaft part 462 projecting outward of the frame receiving part 461 and connected to the housing 21, a holding operation part 463 for pivotally moving the frame receiving part 461 about the shaft part 462, and an inversion assisting part 464. The holding base part 46 configured as above is accommodated inside the housing 21 except the holding operation part 463.

[0036]

The frame receiving part 461 is a frame body having a rectangular shape in plan view capable of accommodating the holding frame part 41 therein, and can be fixed with the holding frame part 41 accommodated therein. Specifically, the frame receiving part 461 includes a frame connecting part 461a engaged with the connecting hole 41a of the holding frame part 41 accommodated therein. The frame connecting part 461a includes a plurality of projections protruding inward of the frame receiving part 461, and is disposed to enter and exit from the inside of the frame receiving part 461. Such a frame connecting part 461a is configured to be engaged with the connecting hole 41a by advancing to thereby fix the holding frame part 41 to the frame receiving part 461, and releases engagement with the connecting hole 41a by retracting to thereby unfix the holding frame part 41 from the frame receiving part 461. Such a frame receiving part 461 is configured to allow the upper side of the insect trapping sheet 9 held by the holding frame part 41 for fixing to be visible from above, and allow the lower side thereof to be visible from below.

[0037]

The shaft part 462 is a shaft that extends outward from central portions in the

short-side direction of both ends in the longitudinal direction of the frame receiving part 461. Such a shaft part 462 is connected to the housing 21 to allow the holding base part 46 to pivotally move, specifically, is connected to the housing 21 via a bearing (not shown).

[0038]

The holding operation part 463 is a portion for pivotally moving the frame receiving part 461 about the shaft part 462, and in this embodiment disposed to allow the frame receiving part 461 disposed inside the housing 21 to pivotally move about the shaft part 462 from outside the housing 21. Specifically, the holding operation part 463 includes an operating shaft 465 connected to the shaft part 462 and extending outward in the longitudinal direction of the frame receiving part 461 from the shaft part 462, and a handle 466 connected to the operating shaft 465. The operating shaft 465 is a shaft disposed to have its one end in an extending direction (i.e., longitudinal direction) connected to the shaft part 462 and have its other end extending to the outside of the housing 21. The handle 466 is connected to the other end in the extending direction of the operating shaft 465, and is configured to allow the shaft part 462 to pivotally move through operation from outside the housing 21.

[0039]

As shown in Fig. 4 and Fig. 7, the inversion assisting part 464 includes the inversion assisting part 464 configured to assist the frame receiving part 461 in pivotal movement about the shaft part 462 to allow the insect trapping surface 91a of the insect trapping sheet 9 to face the imaging device 5 to be described later. Specifically, the inversion assisting part 464 includes a first magnetic body 464a that is a magnetic body pivotally moving about the shaft part 462 integrally with the frame receiving part 461, and a second magnetic body configured to be attracted to the first magnetic body 464a in a state where the imaging device 5 to be described later faces the insect trapping surface 91a of the held insect trapping sheet 9.

[0040]

The first magnetic body 464a is a magnetic body disposed on the frame receiving part 461, and is, for example, a magnet. Specifically, the first magnetic body 464a is a magnetic body disposed on each of both ends in the short-side direction of the frame

receiving part 461. Such a first magnetic body 464a can pivotally move about the shaft part 462 integrally with the frame receiving part 461.

[0041]

As shown in Fig. 7, the second magnetic body is a magnetic body that can be attracted to the first magnetic body 464a, and is, for example, iron. The second magnetic body of this embodiment is a part of a wall surface of the housing 21.

[0042]

In this embodiment, the first magnetic body 464a is located closest to the wall surface of the housing 21 when the insect trapping surface 91a (on the upper side or the lower side) of the held insect trapping sheet 9 faces the imaging device 5 during pivotal movement of the frame receiving part 461 about the shaft part 462. Since the first magnetic body 464a can attract the second magnetic body, the first magnetic body 464a is attracting the second magnetic body with the magnetic force when the first magnetic body 464a comes close to the second magnetic body during pivotal movement of the frame receiving part 461 about the shaft part 462. The first magnetic body 464a thus comes closest to the second magnetic body (in this embodiment the wall surface of the housing 21), and can assist the insect trapping surface 91a of the insect trapping sheet 9 held by the holding part 4 in facing the imaging device 5.

[0043]

As shown in Fig. 3 and Fig. 7, the imaging device 5 is disposed above the insect trapping sheet 9 held by the holding part 4, and is configured to be capable of capturing an image of the surface on the upper side (i.e., insect trapping surface 91a) of the insect trapping sheet 9. Specifically, the imaging device 5 includes an imaging part 51 for capturing an image of the insect trapping surface 91a, and a running part 52 for allowing the imaging part 51 to run along the tensioning direction (longitudinal direction) of the insect trapping sheet 9. Such an imaging device 5 can capture images of the entire area of the insect trapping surface 91a of the insect trapping sheet 9.

[0044]

The imaging part 51 is disposed to face the insect trapping surface 91a of the insect trapping sheet 9 held by the holding part 4, and is configured to be capable of capturing an image of the facing insect trapping surface 91a. Specifically, the imaging

part 51 is a camera. The imaging part 51 of this embodiment is configured to focus on a portion of the insect trapping surface 91a that faces the imaging part 51 (i.e., a portion located directly below the imaging part 51). As shown in Fig. 8, the imaging part 51 of this embodiment is capable of capturing an image of the entire area in the short-side direction (width direction) of the insect trapping surface 91a, and is capable of capturing an image of a portion in the longitudinal direction (tensioning direction) of the insect trapping surface 91a.

[0045]

The running part 52 includes a rail 53 extending along the tensioning direction (longitudinal direction), and a moving part 54 connected to the imaging part 51, engaged with the rail 53, and capable of moving along the rail 53. The rail 53 is disposed to extend from a position on one end side of the one end in the tensioning direction (longitudinal direction) of the holding frame part 41 connected to the housing 21 to a position on the other end side of the other end of the holding frame part 41.

[0046]

The imaging device 5 as described above is capable of capturing images of the insect trapping surface 91a at a plurality of positions away from each other in the tensioning direction of the insect trapping sheet 9. Specifically, the imaging part 51 is configured to capture images of the insect trapping sheet 9 at the plurality of positions while moving along the rail 53 in the tensioning direction. The imaging part 51 of this embodiment is configured to capture images of the insect trapping surface 91a at certain intervals in the tensioning direction. Specifically, the intervals at which the imaging part 51 captures images of the insect trapping surface 91a are set so that end parts in the longitudinal direction of images captured by the imaging part 51 at each adjacent imaging positions in the tensioning direction overlap each other, and in this embodiment, the intervals at which the imaging part 51 captures images of the insect trapping surface 91a are set so that in-focus portions of the captured images are adjacent to each other in the tensioning direction. The rail 53 extending along the tensioning direction allows the imaging part 51 to run substantially in parallel with the insect trapping surface 91a. This configuration can achieve a substantially constant distance between the insect trapping surface 91a and the imaging part 51 at the plurality of imaging positions away from each

other in the tensioning direction. Before capturing the images of the insect trapping surface 91a, the imaging device 5 of this embodiment captures an image of the first sheet end part 921 to include the writing part 921b.

[0047]

As shown in Fig. 3 and Fig. 7, the illuminating apparatus 6 is a portion of illuminating the insect trapping surface 91a of the insect trapping sheet 9 held by the holding part 4 with light. The illuminating apparatus 6 of this embodiment is configured to illuminate the insect trapping surface 91a with light from both sides across the tensioning direction. Specifically, the illuminating apparatus 6 includes illuminating parts 61 (e.g., LED lights) on one side and the other side in the width direction with the rail 53 of the running part 52 therebetween, and each of the illuminating parts 61 illuminates the insect trapping surface 91a with light. Further, each of the illuminating parts 61 is disposed for illumination from a position at substantially 45 degrees away from above a center in the width direction (i.e., a direction orthogonal to the plane direction) of the insect trapping surface 91a. The illuminating apparatus 6 of this embodiment has a plurality of the illuminating parts 61 arranged along the tensioning direction; specifically, has the plurality of illuminating parts 61 arranged from one side of the one end part in the tensioning direction (longitudinal direction) of the holding frame part 41 to the other side of the other end part of the holding frame part 41. The illuminating apparatus 6 of this embodiment illuminates the insect trapping surface 91a with white light.

[0048]

As shown in Fig. 2, the operating part 7 is configured to be capable of inputting various operations from outside the housing 21. For example, operation inputs can be made to the operating part 7 for capturing images of the insect trapping sheet 9 with the imaging part 51 and for transmitting the captured image result to the external determination processing part 3. The operating part 7 of this embodiment is a touch panel disposed on an outer surface of the housing 21, but without limitation thereto, the operating part 7 can be configured as a wired or wireless controller disposed outside the housing 21, or can be configured to allow operation inputs from an external computer.

[0049]

As shown in Fig. 8 and Fig. 9, the image processing part 8 executes image processing for generating a processed image data D based on a plurality of images P1, P2 of the insect trapping surface 91a captured by the imaging device 5. In the image processing, the imaging device 5 generates the processed image data D by combining the plurality of images of the insect trapping surface 91a captured by the imaging device 5. Specifically, in the image processing, one processed image data D is generated by connecting the plurality of images P1, P2 captured of one insect trapping surface 91a to each other in the tensioning direction. In the image processing of this embodiment, in-focus portions P1a, P2a respectively of the images P1, P2 captured by the imaging device 5 are extracted, and the in-focus portions P1a, P2a extracted from the images P1, P2 are arranged and connected to each other in the tensioning direction to generate the processed image data D. The term in-focus means that the images are in focus to the extent not causing any trouble in processing in the determination processing part 3 to be described later. In this embodiment, the in-focus portions of the images P1 and P2 each refer to a predetermined range in consideration of the performance of the imaging part 51 or effects on the processing in the determination processing part 3 to be described later. Making smaller the in-focus portions P1a, P2a can reduce an adverse effect on the processed image data D that could be caused by defocusing, although a larger number of images need to be captured by the imaging part 51 to generate the processed image data D. Making larger the in-focus portions P1a, P2a increases the adverse effect on the processed image data D that could be caused by defocusing, although only a smaller number of images need to be captured by the imaging part 51 to generate the processed image data D.

[0050]

The control part 23 is configured to control the entire imaging apparatus 2. Specifically, the control part 23 is configured to operate the imaging device 5 based on the input from the operating part 7, and command the image processing part 8 to process the images captured by the imaging device 5. The control part 23 transmits the processed image data D processed by the image processing part 8 to the external determination processing part 3.

[0051]

A description will be given on a method for capturing images of the insect trapping surface 91a using the imaging apparatus 2 configured as above. To capture images of the insect trapping surface 91a with the imaging apparatus 2, the insect trapping sheet 9 is first fixed to the holding part 4. The method for fixing the insect trapping sheet 9 to the holding part 4 has been described as above. To fix the insect trapping sheet 9 to the holding frame part 41, the insect trapping sheet 9 can be fixed to the holding frame part 41 removed from the holding base part 46, or can be fixed to the holding frame part 41 while the holding frame part 41 is fixed to the holding base part 46. When the insect trapping sheet 9 is fixed to the holding frame part 41, tension is applied to the insect trapping sheet 9 in the longitudinal direction by the tension applying device 45, thereby suppressing the insect trapping sheet 9 from warping. After the insect trapping sheet 9 is fixed to the holding part 4, the door 22 of the housing 21 is closed.

[0052]

Next, the operating part 7 is operated to capture images of the insect trapping sheet 9 with the imaging device 5. In this embodiment, first captured are an image of the writing part 921b on the first sheet end part 921 and images of the insect trapping surface 91a on one side (i.e., upper side) of the insect trapping surfaces 91a disposed on both sides. Once capturing the images of the surface on the upper side is completed, an operator pivotally moves the handle 466 of the holding operation part 463 about the shaft part 462 to invert the holding part 4 and insect trapping paper held by the holding part 4 about the shaft part 462 and turn over the insect trapping surface 91a located on the upper side, so that the insect trapping surface 91a on the other side is located on the upper side. The holding part 4 including the inversion assisting part 464 can stop its pivotal movement about the shaft part 462 at a position at which the insect trapping surface 91a faces the imaging part 51; thus, the insect trapping surface 91a on the other side can be securely made to face the imaging part 51. Then, the insect trapping sheet 9 is inverted and the operating part 7 is operated again to capture images of the insect trapping surface 91a on the other side with the imaging device 5.

[0053]

When capturing the images of the insect trapping surfaces 91a on both sides is completed, the image processing part 8 processes the captured images of each of the

insect trapping surfaces 91a to generate the processed image data D. The image processing part 8 of this embodiment generates the processed image data D corresponding to the insect trapping surface 91a on the one side and the processed image data D corresponding to the insect trapping surface 91a on the other side.

[0054]

Then, the control part 23 transmits the processed image data D to the external determination processing part 3. In this embodiment, the processed image data D for the two insect trapping surfaces 91a on the one side and the other side and the captured image of the writing part 921b are associated with each other and transmitted to the determination processing part 3. The processing in the imaging apparatus 2, such as capturing images, is thus completed.

[0055]

Next, a description will be given on processing in the determination processing part 3. The determination processing part 3 is configured to determine a type of insect captured by the insect trapping surface 91a and the number of captured insects per type, based on the processed image data D.

[0056]

The determination processing part 3 of this embodiment is configured to identify the type of insect in the processed image data D through a learned model constructed by machine learning using training data, and calculate the number of insects per type. The learned model is constructed by machine learning using training image data to be described later as the training data.

[0057]

The training image data is data in which frame information for identifying a position of the insect in the image, posture information for identifying posture of the insect, and type information for identifying the type of insect are imparted to the image of the insect. In this embodiment, the posture information includes point information imparted to at least three points in which a head and a trunk of the insect are included, and sequence information on an order imparted to the point information.

[0058]

Such a determination processing part 3 processes the processed image data D to

find an insect in the processed image data D and identify the type of the found insect. The determination processing part 3 of this embodiment is configured to impart the type information of the found insect to the processed image data D to output the number of insects per type as an identification result. In the determination processing part 3 of this embodiment, the identification result is output in association with the information written on the writing part 921b associated with the processed image data D. For example, the identification result is output in association with the location and time written on the writing part 921b at which the insect is trapped. In this embodiment, classification at a family level is mainly employed as the type of the insect.

[0059]

According to such a determination processing part 3, the learned model is constructed by machine learning using the training data including the posture information that includes the point information and the sequence information on the at least three points designated from among the insect data included in the training image data. Thus, the type of insect in the processed image data D can be properly identified even when the insect is, for example, bent.

[0060]

The imaging system 1 configured as above, in which the holding part 4 holds the insect trapping sheet 9 under tension in the direction along the plane direction of the insect trapping surface 91a, allows the tension to suppress the insect trapping sheet 9 from warping. This configuration enables the images of the insect trapping surface 91a of the insect trapping sheet 9 to be appropriately captured. Suppressing warping means suppressing the warping to the extent not affecting the subsequent steps (e.g., processing in the determination processing part 3), and is not limited to the case of completely eliminating the warping.

[0061]

The configuration that the tension applying device 45 applies tension to the insect trapping sheet 9 fixed to the fixing device can securely apply tension to the insect trapping sheet 9 held by the holding part 4, and can thus suppress the insect trapping sheet 9 from warping.

[0062]

Further, the configuration that the imaging device 5 runs in parallel with the tensioning direction in the state where the warping of the insect trapping surface 91a is suppressed by tension enables the imaging apparatus 2 to be located at different positions to capture the images of the insect trapping surface 91a while the distance between the insect trapping surface 91a and the imaging device 5 is kept substantially constant. This configuration enables the images of the insect trapping surface 91a of the insect trapping sheet 9 to be appropriately captured.

[0063]

The configuration that the illuminating apparatus 6 illuminates the insect trapping surface 91a with light from at least one side in the width direction enables the insect trapping paper to be securely irradiated with light even if the length of the insect trapping paper changes in the tensioning direction due to the tension. This configuration enables the images of the insect trapping surface 91a of the insect trapping sheet 9 to be appropriately captured.

[0064]

Further, the configuration that the image processing part 8 generates the processed image data D based on the plurality of images captured by the imaging device 5 enables the images at a plurality of positions in the tensioning direction to be used to generate the processed image data D, thus allowing the obtained image data to be easily handled.

[0065]

The tension applying device 45 includes a biasing device 452 biasing one of the pair of fixing devices (second fixing device 44) in a direction away from the other fixing device (first fixing device 43), and the biasing device 452 includes a pair of the biasing devices 452 disposed on one side and the other side in the width direction of the insect trapping sheet 9 fixed by the pair of fixing devices. This configuration suppresses tension from being applied to a partial area in the width direction of the insect trapping sheet 9, and thus suppresses the insect trapping sheet 9 from warping due to tension.

[0066]

Further, the tension applying device 45 is configured to bias one of the fixing devices in the direction away from the other one of the fixing devices, and at least one of

the pair of fixing devices (second fixing device 44) is configured to hold the entire area in the width direction of the insect trapping sheet 9. This configuration suppresses tension from being applied to a partial area in the width direction of the insect trapping sheet 9, and thus suppresses the insect trapping sheet 9 from warping due to tension.

[0067]

The distance between the pair of fixing devices can be changed between a shorter distance and a longer distance than the length in the tensioning direction of the insect trapping sheet 9 before being attached for insect trapping. This configuration enables tension to be applied to the insect trapping sheet 9 in both cases where the insect trapping sheet 9 is shrunk and stretched by the warping, thereby being capable of securely suppressing the insect trapping sheet 9 from warping. This configuration enables the images of the insect trapping surface 91a of the insect trapping sheet 9 to be appropriately captured.

[0068]

Further, the holding part 4 includes the pivoting mechanism K configured to pivotally move the held insect trapping sheet 9 about the shaft part 462 extending along the tensioning direction. This configuration can invert the insect trapping sheet 9 to turn over the surface facing the imaging device 5, thereby being capable of smoothly capturing images of the both surfaces of the insect trapping sheet 9 with the insect trapping surfaces 91a located on the both sides.

[0069]

The pivoting mechanism K includes the inversion assisting part 464 for assisting in inverting the insect trapping sheet 9 so as to have the insect trapping surface 91a facing the camera. This configuration enables the insect trapping surface 91a to securely face the imaging part 51, and can thus appropriately capture images of the insect trapping surface 91a of the insect trapping sheet 9.

[0070]

Further, the inversion assisting part 464 includes the first magnetic body 464a pivotally moving about the shaft part 462 together with the insect trapping surface 91a, and the second magnetic body attracted to the first magnetic body 464a in the state where the insect trapping surface 91a faces the imaging device 5. This simplifies the

configuration for allowing the insect trapping surface 91a to face the imaging device 5.

[0071]

The pivoting mechanism K includes the holding operation part 463 for an inverting operation of the insect trapping sheet 9, and the holding operation part 463 is disposed to have at least a part thereof located outside the housing 21. This configuration can invert the insect trapping sheet 9 through the operation from outside the housing 21, enabling the insect trapping sheet 9 to be easily inverted.

[0072]

Further, the holding part 4 further includes the holding frame part 41 for holding the insect trapping sheet 9, and the holding base part 46 for fixing the holding frame part 41 to the housing 21, and the holding frame part 41 is detachably attached to the holding base part 46. The configuration that the holding frame part 41 is detachable from the holding base part 46 enables the holding frame part 41 to be removed from the holding base part 46 as needed for attaching the insect trapping sheet 9. This configuration enables the insect trapping sheet 9 to be easily attached to the holding part 4.

[0073]

The embodiments of the present invention have been described by way of example, but the present invention is not limited to the aforementioned embodiments, and various modifications can be made without departing from the gist of the present invention.

[0074]

For example, the configuration of the insect trapping sheet 9 is not limited to the configuration described in the embodiment. For example, the description has been given on the case where the insect trapping surface 91a is an adhesive surface. However, the configuration is not limited thereto, and various configurations capable of trapping insects can be employed. For example, the configuration can be such that an upper side of a tray having one surface on which the dead body of a falling insect is placed serves as the insect trapping surface 91a, or even when being formed as an adhesive surface, the configuration can be such that the insect trapping surface 91a is disposed not only on both sides but also only on either side. Further, the description has been given on the case where the insect trapping surface 91a has a substantially rectangular shape elongated in

the tensioning direction, without limitation thereto. The configuration can be such that the insect trapping surface 91a has various shapes such as a circular shape or a square shape.

[0075]

The configuration of the fixing device is not limited to the configuration that it includes the first fixing device 43 having the hook part 432 and the second fixing device 44 capable of allowing the entire part of the second sheet end part 922 to be engaged therewith, but can employ various devices capable of fixing end parts of the insect trapping sheet 9. For example, the fixing device can be configured to allow both end parts of the insect trapping sheet 9 to serve as hooks or as portions for hooking the entire sheet end parts 92, or to allow the sheet end parts 92 to be clamped to fix the end parts of the insect trapping sheet 9.

[0076]

Further, the description has been given on the case where the holding part 4 has the tension applying device 45 applying tension to the insect trapping sheet 9 in the tensioning direction, without limitation thereto. For example, the configuration can be such that tension is applied in the tensioning direction by an operator's force and the insect trapping sheet 9 held under tension has its both end parts fixed to thereby hold the insect trapping sheet 9 under tension.

[0077]

The description has been given on the case where the holding part 4 holds the insect trapping sheet 9 so as to extend in the horizontal direction, without limitation thereto. The holding part 4 can be configured to hold the insect trapping sheet 9 so as to extend in the vertical direction. When such a configuration is employed, the combination of gravity and the tension applying device 45 can suppress warping.

[0078]

Further, the description has been given on the case where the holding part 4 includes the pivoting mechanism K without limitation thereto. The configuration can be such that the holding part 4 is unable to invert the insect trapping sheet 9. When employing such a configuration, the operator removes the insect trapping sheet 9 from the holding part 4 after the imaging device 5 captures images of the insect trapping sheet 9 on

one side, inverts the insect trapping sheet 9, and again fixes the insect trapping sheet 9 to the holding part 4 to allow the images of the surfaces on both sides to be captured, or the imaging devices 5 are disposed respectively on the one side and the other side of the insect trapping sheet 9 to thereby allow the images of the surfaces on both sides to be captured without inverting the insect trapping sheet 9.

[0079]

The description has been given on the case where the imaging device 5 runs in the tensioning direction to capture images of the adhesive surface at the plurality of positions away in the tensioning direction from each other, without limitation thereto. For example, the configuration can be such that a plurality of the imaging parts 51 are disposed respectively at the plurality of positions away in the tensioning direction from each other and each of the plurality of imaging parts 51 captures an image to obtain the images of the adhesive surface captured at the plurality of positions away in the tensioning direction from each other, or the configuration can be such that the imaging part 51 runs in the tensioning direction of the insect trapping sheet 9 and captures an image of the insect trapping surface 91a only at a single position suitable for capturing the image.

[0080]

Further, the description has been given on the case where the image processing part 8 is disposed inside the imaging apparatus 2, without limitation thereto. The image processing part 8 can be disposed outside the imaging apparatus 2. For example, the configuration can be such that the images captured by the imaging device 5 are transmitted to an external computer as the image processing part 8, and the external computer executes image processing.

[0081]

The description has been given on the case where, in the image processing, a predetermined area as an in-focus portion is cut out from each of the plurality of images, and the cut out portions are connected to each other to generate the processed image data D, without limitation thereto. For example, the configuration can be such that the in-focus portion is determined for each of the plurality of images, and the portions determined as being in focus are cut out and connected to each other.

[0082]

Further, the description has been given on the case where the image processing part 8 transmits the processed image data D generated in the image processing to the determination processing part 3 disposed outside the imaging apparatus 2, and the determination processing part 3 executes determination processing for the insect trapped on the insect trapping surface 91a, without limitation thereto. The configuration can be such that the determination processing part 3 is disposed inside the imaging apparatus 2.

[0083]

The description has been given on the case where the determination processing part 3 executes determination processing for the insect trapped on the insect trapping surface 91a based on the processed image data D generated in the image processing, without limitation thereto. The configuration can be such that the determination processing part 3 is not disposed, or such that the determination processing part 3, even if disposed, executes only part of the exemplified determination processing (e.g., calculating the sum of insects for output).

[0084]

Further, the configuration can be such that the imaging apparatus 2 serves as a part of an insect trap to enable the imaging device 5 to capture images of the insect trapping surface 91a at predetermined time intervals while trapping insects with the insect trapping sheet 9 fixed to the holding part 4. Such a configuration enables monitoring of the insect trapping sheet 9 trapping insects, and thus enables generation or increase of insects to be easily recognized. In the above case, an attracting device for attracting insects to the insect trapping sheet 9 (for example, a mechanism that generates smell or light to attract insects) can be disposed.

[0085]

This embodiment will be summarized as follows:

[0086]

(1) An imaging system of this embodiment is an imaging system for capturing an image of an insect trapping surface disposed on at least one side of an insect trapping sheet and configured to be capable of trapping an insect, the imaging system including: a holding part for holding the insect trapping sheet under tension in a tensioning direction

along a plane direction of the insect trapping surface; and an imaging device for capturing the image of the insect trapping surface of the insect trapping sheet held by the holding part.

[0087]

Such a configuration allows the holding part to hold the insect trapping sheet under tension in the direction along the plane direction of the insect trapping surface, and can thus suppress the insect trapping sheet from warping due to the tension. This configuration allows the images of the insect trapping surface of the insect trapping sheet to be appropriately captured.

[0088]

(2) The imaging system can be configured as the imaging system according to (1), in which the holding part includes: a pair of fixing devices for fixing both end parts away in the tensioning direction from each other of the insect trapping sheet; and a tension applying device for applying tension in the tensioning direction to the insect trapping sheet with the both end parts of the insect trapping sheet fixed by the pair of fixing devices.

[0089]

Such a configuration allows the tension applying device to apply tension to the insect trapping sheet fixed to the fixing device, and can thus securely apply tension to the insect trapping sheet held by the holding part and suppress the insect trapping sheet from warping.

[0090]

(3) The imaging system can be configured as the imaging system according to (1) or (2), in which the imaging device is configured to be capable of running substantially in parallel with the tensioning direction.

[0091]

Such a configuration allows the imaging device to run in parallel with the tensioning direction in the state where the warping of the insect trapping surface is suppressed by the tension, and thus enables the imaging apparatus to capture the images by locating the imaging apparatus at different positions while the distance between the insect trapping surface and the imaging device is kept substantially constant. This

configuration allows the images of the insect trapping surface of the insect trapping sheet to be appropriately captured.

[0092]

(4) The imaging system can be configured as the imaging system according to any of (1) to (3), further including an illuminating apparatus for illuminating the insect trapping surface with light, in which the illuminating apparatus is configured to illuminate the insect trapping surface with light from at least one side in a direction along the plane direction of the insect trapping surface and orthogonal to the tensioning direction.

[0093]

Such a configuration allows the illuminating apparatus to illuminate the insect trapping surface with light from at least one side in the width direction, and can thus securely illuminate the insect trapping paper with light even if the tension changes the length in the tensioning direction of the insect trapping paper. This configuration allows the images of the insect trapping surface of the insect trapping sheet to be appropriately captured.

[0094]

(5) The imaging system can be configured as the imaging system according to any of (1) to (4), further including an image processing part, in which the imaging device is configured to capture a plurality of the images of the insect trapping surface respectively at a plurality of positions away in the tensioning direction from each other, and the image processing part is configured to execute image processing for generating a processed image data based on the plurality of images captured by the imaging device at the plurality of positions.

[0095]

Such a configuration enables the image processing part to generate the processed image data based on the plurality of images captured by the imaging device, and can thus use the images captured at the plurality of positions in the tensioning direction for generating the processed image data. This configuration allows the obtained image data to be easily handled.

REFERENCE SIGNS LIST

[0096]

1: Imaging system

2: Imaging apparatus

21: Housing

22: Door

23: Control part

3: Determination processing part

4: Holding part

41: Holding frame part

41a: Connecting hole

42: Frame body

43: First fixing device

431: First fixing base

432: Hook part

44: Second fixing device

441: Second fixing base

442: Stopper

443: Fixing body part

444: Positioning part

45: Tension applying device

451: Guide part

452: Biasing device

453: Guide body part

454: Biasing connecting part

455: Slide restricting part

46: Holding base part

461: Frame receiving part

462: Shaft part

463: Holding operation part

464: Inversion assisting part

464a: First magnetic body

465: Operating shaft

466: Handle

5: Imaging device

51: Imaging part

52: Running part

53: Rail

54: Moving part

6: Illuminating apparatus

61: Illuminating part

7: Operating part

8: Image processing part

9: Insect trapping sheet

91: Insect trapping part

91a: Insect trapping surface

92: Sheet end part

921: First sheet end part

921a: First sheet end part

921b: Writing part

922: Second sheet end part

922a: Inward portion

922b: Outward portion

CLAIMS

1. An imaging system for capturing an image of an insect trapping surface disposed on at least one side of an insect trapping sheet and configured to be capable of trapping an insect, the imaging system comprising:

a holding part for holding the insect trapping sheet under tension in a tensioning direction along a plane direction of the insect trapping surface; and

an imaging device for capturing the image of the insect trapping surface of the insect trapping sheet held by the holding part.

2. The imaging system according to claim 1, wherein the holding part comprises:

a pair of fixing devices for fixing both end parts away in the tensioning direction from each other of the insect trapping sheet; and

a tension applying device for applying tension in the tensioning direction to the insect trapping sheet with the both end parts of the insect trapping sheet fixed by the pair of fixing devices.

3. The imaging system according to claim 1 or 2, wherein the imaging device is configured to be capable of running substantially in parallel with the tensioning direction.

4. The imaging system according to claim 1 or 2, further comprising an illuminating apparatus for illuminating the insect trapping surface with light, wherein

the illuminating apparatus is configured to illuminate the insect trapping surface with light from at least one side in a direction along the plane direction of the insect trapping surface and orthogonal to the tensioning direction.

5. The imaging system according to claim 1 or 2, further comprising an image processing part, wherein

the imaging device is configured to capture a plurality of the images of the insect trapping surface respectively at a plurality of positions away in the tensioning direction from each other, and

the image processing part is configured to execute image processing for generating a processed image data based on the plurality of images captured by the imaging device at the plurality of positions.