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(54) METHOD FOR ACCESS CONTROL, READER DEVICE AND ACCESS CONTROL SYSTEM

(57) The invention relates to a method comprising:
- receiving by a reader device (R) a communication signal from a first mobile device (M1), the reader determining a first received signal strength indicator (RSSI1) of the communication signal of the first mobile device;
- receiving by the reader device (R) the first correction value (cv1) from the first mobile device (M1), wherein the first correction value (cv1) is a first correction value (cv1) of the mobile device (M1);
- applying the first correction value (cv1) to the first received signal strength indicator (RSSI1) to obtain a first distance indicator (DI1);
- performing at least one function by the reader device (R) depending on the first distance indicator (DI1).

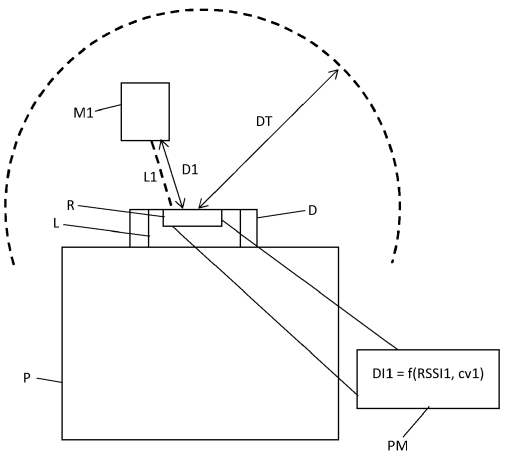


FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention is related to the field of access control systems for controlling access to one or more specific areas in a building.

STATE OF THE ART

[0002] It is known that electronic access control systems are often used to control access to certain areas or physical spaces within the building. These electronic access control systems (which will be also referred to in the following as EAC systems) usually comprise a door lock that gives access to that specific physical space of the building; a user who wants to access this space is in possession of some sort of mobile data carrier with an identification code stored therein. When the user approaches that door lock and the mobile data carrier is within certain proximity of a reader in the door, a communication channel is established between the mobile data carrier and the reader for the exchange of authentication data. After this authentication process, access to the space secured by the door lock may be given to the holder of the mobile data carrier.

[0003] In order to improve the user experience, for example, regarding speediness of the authentication procedure with the reader, it may be desirable that the exchange of data between the mobile data carrier and the reader starts whenever it is determined that the mobile data carrier is within a specific distance from the reader.

[0004] Some solutions evaluate the proximity of the mobile data carrier to the reader based on the received signal strength.

[0005] Patent document WO-2014/028893-A2 discloses an access control system including a mobile device that communicates with a reader device associated with an electronic lock. In this system, once the mobile device is determined to be within pre-established ranges of the reader device, the system can cause the electronic lock to perform a specific function, such as an auto-unlock feature, or an auto-open feature, or other feature that is automatically performed (wirelessly transmitting a message, ringing a doorbell, etc.). The position of the mobile device with respect to the reader device can be determined by processing position data received via the GPS capability, or RSSI data received and/or determined via the BLE capability.

[0006] However, the determination of the position based on these data may prove not to be sufficiently reliable, for instance, due to the inaccuracy of the position provided by the GPS, or due to the fact that the received signal strength at the reader may be different depending on the mobile data carrier, and also, depending on the battery of the mobile data carrier. Thus, the system may determine that the mobile device is positioned within the pre-established range when it is actually not within range, and vice versa.

[0007] This problem can become more severe in the case of several mobile devices being close to a same reader device, when it may occur that the reader device receives a signal strength from a first mobile device that is lower than the signal strength received from a second mobile device, when the first mobile device is actually closer to the reader device than the second mobile device. As a result, the automatic function performed by the system may be applied to a mobile device which is, in fact, not the closest one to the reader device and, for instance, it is the one that should be given access.

[0008] To overcome this problem, some other solutions have proposed to include further parameters, such as an estimation of the direction of movement of the mobile device, based for instance in the output of an accelerometer of the mobile device, or by including additional beacons in the system) to more securely measure distance. But in exchange, determination of the actual distance in these systems is too complicated.

[0009] It is thus necessary to find a solution that overcomes the above situation, in a simple and reliable way.

DESCRIPTION OF THE INVENTION

[0010] In order to solve the deficiencies posed by the prior-art solutions, the present invention relates to a method for access control, to a reader device and to an access control system, in which the signal strength of a mobile device received by a reader device is corrected to provide a more accurate and reliable of the actual distance between that mobile device and the reader.

[0011] For this purpose, a first aspect of the present invention relates to a method comprising:

- receiving by a reader device a communication signal from a first mobile device, the reader determining a first received signal strength indicator of the communication signal of the first mobile device;
- receiving by the reader device a first correction value from the first mobile device, wherein the first correction value is a first correction value of the mobile device;
- applying the correction value to the first received signal strength indicator to obtain a first distance indicator;
- performing at least one function (or an action) by the reader device depending on the first distance indicator.

[0012] That is, according to the invention, the reader device only performs a specific function after the received signal strength indicator has been corrected with the correction value, and it is thus more representative of the real distance the mobile device is from the reader.

[0013] In certain embodiments the function performed by the reader device is starting an authenticating procedure with the first mobile device when the received first

distance indicator is lower than a preestablished threshold. That is, the reader device only starts the authenticating procedure upon verifying that the corrected first distance indicator is below that preestablished threshold which is indicative that the mobile device is in close proximity of the reader device, close enough to start an authentication procedure. It should be noted that it is also possible that this verification is carried out in a negative manner without departing from the scope of the invention; that is, if the received first distance indicator is lower than a preestablished threshold then the reader device will not start any authenticating procedure with the first mobile device which has been determined to be at a distance greater than that of the threshold. The preestablished threshold can be established, for instance, at the reader device; and this threshold can be defined as a value or as a range. The threshold can be defined as a value or range above which users are considered to be too far from the reader, or a value or range below which users are considered close enough to the reader. The threshold value or range can be pre-set in the reader or it can be configured into the reader by any existing configuration way (which is also used for other configuration data).

[0014] In certain embodiments the method further comprises:

- receiving by the reader device a communication signal from a second mobile device, the reader determining a second received signal strength indicator of the communication signal of the second mobile device;
- receiving by the reader device a second correction value from the second mobile device, wherein the second correction value is a second correction value of the second mobile device;
- applying the second correction value to the second received signal strength indicator to obtain a second distance indicator.

[0015] And the function performed by the reader device is determining which of the first and the second mobile devices is closer to the reader device based on the first distance indicator and the second distance indicator.

[0016] That is, if two or more mobile devices are within communication range from the reader device, and the reader device receives signals from those two or more mobile devices, the reader device only performs the specific function or action in respect with the mobile device that has been determined to be closest to the reader device upon comparing the first and the second distance indicators.

[0017] In certain embodiments the method further comprises starting an authenticating procedure with the i-th mobile device when the distance indicator of the i-th mobile device closer to the reader device is greater than or lower than a preestablished threshold.

[0018] The method of the present invention is applicable in a scenario where there are more than two mobiles device. For the sake of clarity, instead of referring to the first correction value, the second correction value, the third correction value and so forth, in the present disclosure they may be generically referred to as "the i-th correction value" or simply to "the correction value". A similar approach has been followed with the first mobile device, the second mobile device, etc., which can also be referred to as "the i-th mobile device" or simply "the mobile device". And also with their respective received signal strengths indicators and distance indicators.

[0019] The correction value can be made dependent on the mobile device make and/or model and/or type. This way, the correction value accounts for the differences between the signal strengths existing among different manufacturers and models of mobile devices. The correction value can also be dependent on other factors such as hardware or firmware versions, the operating system of the mobile device; or upon other parameters such as temperature of the mobile device

[0020] There are several ways in which the i-th correction value of the i-th mobile device can be made available to the mobile device.

[0021] For instance, the i-th correction value can be stored in a server -remote or local-, and the method comprises retrieving or receiving the correction value from the server. This way it can be assured that the reader receives from each mobile device the most updated value of the correction value and this most updated value is applied by the reader device.

[0022] If the correction values of the different mobile devices are stored in a remote server, for instance, in a database, these correction values can be easily and readily updated with any new model of mobile device that is launched on the market.

[0023] The step of sending by the i-th mobile device its i-th correction value to the reader can be done upon request of the reader. It can also be done at the mobile device's own motion. So, the i-th correction value can be stored in the respective i-th mobile device and that the method comprises automatically sending the i-th correction value to the reader device by the mobile device (at its own motion or initiative), usually once a communication has been established between the reader device and the i-th mobile device. This way, each mobile device can promptly provide its correction value to the reader device, thereby providing a faster way of enabling the reader to carry out the function.

[0024] It is also possible that the reader requests the correction value. This way, the reader device has a control of the whole process and only requests correction value(s) to the mobile devices which have been previously determined to be within certain proximity of the reader.

[0025] In some embodiments, the i-th correction value is inputted in the i-th mobile device upon request, and the method comprises sending the i-th correction value to the reader device. The user may be prompted to input a correction value within a certain range, which range

depends on how the correction value is applied to the received signal strength. This may prove useful if no correction value has been previously assigned or registered to that mobile device. For instance, if the correction value is applied by multiplication, the user may be able to input 1 as correction value so as to indicate that no correction value is to be applied. Or if the correction value is applied by addition, then a 0 value can be inputted.

[0026] The above possibilities for providing the correction value to the reader device may be combined. For instance, the first and second correction values can be both stored in the first and second mobile devices, respectively. But it is also possible that the first correction value is stored in a server, while the second correction value is stored in the second mobile device or inputted into the second mobile device upon request.

[0027] The received communication signal at the reader device can be a Bluetooth signal, preferably a Bluetooth Low Energy signal. It is also possible that the received communication signal follows another short-range communication protocol the signal strength of which is measurable at the reader device.

[0028] In certain embodiments the method further comprises:

- receiving by the reader device credential information sent by the i-th mobile device (be it the first mobile device or the second mobile device);
- determining validity of the credential information received by the reader device;
- actuating an electronic lock in a manner depending on the distance indicator (be it the first or the second distance indicators) and on the determined validity of the credential information.

[0029] A second aspect of the invention relates to a reader device, the reader device comprising:

- a short-range wireless communication interface for wirelessly communicating with, at least, a first mobile device;
- a non-transitory computer-readable medium storing executable instructions; and
- one or more processors configured to execute executable instructions,
  wherein executing the executable instructions causes the one or more processors to:
  - receive a communication signal from the first mobile device and determine a first received signal strength indicator of the communication signal of the first mobile device;
  - receive a first correction value from the first mobile device;
  - apply the first correction value to the first received signal strength indicator to obtain a first distance indicator;
  - perform at least one function depending on the first distance indicator.

[0030] In certain embodiments, executing the executable instructions causes the one or more processors to start an authenticating procedure with the at least first mobile device when the received distance indicator is lower than a preestablished threshold. Alternatively, if the received distance indicator is greater than a preestablished threshold, no authenticating procedure with the at least first mobile device will be started.

[0031] In certain embodiments the reader device is configured to:

- receive another communication signal from at least a second mobile device, the reader determining a second received signal strength indicator of the communication signal of the second mobile device;
- receive a second correction value from the second mobile device;
- apply the second correction value to the second received signal strength indicator to obtain a second distance indicator;
- compare the first and the second distance indicators to determine which of the first and the second mobile devices is closer to the reader device.

[0032] In certain embodiments executing the executable instructions at the reader device further causes the one or more processors to start an authenticating procedure with the i-th mobile device when the distance indicator of the i-th mobile device closer to the reader device is lower than a preestablished threshold.

[0033] According to another aspect, the invention relates to a computer program product comprising computer-executable instructions which, when executed by a processor of a reader device, causes the reader device to carry out the method defined in the first aspect and its embodiments.

[0034] The invention also relates to an access control system which comprises a reader device as defined in the foregoing.

[0035] The different aspects and embodiments of the invention defined in the foregoing can be combined with one another, as long as they are compatible with each other.

[0036] Additional advantages and features of the invention will become apparent from the detailed description that follows and will be particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] To complete the description and in order to provide for a better understanding of the invention, a set of drawings is provided. Said drawings form an integral part of the description and illustrate an embodiment of the invention, which should not be interpreted as restricting the scope of the invention, but just as an example of how

the invention can be carried out. The drawings comprise the following figures:

Figure 1 is a schematic block representation of the access control system of the present invention, with a mobile device trying to gain access to premises limited by a door.

Figures 2 shows the access control system of Figure 1, with two mobile devices near the door.

Figures 3 shows another situation in which there are three mobile devices in the surroundings of the premises, but only two mobile devices being near the reader.

Figure 4 is a diagram flow of the method of the invention, in a situation with more than one mobile devices.

Figure 5 shows a possible way of feeding correction values to a database of correction values, and their subsequent distribution to mobile devices.

Figure 6 shows another possible way of providing a mobile device with a correction value.

DESCRIPTION OF A WAY OF CARRYING OUT THE INVENTION

[0038] The following description is not to be taken in a limiting sense but is given solely for the purpose of describing the broad principles of the invention. Embodiments of the invention will be now described by way of example, with reference to the above-mentioned drawings showing elements and results according to the invention.

[0039] Figure 1 shows a first mobile device M1 arranged nearby premises P. An access control system restricts the access to premises P. When access is allowed by the reader R, and a door D of the premises P is in a locked state through lock L, the state of the lock L is changed such that the door D is unlocked thereby allowing access to the premises P.

[0040] The access control system comprises a reader device R which receives a signal, for example a Bluetooth Low Energy BLE signal, from the first mobile device M1 through a first wireless communication link L1. The BLE signal is received at the reader device R with a particular signal strength, and the reader determines a first signal strength indicator RSSI1 of the signal received from the mobile device M1. The first mobile device M1 sends a first correction value cv1 of the first mobile device M1 to the reader R. The first correction value cv1 is a correction value of the first signal strength indicator RSSI1 of the signal received by the reader device R.

[0041] At some point, the access control system defines a distance threshold DT and the reader is made aware of this distance threshold DT. Access to the premises P is checked to users carrying the first mobile device M1 when the distance D1 between the first mobile device M1 and the reader device R is lower than the distance threshold DT; that is, an authentication process between n the reader R and the mobile device M1 will be carried out once the distance check has been done, having used the correction value cv1.

[0042] In order to obtain a first indicator DI1 of the distance D1 between the first mobile device M1 and the reader device R, the reader R performs a calculation *f* with the signal strength indicator RSSI1 and the correction value cv1 sent by the first mobile device M1. In particular the operation(s) of the calculation *f* may be predefined in a memory (not shown in the drawings), and can be, for instance, in the form of addition/subtraction and/or multiplication/division or other simple mathematical operations, to keep the operation of the reader R simple and fast. The reader R comprises some sort of processing means PM for performing the calculation.

[0043] After obtaining the first distance indicator DI1 of the distance D1 between the reader device R and the first mobile device M1, the first distance indicator DI1 is compared with an indicator of the distance threshold DT in order to estimate whether the distance D1 between the first mobile device M1 and the reader device R is lower than the distance threshold TD. If it is estimated that the distance D1 is lower than the threshold distance DT, and the door D is locked, the reader device R sends a signal for unlocking the door D if the mobile device M1 is authenticated by the reader R. If it is estimated that the distance D1 is higher than the distance threshold DT, the reader device R does not carry out any specific function or action, since that mobile device M1 is deemed to be too far. This way, access to the premises P is allowed first, depending on the actual distance D1 between the first mobile device M1 and the reader device R and then, depending on the specific authentication process defined between the mobile device and the reader.

[0044] Figures 2 shows the access control system of Figure 1, in this case two mobile devices are near the door. As shown in Figure 2, the reader device R may receive signals from the first mobile device M1, in the manner explained in reference to figure 1, and from a second mobile device M2. In addition, the reader device R receives a signal (for instance, a BLE signal) from the second mobile device M2 through a second wireless communication link L2. The signal is received at the reader device R having a particular signal strength, and the reader determines a second signal strength indicator RSSI2 of the signal received from the second mobile device M2. The second mobile device M2 sends a second correction value cv2 of the second mobile device M2. The second correction value cv2 is a correction value of the second signal strength indicator RSSI2.

[0045] In order to obtain a second indicator DI2 of the distance D2 between the second mobile device M2 and the reader device R, the reader R performs a calculation

f2 with the signal strength indicator RSSI2 and the correction value cv2 of the signal sent by the second mobile device M2.

[0046] In the situation shown in Figure 2, where there is more than one mobile device within reach of the reader R, it is desirable to grant access to the mobile device which is closest to the reader R. Thus, after obtaining the second distance indicator DI2 of the distance D2 between the reader device R and the second mobile device M2, the first and second distance indicators DI1, DI2 are compared, and access is granted to the mobile device closest to the reader (to the first mobile device M1 in the situation shown in Figure 2). It is possible that subsequently access is granted to the other mobile device(s) within reach of the reader R, if it is determined that the distance Di of the mobile device is lower than the defined distance threshold DT (as is the case of the second mobile device M2 in Figure 2).

[0047] In the situation shown in Figure 3, three mobile devices are in the surroundings of the premises P, but only two mobile devices are sufficiently close to the reader R, within a distance lower than the distance threshold DT. In this situation, the reader R determines a respective received signal strength indicator RSSIi for each of the signals received from the two mobile devices. The i-th correction value cvi sent to the reader R is used to determine the i-th distance indicator DIi. Upon comparing the distance indicators from the mobile devices M1, M2 and Mi, the i-th mobile device Mi is determined to be farthest from the reader. The reader will also determine that this i-th mobile device Mi is farther than the distance threshold DT and thus, the function performed by the reader relating to authenticating the mobile device will not be carried out for that i-th mobile device Mi.

[0048] The method performed by the reader R of Figures 1-3 is shown as a flow diagram in Figure 4. At step S11 the reader device R receives a BLE signal from the first mobile device M1 and, also the reader R receives the BLE signal from another mobile device Mi (step S21). The reader R determines respective signal strength indicators RSSI1 and RSSIi of the received signals from the respective mobile devices M1, Mi (steps S12 & S22). Each mobile device M1, Mi sends their respective correction values cv1, cvi to the reader R (S13 & S23), where they are received (steps S14 & S24). At the reader, the respective correction values cv1, cvi are applied to the respective signal strength indicators RSSI1 and RSSIi at the reader R to obtain a respective distance indicator DI1, DIi of the respective first and i-th mobile devices M1, Mi (steps S15 & S25).

[0049] It is then checked whether the distance indicators DI1, DIi correspond to a distance which is smaller than a specific distance threshold DT (step S16, S26). The distance threshold is a value that has been previously defined, as a distance within which it is considered that the mobile device is sufficiently close to the reader R so as to believe that a user carrying such mobile device wants to enter the premises P. The distance threshold in this example is set as a top value below which the distance between mobile device and reader is considered to be sufficient to start an authentication procedure. Obviously, it is also possible to set the distance threshold as a minimum value and discard mobile devices whose distance is greater than the threshold value; so, if the distance indicator is above the distance threshold DT, the corresponding mobile device is considered not to be sufficiently close to the reader R and no action is taken.

[0050] As a result of the decision steps S16 & S26, the first mobile device M1 and/or the i-th mobile device Mi are left out (steps S17 & S27) of any function to be done by the reader R if they are determined to be farther away from the reader R than the distance threshold DT.

[0051] If the result of the decision steps S16 & S26 is affirmative, then at step S8, the distance indicators DI1, DIi are compared to find out the mobile device that has the smallest distance indicator DI, so as to establish which is the mobile device that is closest to the reader.

[0052] Finally, at step S9 the reader R carries out or performs an action with the mobile device that is associated with the smallest distance indicator DI. This action can be, for example, to check the credentials of the mobile device (or its user) to unlock the door D, if it the mobile device is authenticated and determined to be an authorized user to access that premises P.

[0053] Figure 5 shows a possible way of feeding correction values to a server S including a database which stores correction values cv. There are several possible ways of building or feeding and updating this database. For instance, a user U can input a correction value cvx into the server S by means of a terminal T. The correction value cvx can be linked to an identifier IDx associated to a mobile device. These two values are stored in the database in the form of a tuple. Similarly, other users (not shown in the figure) can upload their correction values cva, cvb, cvc, etc. by means of corresponding mobile devices Ma, Mb, Mc, etc. upon establishing respective communication links La, Lb, Lc, etc. with the server S, be it remote or local.

[0054] It is possible that the user U works as a "bulk uploader" and sends to the server Sthe correction values cvx of several mobile devices, which are identified by the corresponding identifier IDx. This identifier IDx can refer to a single mobile device model, or to a mobile device make.

[0055] The right-hand side of Figure 5 shows how the correction values cv stored in the server S can be subsequently distributed to mobile devices. A mobile device M1, M2, ..., Mi establishes a link L1, L2,... Li with the server s. For retrieving the correction value cv from the server S, the mobile device sends an identifier ID1, ID2, ... IDi of the mobile device Mi to the server S. The server S then sends the corresponding correction value cv linked to that identifier IDi to the respective mobile devices.

[0056] Figure 6 shows another possible way of providing a mobile device with a correction value. In this case,

a user Ui of a mobile device Mi directly inputs the correction value cvi into the mobile device. This manual inputting of the correction value cvi can be done at any moment, and also once the user is in front of a door, upon request of the reader R.

[0057] The correction value can be determined using the following procedure:

- Set a known distance between a reader R and a mobile device.
- Define a reference value of the distance indicator DI for that known distance between the reader R and a mobile device.
- Measure the signal received at the reader R from the mobile device at that known distance and determine the received signal strength indicator RSSI for that mobile device.
- Establish a correction value based on the reference value at the known distance and the determined value of the received signal strength indicator RSSI. That is, the correction value could be defined as follows: $cv=f^{-1}$ (RSSI, DI)

[0058] For instance, a mobile device is set at a distance of 50 cm of a reader R. A reference value of the distance indicator is defined to be 50. Then, the RSSI for that mobile device is measured to be -40 dBm. Then, the correction value for that mobile device is 10 (formula: correction value 10 = distance indicator 50 - measured RSSI value -40 * -1). With another mobile device the RSSI measured is, for instance, -30 dBm. For that mobile device the correction value is 20 (formula: correction value 20 = distance indicator 50 - measured RSSI value -30 * -1). With third mobile device the RSSI measured is, for instance, -60 dBm. For that mobile device the correction value is -10 (formula: correction value -10 = distance indicator 50 - measured RSSI value -60 * -1).

[0059] Following this procedure, once a new model of mobile device is launched into the market, it is possible to establish its correction value. And the server S can be updated with this new correction value either by a bulk uploader, or by any individual user U.

[0060] In this text, the term "comprises" and its derivations (such as "comprising", etc.) should not be understood in an excluding sense, that is, these terms should not be interpreted as excluding the possibility that what is described and defined may include further elements, steps, etc.

[0061] The invention is obviously not limited to the specific embodiment(s) described herein, but also encompasses any variations that may be considered by any person skilled in the art (for example, as regards the choice of materials, dimensions, components, configuration, etc.), within the general scope of the invention as defined in the claims.

Claims

1. A method comprising:

   - receiving by a reader device (R) a communication signal from a first mobile device (M1), the reader determining a first received signal strength indicator (RSSI1) of the communication signal of the first mobile device;
   - receiving by the reader device (R) a first correction value (cv1) from the first mobile device (M1), wherein the first correction value (cv1) is a first correction value (cv1) of the first mobile device (M1);
   - applying the first correction value (cv1) to the first received signal strength indicator (RSSI1) to obtain a first distance indicator (DI1);
   - performing at least one function by the reader device (R) depending on the first distance indicator (DI1).

2. The method of claim 1, wherein the function performed by the reader device (R) is starting an authenticating procedure with the first mobile device (M1) when the received first distance indicator (DI1) is lower than a preestablished threshold.

3. The method of claim 1 or 2, the method further comprises:

   - receiving by the reader device (R) another communication signal from a second mobile device (M2), the reader determining a second received signal strength indicator (RSSI2) of the communication signal of the first mobile device;
   - receiving by the reader device (R) a second correction value (cv2) from the second mobile device (M2), wherein the second correction value (cv2) is a second correction value (cv2) of the second mobile device (M2);
   - applying the second correction value (cv2) to the second received signal strength indicator (RSSI2) to obtain a second distance indicator (DI2);

   wherein the function performed by the reader device is determining which of the first and the second mobile devices (M1, M2) is closer to the reader device (R) based on the first distance indicator (DI1) and the second distance indicator (DI2).

4. The method of claim 3, wherein the method further comprises starting an authenticating procedure with the first or the second mobile devices (M1, M2) when the distance indicator (Dli) of the first or the second mobile devices closest to the reader device (R) is lower than a preestablished threshold.

5. The method of any previous claim, wherein the i-th correction value is stored in the i-th mobile device.

6. The method of any of claims 1-4, comprising retrieving or receiving the i-th correction value from a server.

7. The method of any of claims 1-4, wherein the i-th correction value is entered in the i-th mobile device.

8. The method of any of claims 1-7, wherein the i-th correction value is dependent on the mobile device make and/or model.

9. The method of any of claims 1-8, wherein the communication signal is a Bluetooth signal, preferably a Bluetooth Low Energy signal.

10. The method of any previous claim, further comprising:

- receiving by the reader device (R) credential information sent by the i-th mobile device (Mi);
- determining validity of the credential information received by the reader device (R);
- actuating an electronic lock in a manner depending on the i-th distance indicator (Dli) and on the determined validity of the credential information.

11. A reader device (R) comprising:

- a short-range wireless communication interface for wirelessly communicating with, at least, a first mobile device (M1);
- a non-transitory computer-readable medium storing executable instructions; and
- one or more processors configured to execute executable instructions,

wherein executing the executable instructions causes the one or more processors to:

- receive a communication signal from the first mobile device (M1) and determine a first received signal strength indicator (RSSI1) of the communication signal of the first mobile device;
- receive a first correction value (cv1) from the first mobile device;
- apply the first correction value (cv1) to the first received signal strength indicator (RSSI1) to obtain a first distance indicator (DI1);
- perform at least one function depending on the first distance indicator (DI1).

12. The reader device (R) of claim 11, wherein executing the executable instructions further causes the one or more processors to:

- receive another communication signal from at least a second mobile device (M2), the reader determining a second received signal strength indicator (RSSI2) of the communication signal of the second mobile device;
- receive a second correction value (cv2) from the second mobile device;
- apply the second correction value (cv2) to the second received signal strength indicator (RSSI2) to obtain a second distance indicator (DI2);
- compare the first distance indicator (DI1) and the second distance indicator (DI2) to determine which of the first and the second mobile devices (M1, M2) is closer to the reader device (R).

13. The reader device of any of claims 11-12, wherein executing the executable instructions further causes the one or more processors to start an authenticating procedure with the i-th mobile device (Mi) when the distance indicator of the i-th device is lower than a preestablished threshold.

14. An access control system, comprising a reader device according to any of claim 11-13.

15. A computer program product comprising computer-executable instructions which, when executed by a processor of a reader device, causes the reader device to carry out the method according to one of the claims 1 to 10.

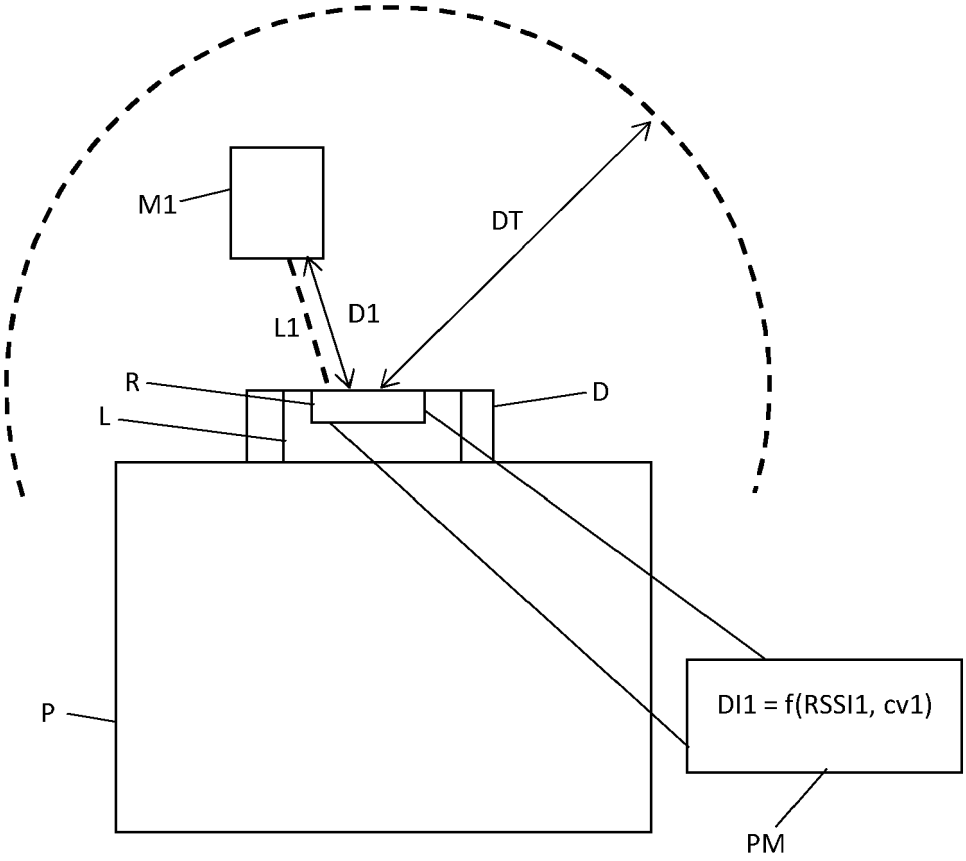


FIG. 1

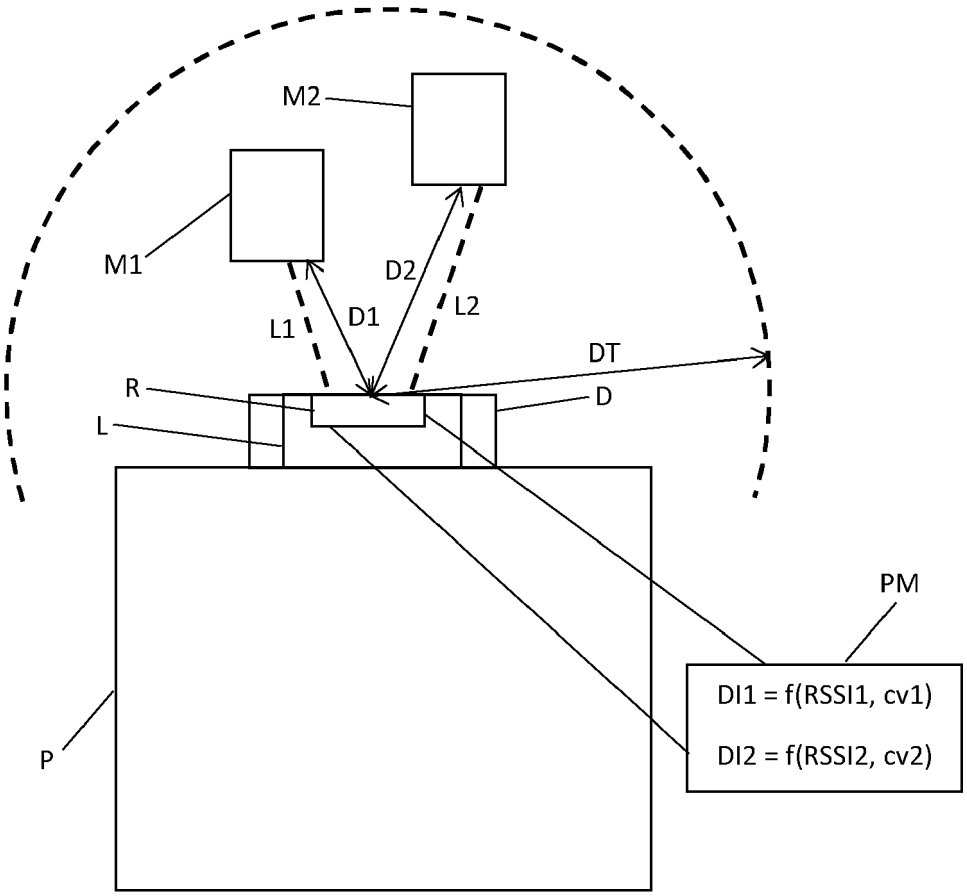


FIG. 2

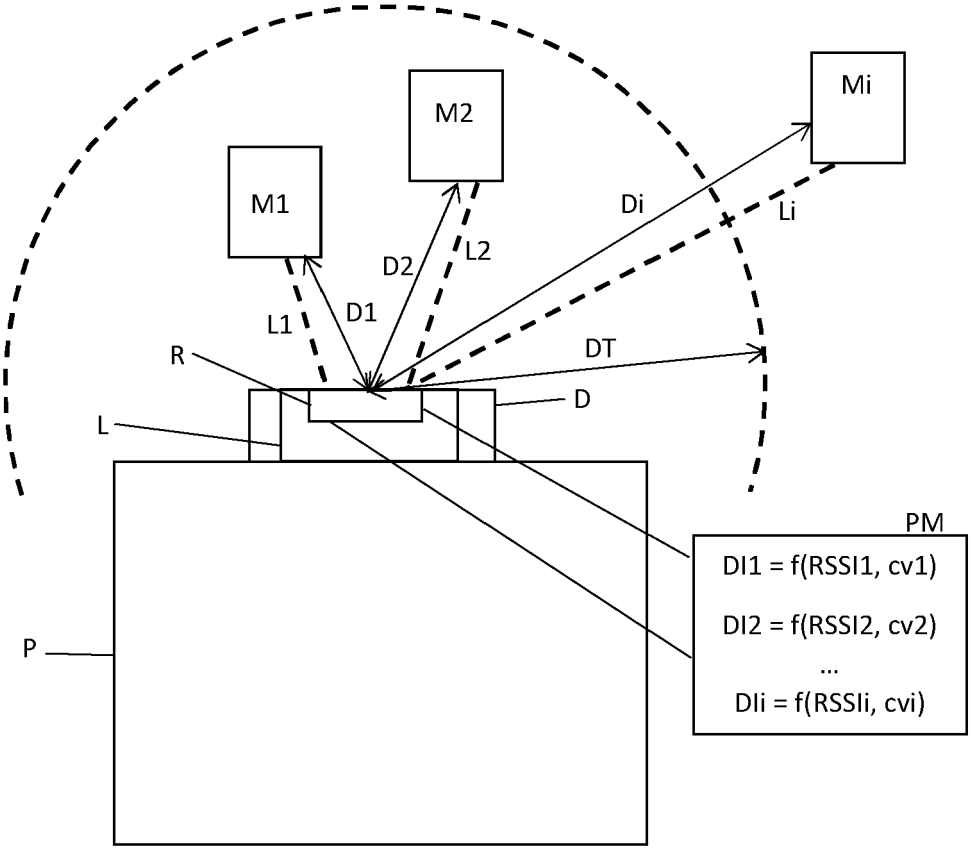

Mi
M2
M1
Di
Li
D2
L2
L1
D1
R
DT
D
L
PM
DI1 = f(RSSI1, cv1)
DI2 = f(RSSI2, cv2)
...
DIi = f(RSSIi, cvi)
P

FIG. 3

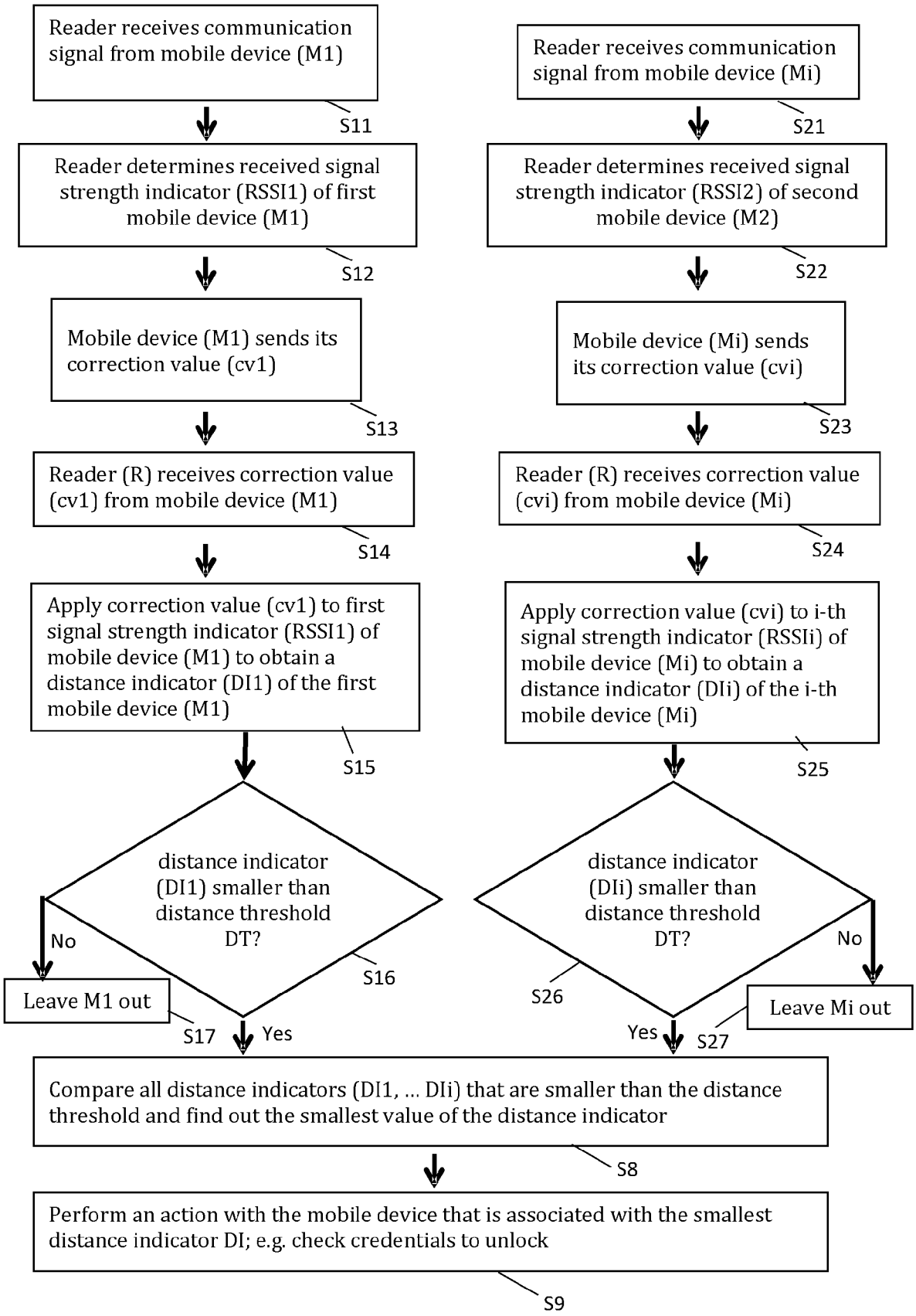

Reader receives communication signal from mobile device (M1)
S11
Reader determines received signal strength indicator (RSSI1) of first mobile device (M1)
S12
Mobile device (M1) sends its correction value (cv1)
S13
Reader (R) receives correction value (cv1) from mobile device (M1)
S14
Apply correction value (cv1) to first signal strength indicator (RSSI1) of mobile device (M1) to obtain a distance indicator (DI1) of the first mobile device (M1)
S15
distance indicator (DI1) smaller than distance threshold DT?
S16
No
Leave M1 out
S17
Yes
Reader receives communication signal from mobile device (Mi)
S21
Reader determines received signal strength indicator (RSSI2) of second mobile device (M2)
S22
Mobile device (Mi) sends its correction value (cvi)
S23
Reader (R) receives correction value (cvi) from mobile device (Mi)
S24
Apply correction value (cvi) to i-th signal strength indicator (RSSIi) of mobile device (Mi) to obtain a distance indicator (DIi) of the i-th mobile device (Mi)
S25
distance indicator (DIi) smaller than distance threshold DT?
S26
No
Leave Mi out
S27
Yes
Compare all distance indicators (DI1, ... DIi) that are smaller than the distance threshold and find out the smallest value of the distance indicator
S8
Perform an action with the mobile device that is associated with the smallest distance indicator DI; e.g. check credentials to unlock
S9

FIG. 4

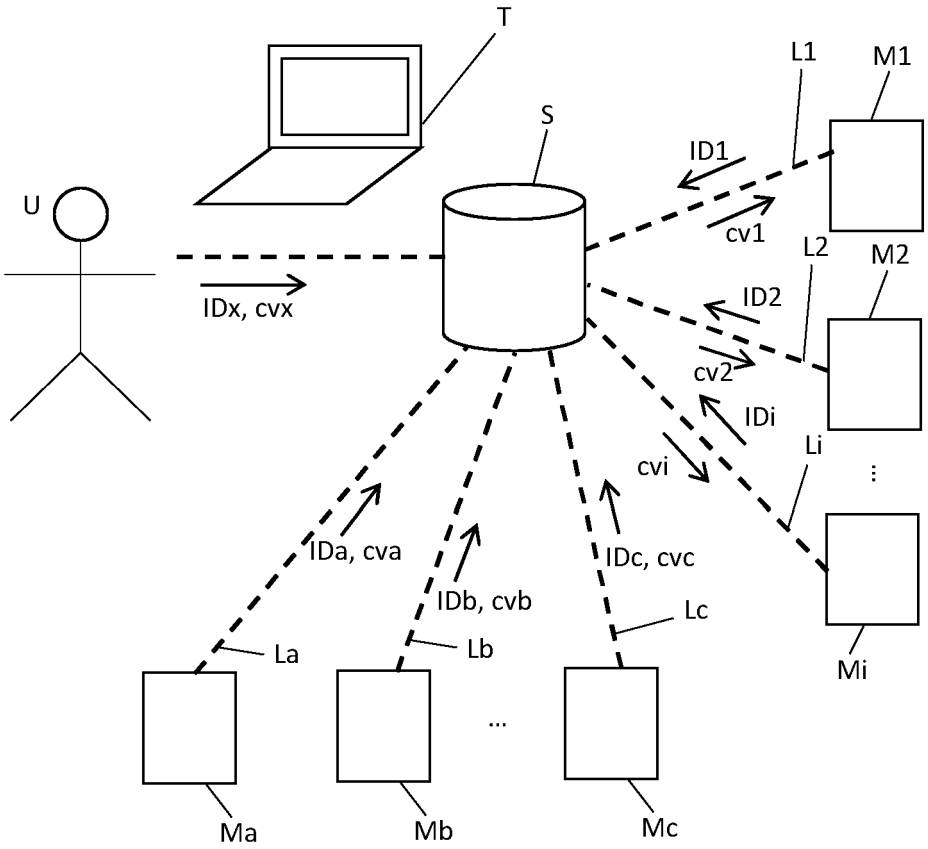

T
S
U
IDx, cvx
L1
M1
ID1
cv1
L2
M2
ID2
cv2
IDi
cvi
Li
IDa, cva
IDb, cvb
IDc, cvc
Lc
La
Lb
...
Ma
Mb
Mc
Mi

FIG. 5

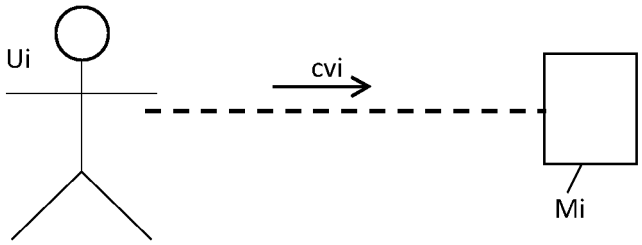

Ui
cvi
Mi

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 7733

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G07C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 April 2022	Holzmann, Wolf

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