CLAIMS

[Claim 1]

An RF tag attachment tool for attaching, to a submersion determination target, an RF tag that performs wireless communication in a frequency band in which radio waves do not pass through water, the RF tag attachment tool comprising:

a tag support structure capable of supporting the RF tag; and

a mounting structure for mounting the tag support structure on an attachment member for attachment to the submersion determination target,

wherein a gap is formed between an arrangement position of an IC chip built in the RF tag and the submersion determination target, and

the RF tag is of a passive type.

[Claim 2]

The RF tag attachment tool according to claim 1,

wherein the tag support structure includes a first support structure for supporting the RF tag and a second support structure for supporting the first support structure, and

when a portion of the first support structure located in a vicinity of the arrangement position of the IC chip is

defined as a chip-vicinity support structure portion, the chip-vicinity support structure portion is spaced apart from the second support structure or the submersion determination target.

[Claim 3]

The RF tag attachment tool according to claim 2,

wherein, assuming that an end portion on one side relative to the chip-vicinity support structure portion is defined as a one-side support structure end portion and an end portion on the other side relative to the chip-vicinity support structure portion is defined as an other-side support structure end portion when the first support structure is viewed from a predetermined direction, the chip-vicinity support structure portion is spaced further apart from the second support structure or the submersion determination target than the one-side support structure end portion and the other-side support structure end portion.

[Claim 4]

The RF tag attachment tool according to claim 3,

wherein the one-side support structure end portion engages with a one-side engagement portion of the second support structure,

the other-side support structure end portion engages with an other-side engagement portion of the second support structure, and

a length between the one-side engagement portion and the other-side engagement portion is shorter than a length between the one-side support structure end portion and the other-side support structure end portion.

[Claim 5]

The RF tag attachment tool according to claim 4,

wherein the one-side support structure end portion and the one-side engagement portion are attachable to and detachable from each other by a one-side button mechanism, and

the other-side support structure end portion and the other-side engagement portion are attachable to and detachable from each other by an other-side button mechanism.

[Claim 6]

The RF tag attachment tool according to claim 1, further comprising:

an attachment member that supports the tag support structure and is attached to the submersion determination target,

wherein, assuming that a portion of the tag support structure located in a vicinity of the arrangement position of the IC chip is defined as a chip-vicinity support structure portion, when the attachment member is attached to the submersion determination target, the chip-vicinity support structure portion is spaced apart from the attachment member or the submersion determination target.

[Claim 7]

The RF tag attachment tool according to claim 6,

wherein, assuming that an end portion on one side relative to the chip-vicinity support structure portion is defined as a one-side support structure end portion and an end portion on the other side relative to the chip-vicinity support structure portion is defined as an other-side support structure end portion when the tag support structure is viewed from a predetermined direction, the one-side support structure end portion engages with a one-side engagement portion of the attachment member,

the other-side support structure end portion engages with an other-side engagement portion of the attachment member, and

a length between the one-side engagement portion and the other-side engagement portion is shorter than a length between the one-side support structure end portion and the

other-side support structure end portion.

[Claim 8]

The RF tag attachment tool according to claim 7,

wherein the attachment member is formed in an elongated shape,

a one-side hole into which the attachment member is insertable is formed in the one-side support structure end portion,

an other-side hole into which the attachment member is insertable is formed in the other-side support structure end portion, and

when a position of the attachment member where the one-side hole engages with the attachment member is defined as a one-side engagement position and a position of the attachment member where the other-side hole engages with the attachment member is defined as an other-side engagement position, a distance between the one-side engagement position and the other-side engagement position is shorter than a distance between the one-side hole and the other-side hole.

[Claim 9]

The RF tag attachment tool according to claim 7 or 8, further comprising:

a spacer arranged between the tag support structure and the attachment member,

wherein the attachment member engages with the one-side support structure end portion, the other-side support structure end portion, and the spacer.

[Claim 10]

The RF tag attachment tool according to any one of claims 1 to 9,

wherein, when a portion of the tag support structure located in a vicinity of the arrangement position of the IC chip is defined as a chip-vicinity support structure portion, the gap is formed in the chip-vicinity support structure portion of the tag support structure, or the gap is formed by arranging the tag support structure so as to avoid the chip-vicinity support structure portion.

[Claim 11]

The RF tag attachment tool according to any one of claims 1 to 10, further comprising:

the RF tag supported by the tag support structure.

[Claim 12]

The RF tag attachment tool according to any one of claims 1 to 11, when a portion to be brought into contact

with the submersion determination target is defined as a contact surface, an orientation of an antenna pattern of the IC chip is oblique with respect to an orientation of the contact surface.

[Claim 13]

The RF tag attachment tool according to claim 12,

wherein at least one of following conditions is satisfied:

in a first RF tag located upward in an attached state in which the attachment member is attached to the submersion determination target, an upper end of the antenna pattern of the first RF tag is spaced further apart from the contact surface than a lower end of the antenna pattern of the first RF tag; and

in a second RF tag located downward in the attached state, a lower end of the antenna pattern of the second RF tag is spaced further apart from the contact surface than an upper end of the antenna pattern of the second RF tag.

[Claim 14]

The RF tag attachment tool according to claim 12 or 13, further comprising:

a hinge structure provided on the tag support structure or the attachment member,

wherein the hinge structure is switchable between a first state in which the antenna pattern faces in a first direction and a second state in which the antenna pattern faces in a second direction different from the first direction.

[Claim 15]

The RF tag attachment tool according to any one of claims 1 to 14,

wherein the attachment member includes a first attachment member on which the tag support structure is mounted and a second attachment member connected to the first attachment member, and

a plurality of the tag support structures are aligned around the submersion determination target by the first attachment member.

[Claim 16]

The RF tag attachment tool according to any one of claims 1 to 15,

wherein the attachment member is attachable to a head of the submersion determination target.

[Claim 17]

A submersion determination program causing a computer

to execute:

a signal output step of outputting a predetermined signal to the passive RF tag attached to the submersion determination target by the RF tag attachment tool according to claim 11;

a response signal reception step of receiving a response signal from the RF tag with respect to the predetermined signal;

a response signal storage step of storing the response signal in a storage device;

a communication state determination step of reading a log of the response signal stored in the storage device and determining whether a status is a communication state in which the response signal from the RF tag is detected under predetermined conditions or a non-communication state in which the response signal from the RF tag is not detected under the predetermined conditions; and

a submersion state determination step of determining that the RF tag attachment tool or the submersion determination target is submerged when the non-communication state continues for a predetermined period,

wherein the storage device is capable of storing an identifier of the RF tag and an identifier of the RF tag attachment tool or the submersion determination target in association with each other,

in the communication state determination step, it is determined whether each of a plurality of the RF tags is in the communication state or in the non-communication state, and

in the submersion state determination step, when it is determined that all of the RF tags associated with the identifier of the RF tag attachment tool or the submersion determination target are in the non-communication state, it is determined that the RF tag attachment tool or the submersion determination target is submerged, while when it is determined that at least one of the RF tags associated with the identifier of the RF tag attachment tool or the submersion determination target is in the communication state regardless of an installation location of the RF tag, it is determined that the RF tag attachment tool or the submersion determination target is not submerged.

[Claim 18]

A submersion determination program causing a computer to execute:

a signal output step of outputting a predetermined signal to a plurality of passive RF tags attached to a submersion determination target by an RF tag attachment tool;

a response signal reception step of receiving a

response signal from the RF tag with respect to the predetermined signal;

a response signal storage step of storing the response signal in a storage device;

a communication state determination step of reading a log of the response signal stored in the storage device and determining whether a status is a communication state in which the response signal from the RF tag is detected under predetermined conditions or a non-communication state in which the response signal from the RF tag is not detected under the predetermined conditions; and

a submersion state determination step of determining that the RF tag attachment tool or the submersion determination target is submerged when the non-communication state continues for a predetermined period,

wherein the storage device is capable of storing an identifier of the RF tag and an identifier of the RF tag attachment tool or the submersion determination target in association with each other,

in the communication state determination step, it is determined whether each of the plurality of RF tags is in the communication state or in the non-communication state, and

in the submersion state determination step, when it is determined that all of the RF tags associated with the

identifier of the RF tag attachment tool or the submersion determination target are in the non-communication state, it is determined that the RF tag attachment tool or the submersion determination target is submerged, while when it is determined that at least one of the RF tags associated with the identifier of the RF tag attachment tool or the submersion determination target is in the communication state regardless of an installation location of the RF tag, it is determined that the RF tag attachment tool or the submersion determination target is not submerged.

[Claim 19]

The submersion determination program according to claim 18,

wherein, in the submersion state determination step, when it is determined that all of the RF tags associated with the identifier of the RF tag attachment tool or the submersion determination target are in the non-communication state for a first period, it is determined that the RF tag attachment tool or the submersion determination target is in a submersion state, and when it is determined that, for an identifier of the RF tag attachment tool or the submersion determination target determined to be submerged, at least one of the RF tags associated with the identifier is in the communication

state for a second period, it is determined that the RF tag attachment tool or the submersion determination target has recovered from submersion, and

the second period is shorter than the first period.

[Claim 20]

The submersion determination program according to any one of claims 17 to 19, causing the computer to further execute:

a final survival tag extraction step of, when it is determined that the RF tag attachment tool or the submersion determination target is submerged, extracting the RF tag that has entered the non-communication state last among the RF tags associated with the identifier of the RF tag attachment tool or the submersion determination target;

a final communication antenna extraction step of extracting an identifier of the antenna that has last detected the response signal from the RF tag extracted in the final survival tag extraction step; and

a submersion occurrence location determination step of determining a candidate for a submersion occurrence location based on an installation location of the antenna corresponding to the identifier of the antenna extracted in the final communication antenna extraction step.

[Claim 21]

The submersion determination program according to any one of claims 17 to 20, causing the computer to further execute:

a partial submersion step of determining whether the RF tag in a state in which a predetermined portion of the submersion determination target, to which the RF tag attachment tool is attached, is submerged is in the communication state or in the non-communicating state; and

an attachment position registration step of storing the predetermined portion as an installation location of the RF tag on the submersion determination target in association with an identifier of the RF tag determined to be in the non-communication state in the partial submersion step.

[Claim 22]

The submersion determination program according to any one of claims 17 to 21, causing the computer to further execute:

a partial submersion step of determining whether the RF tag in a state in which a predetermined portion of the submersion determination target, to which the RF tag attachment tool is attached, is submerged is in the

communication state or in the non-communicating state;

an attachment position determination step of reading, from the storage device, an identifier of the RF tag determined to be in the non-communication state in the partial submersion step and determining whether or not the installation location of the RF tag on the submersion determination target associated with the identifier of the RF tag matches the predetermined portion in the partial submersion step; and

an attachment position determination result output step of outputting a determination result in the attachment position determination step.

[Claim 23]

A submersion determination device, comprising:

a wireless communication control device that performs wireless communication with a passive RF tag; and

a storage device,

wherein the wireless communication control device includes:

a signal output unit that outputs a predetermined signal to the RF tag;

a response signal reception unit that receives a response signal from the RF tag with respect to the predetermined signal;

a communication state determination unit that determines whether a status is a communication state in which the response signal from the RF tag is detected under predetermined conditions or a non-communication state in which the response signal from the RF tag is not detected under the predetermined conditions;

a submersion determination unit that determines that an attachment tool to which the RF tag is attached or a submersion determination target is submerged when the non-communicating state continues for a predetermined period; and

an alarm output unit that outputs an alarm when it is determined that the attachment tool or the submersion determination target is submerged,

the storage device is capable of storing an identifier of the RF tag and an identifier of the attachment tool or the submersion determination target in association with each other,

the communication state determination unit determines whether each of a plurality of the RF tags is in the communication state or in the non-communication state, and

when it is determined that all of the RF tags associated with the identifier of the attachment tool or the submersion determination target are in the non-communication state, the submersion determination unit

determines that the attachment tool or the submersion determination target is submerged, while when it is determined that at least one of the RF tags associated with the identifier of the attachment tool or the submersion determination target is in the communication state regardless of an installation location of the RF tag, the submersion determination unit determines that the attachment tool or the submersion determination target is not submerged.

[Claim 24]

A submersion determination system, comprising:

the RF tag attachment tool according to any one of claims 1 to 16;

the submersion determination device according to claim 23; and

an antenna that enables wireless communication between an RF tag supported by the RF tag attachment tool and the submersion determination device.

[Claim 25]

A storage medium storing the submersion determination program according to any one of claims 17 to 22.

[Claim 26]

A submersion determination method, comprising:

a signal output step of outputting a predetermined signal to a plurality of passive RF tags attached to a submersion determination target by an RF tag attachment tool;

a response signal reception step of receiving a response signal from each of the RF tags with respect to the predetermined signal;

a response signal storage step of storing the response signal in a storage device;

a communication state determination step of reading a log of the response signal stored in the storage device and determining whether a status is a communication state in which the response signal from the RF tag is detected under predetermined conditions or a non-communication state in which the response signal from the RF tag is not detected under the predetermined conditions; and

a submersion state determination step of determining that the submersion determination target is submerged when the non-communication state continues for a predetermined period.