

METHODS FOR DETERMINING A LOCATION TO PROVIDE A MAGNET AND MAGNET PROVIDING DETERMINATION DEVICES

Technical Field

[0001] Various embodiments generally relate to methods for determining a location to provide a magnet and Magnet providing determination devices.

Background

[0002] Localization methods are an important tool for various applications, like navigation or tracking. As such, there may be a need for efficient localization methods.

Summary of the Invention

[0003] According to various embodiments, a method for determining a location to provide a magnet may be provided. The method may include: measuring a geomagnetic field in a pre-determined area; determining whether the measured geomagnetic field in the pre-determined area fulfils a pre-determined criterion; and determining whether to provide a magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion.

[0004] According to various embodiments, a magnet providing determination device may be provided. The magnet providing determination device may include a measuring circuit configured to measure a geomagnetic field in a pre-determined area; a criterion determination circuit configured to determine whether the measured geomagnetic field in the pre-determined area fulfils a pre-determined criterion; and a providing determination circuit configured to determine whether to provide a magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion.

Brief Description of the Drawings

[0005] In the drawings, like reference characters generally refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. The dimensions of the various features or elements may be arbitrarily expanded or reduced for clarity. In the following description, various embodiments of the invention are described with reference to the following drawings, in which:

[0006] FIG. 1 shows a flow diagram illustrating a method for determining a location to provide a magnet according to various embodiments;

[0007] FIG. 2 shows a magnet providing determination device according to various embodiments;

[0008] FIG. 3 shows a scenario in which a method for determining a location to provide a magnet according to various embodiments and/ or a magnet providing determination device according to various embodiments may be used;

[0009] FIG. 4A and FIG. 4B show illustrations of how a magnetic poster may change a signature according to various embodiments; and

[0010] FIG. 5 shows an illustration of a magnetic poster according to various embodiments.

Detailed Description

[0011] The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention. Other embodiments may be utilized and structural, and logical changes may be made without departing from the scope of the invention. The various embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments.

[0012] In this context, the magnet providing determination device as described in this description may include a memory which is for example used in the processing carried out in the magnet providing determination device. A memory used in the embodiments may be a volatile memory, for example a DRAM (Dynamic Random Access Memory) or a non-volatile memory, for example a PROM (Programmable Read Only Memory), an EPROM (Erasable PROM), EEPROM (Electrically Erasable PROM), or a flash memory, e.g., a floating gate memory, a charge trapping memory, an MRAM (Magnetoresistive Random Access Memory) or a PCRAM (Phase Change Random Access Memory).

[0013] In an embodiment, a "circuit" may be understood as any kind of a logic implementing entity, which may be special purpose circuitry or a processor executing software stored in a memory, firmware, or any combination thereof. Thus, in an embodiment, a "circuit" may be a hard-wired logic circuit or a programmable logic circuit such as a programmable processor, e.g. a microprocessor (e.g. a Complex Instruction Set Computer (CISC) processor or a Reduced Instruction Set Computer (RISC) processor). A "circuit" may also be a processor executing software, e.g. any kind of computer program, e.g. a computer program using a virtual machine code such as e.g. Java. Any other kind of implementation of the respective functions which will be described in more detail below may also be understood as a "circuit" in accordance with an alternative embodiment.

[0014] In the specification the term "comprising" shall be understood to have a broad meaning similar to the term "including" and will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps. This definition also applies to variations on the term "comprising" such as "comprise" and "comprises".

[0015] In order that the invention may be readily understood and put into practical effect, particular embodiments will now be described by way of examples and not limitations, and with reference to the figures.

[0016] Various embodiments are provided for devices, and various embodiments are provided for methods. It will be understood that basic properties of the devices also hold

for the methods and vice versa. Therefore, for sake of brevity, duplicate description of such properties may be omitted.

[0017] It will be understood that any property described herein for a specific device may also hold for any device described herein. It will be understood that any property described herein for a specific method may also hold for any method described herein. Furthermore, it will be understood that for any device or method described herein, not necessarily all the components or steps described must be enclosed in the device or method, but only some (but not all) components or steps may be enclosed.

[0018] The term “coupled” (or “connected”) herein may be understood as electrically coupled or as mechanically coupled, for example attached or fixed or attached, or just in contact without any fixation, and it will be understood that both direct coupling or indirect coupling (in other words: coupling without direct contact) may be provided.

[0019] Localization methods are an important tool for various applications, like navigation or tracking. As such, there may be a need for efficient localization methods. According to various embodiments, localization methods using measurements of geomagnetic fields may be improved by determining where to provide (in other words: where to put) magnets in order to influence the geomagnetic field.

[0020] According to various embodiments, magnetic fields may be used to help a person navigate in an environment. For instance, large open areas may make it hard to for a phone to locate an exact location through the detection of the disturbances or infrastructures (pillars, doors, walls) in the magnetic fields. According to various embodiments, this may be changed by introducing magnets into the environment to create artificial disturbances where spaces are too wide apart.

[0021] The phone may record a pattern, and this pattern may be processed through a method which may detect a person’s location.

[0022] According to various embodiments, a venue may be mapped, and magnets (for example embedded to posters) may be provided (for example in shopping malls).

[0023] Various embodiments may provide an indoor positioning method by detecting ferrous anomalies in surrounding areas. According to various embodiments, a geomagnetic method of indoor positioning and navigation may be provided. According to

various embodiments, magnets (for example low cost magnets, for example fridge magnets) may be used to cause disturbances in the magnetic field so as to be detectable by a magnetic field detector device (for example Gaussian metre or smartphone). The use of natural hard magnets (for example in posters) may have a financial case as it may be cheap and low maintenance with no need to replace the magnets as it will never run out of power.

[0024] FIG. 1 shows a flow diagram 100 illustrating a method for determining a location to provide a magnet according to various embodiments. In 102, a geomagnetic field in a pre-determined area may be measured. In 104, it may be determined whether the measured geomagnetic field in the pre-determined area fulfils a pre-determined criterion. In 106, it may be determined whether to provide a magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion.

[0025] In other words, according to various embodiments, a method of how to determine where to best place magnets (for example magnetic posters) may be provided.

[0026] According to various embodiments, the method may further include measuring the geomagnetic field in a plurality of pre-determined areas.

[0027] According to various embodiments, the method may further include collecting information on measurements of the geomagnetic field in a plurality of pre-determined areas from a plurality of users.

[0028] According to various embodiments, measuring the geomagnetic field may include or may be or may be included in measuring a strength of the geomagnetic field.

[0029] According to various embodiments, determining whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion may include or may be or may be included in determining whether the measured strength of the geomagnetic field in the pre-determined area fulfils the pre-determined criterion.

[0030] According to various embodiments, measuring the geomagnetic field may include or may be or may be included in measuring an orientation of the geomagnetic field.

[0031] According to various embodiments, determining whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion may include or may be or may be included in determining whether the measured orientation of the geomagnetic field in the pre-determined area fulfils the pre-determined criterion.

[0032] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a strength of the geomagnetic field.

[0033] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a direction of the geomagnetic field.

[0034] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a uniformity of the geomagnetic field.

[0035] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a homogeneity of the geomagnetic field.

[0036] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a variability of the geomagnetic field.

[0037] According to various embodiments, the pre-determined criterion may include or may be a criterion related to whether the geomagnetic field (or geomagnetic field signature) at the pre-determined location is similar to a geomagnetic field (or geomagnetic field signature) at another location.

[0038] According to various embodiments, the pre-determined criterion may include or may be a criterion related to suitability of the geomagnetic field at the pre-determined location for a location determination method.

[0039] Magnetic fields may be generated by different source. According to various embodiments, devices may detect an electromagnetic field, the earth's magnetic field, or other sources of magnetic fields. According to various embodiments, the pre-determined criterion may include or may be a criterion related to a type of the geomagnetic field.

[0040] According to various embodiments, determining whether to provide the magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion may include or may be or may be included in determining that the magnet is to be provided at the pre-determined

area if it is determined that the geomagnetic field is uniform at least to a pre-determined threshold of homogeneity.

[0041] According to various embodiments, determining whether to provide the magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion may include or may be or may be included in determining that the magnet is to be provided at the pre-determined area if it is determined that the geomagnetic field is variable at least to a pre-determined threshold of variability.

[0042] According to various embodiments, determining whether to provide the magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion may include or may be or may be included in determining that the magnet is to be provided at the pre-determined area if it is determined that the geomagnetic field is suitable for a location determination method at least to a pre-determined threshold of suitability.

[0043] According to various embodiments, the magnet may include or may be or may be included in a magnetic poster (for example like described with reference to FIG. 5 below). According to various embodiments, the method may further include providing the magnet if it is determined to provide the magnet.

[0044] According to various embodiments, the method may further include carrying out a localization method based on determining a magnetic field including the geomagnetic field and the field of the provided magnet.

[0045] According to various embodiments, the localization method may include or may be or may be included in a geo-fencing method.

[0046] According to various embodiments, a computer-readable medium may be provided which includes a program, which, when executed by a processor, performs the method for determining a location to provide a magnet.

[0047] FIG. 2 shows a magnet providing determination device 200 according to various embodiments. The magnet providing determination device 200 may include a measuring circuit 202 configured to measure a geomagnetic field in a pre-determined area. The magnet providing determination device 200 may further include a criterion

determination circuit 204 configured to determine whether the measured geomagnetic field in the pre-determined area fulfils a pre-determined criterion. The magnet providing determination device 200 may further include a providing determination circuit 206 configured to determine whether to provide a magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion. The measuring circuit 202, the criterion determination circuit 204, and the providing determination circuit 206 may be coupled with each other, like indicated by lines 208, for example electrically coupled, for example using a line or a cable, and/ or mechanically coupled.

[0048] According to various embodiments, the measuring circuit 202 may further be configured to measure a strength of the geomagnetic field.

[0049] According to various embodiments, the measuring circuit 202 may further be configured to measure the geomagnetic field in a plurality of pre-determined areas.

[0050] According to various embodiments, the measuring circuit 202 may further be configured to collect information on measurements of the geomagnetic field in a plurality of pre-determined areas from a plurality of users.

[0051] According to various embodiments, the criterion determination circuit 204 may further be configured to determine whether the measured strength of the geomagnetic field in the pre-determined area fulfils the pre-determined criterion.

[0052] According to various embodiments, the measuring circuit 202 may further be further configured to measure an orientation of the geomagnetic field.

[0053] According to various embodiments, the criterion determination circuit 204 may further be configured to determine whether the measured orientation of the geomagnetic field in the pre-determined area fulfils the pre-determined criterion.

[0054] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a strength of the geomagnetic field.

[0055] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a direction of the geomagnetic field.

[0056] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a uniformity of the geomagnetic field.

[0057] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a homogeneity of the geomagnetic field.

[0058] According to various embodiments, the pre-determined criterion may include or may be a criterion related to a variability of the geomagnetic field.

[0059] According to various embodiments, the pre-determined criterion may include or may be a criterion related to whether the geomagnetic field (or geomagnetic field signature) at the pre-determined location is similar to a geomagnetic field (or geomagnetic field signature) at another location.

[0060] According to various embodiments, the pre-determined criterion may include or may be a criterion related to suitability of the geomagnetic field at the pre-determined location for a location determination method.

[0061] According to various embodiments, the providing determination circuit 206 may further be configured to determine that the magnet is to be provided at the pre-determined area if it is determined that the geomagnetic field is uniform at least to a pre-determined threshold of homogeneity.

[0062] According to various embodiments, the providing determination circuit 206 may further be configured to determine that the magnet is to be provided at the pre-determined area if it is determined that the geomagnetic field is variable at least to a pre-determined threshold of variability.

[0063] According to various embodiments, the providing determination circuit 206 may further be configured to determine that the magnet is to be provided at the pre-determined area if it is determined that the geomagnetic field is suitable for a location determination method at least to a pre-determined threshold of suitability.

[0064] According to various embodiments, the magnet may include or may be a magnetic poster.

[0065] FIG. 3 shows an illustration 300 of a scenario in which a method for determining a location to provide a magnet according to various embodiments (for example like described above with reference to FIG. 1) and/ or a magnet providing determination device according to various embodiments (for example like described above with reference to FIG. 2) may be used. For example, a top view of an area (which

may be an outdoor areas, like for example a street or market place, or an indoor area, like for example a shopping mall, supermarket, or exhibition hall) is shown. Lines (an exemplary line is referenced by 308) indicate magnetic field lines of the geomagnetic field. In areas with a lot of obstacles 302 (for example houses or trees or exhibition booths), the magnetic field lines may be non-homogeneous (in other words: may show a low degree of homogeneity), like indicated by 304. In areas without obstacles, the magnetic field lines may be at least substantially homogeneous (in other words: may show a high degree of homogeneity), like indicated by 306.

[0066] According to various embodiments, an indoor navigation method may provide the user with a tool (for example a mobile app) to navigate in an indoor environment. To detect weak instances of geomagnetic anomalies such as large flat areas or similar geomagnetic signatures, first a calibration of the intended area may be done using a Gaussian meter to measure and record the geomagnetic field signatures of the indoor venue.

[0067] According to various embodiments, a crowdsourced field signature (in other words: measurements of the geomagnetic field in a plurality of pre-determined areas from a plurality of users) may be provided. According to various embodiments, geo-magnetic field signatures from a plurality of users may be collected (for example through the use of the mobile app). This may provide to detect weak and inconsistent areas within the indoor venues which would be desired to be reinforced through the placement of a magnet (for example of a magnetic poster). The more users provide the data, the more data is collected, and therefore the more reliable the devices and methods according to various embodiments are.

[0068] FIG. 4A and FIG. 4B show illustrations of how a magnetic poster may change a signature according to various embodiments.

[0069] In FIG. 4A, an illustration 400 shows, on a left side, a first magnetic signature 404 over a first path 402 is shown. On a right side of FIG. 4A, a second magnetic signature 408 over a second path 406 is shown. In this case, like illustrated, the second path 406 has the same signature as the first path 402, and thus, a system may not determine a location from the signature. In other words, the first signature 404 and the

second signature 408 are identical, and therefore, it may not be determined whether a user using a system according to various embodiments, is moving along the first path 402 or along the second path 406.

[0070] FIG. 4B shows an illustration 410 of adding a magnet 412 (for example a magnetic poster) to the second path 406. The second signature changes (for example to a second signature 414). Now, the first magnetic signature 404 is different from the second magnetic signature 414, and as such, it may be determined whether a user using a system according to various embodiments, is moving along the first path 402 or along the second path 406.

[0071] FIG. 5 shows an illustration 500 of a magnetic poster according to various embodiments. For example a poster 502 (which may show an advertisement or an announcement or any other information) may include a magnet 504. The magnet 504 may be a permanent magnet, and may provide a magnetic field, like indicated by magnetic field lines 506, and thus may provide changes to the magnetic signature of a location.

[0072] While the invention has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

CLAIMS

1. A method for determining a location to provide a magnet, the method comprising:
measuring a geomagnetic field in a pre-determined area;
determining whether the measured geomagnetic field in the pre-determined area fulfils a pre-determined criterion; and
determining whether to provide a magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion.
2. The method of claim 1, further comprising:
measuring the geomagnetic field in a plurality of pre-determined areas.
3. The method of claim 1 or 2, further comprising:
collecting information on measurements of the geomagnetic field in a plurality of pre-determined areas from a plurality of users.
4. The method of any one of claims 1 to 3,
wherein measuring the geomagnetic field comprises measuring a strength of the geomagnetic field.
5. The method of claim 4,
wherein determining whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion comprises determining whether the measured strength of the geomagnetic field in the pre-determined area fulfils the pre-determined criterion.
6. The method of any one of claims 1 to 5,

wherein measuring the geomagnetic field comprises measuring an orientation of the geomagnetic field.

7. The method of claim 6,

wherein determining whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion comprises determining whether the measured orientation of the geomagnetic field in the pre-determined area fulfils the pre-determined criterion.

8. The method of any one of claims 1 to 7,

wherein the pre-determined criterion comprises a criterion related to a strength of the geomagnetic field.

9. The method of any one of claims 1 to 8,

wherein the pre-determined criterion comprises a criterion related to a direction of the geomagnetic field.

10. The method of any one of claims 1 to 9,

wherein the pre-determined criterion comprises a criterion related to a uniformity of the geomagnetic field.

11. The method of any one of claims 1 to 10,

wherein the pre-determined criterion comprises a criterion related to a homogeneity of the geomagnetic field.

12. The method of any one of claims 1 to 11,

wherein the pre-determined criterion comprises a criterion related to a variability of the geomagnetic field.

13. The method of any one of claims 1 to 12,

wherein the pre-determined criterion comprises a criterion related to whether the geomagnetic field in the pre-determined area is similar to a geomagnetic field in another area.

14. The method of any one of claims 1 to 13,

wherein the pre-determined criterion comprises a criterion related to suitability of the geomagnetic field at the pre-determined location for a location determination method.

15. The method of any one of claims 1 to 14,

wherein determining whether to provide the magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion comprises determining that the magnet is to be provided at the pre-determined area if it is determined that the geomagnetic field is uniform at least to a pre-determined threshold of homogeneity.

16. The method of any one of claims 1 to 15,

wherein determining whether to provide the magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion comprises determining that the magnet is to be provided at the pre-determined area if it is determined that the geomagnetic field is variable at least to a pre-determined threshold of variability.

17. The method of any one of claims 1 to 16,

wherein determining whether to provide the magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion comprises determining that the magnet is to be provided at the pre-determined area if it is determined that the geomagnetic field is suitable for a location determination method at least to a pre-determined threshold of suitability.

18. The method of any one of claims 1 to 17,

wherein the magnet comprises a magnetic poster.

19. The method of any one of claims 1 to 18, further comprising:
providing the magnet if it is determined to provide the magnet.
20. The method of claim 19, further comprising:
carrying out a localization method based on determining a magnetic field comprising the geomagnetic field and the field of the provided magnet.
21. The method of claim 20,
wherein the localization method comprises a geo-fencing method.
22. A magnet providing determination device comprising:
a measuring circuit configured to measure a geomagnetic field in a pre-determined area;
a criterion determination circuit configured to determine whether the measured geomagnetic field in the pre-determined area fulfils a pre-determined criterion; and
a providing determination circuit configured to determine whether to provide a magnet at the pre-determined area based on whether the measured geomagnetic field in the pre-determined area fulfils the pre-determined criterion.
23. The magnet providing determination device of claim 22,
wherein the measuring circuit is further configured to measure the geomagnetic field in a plurality of pre-determined areas.
24. The method of claim 22 or 23,
wherein the measuring circuit is further configured to collect information on measurements of the geomagnetic field in a plurality of pre-determined areas from a plurality of users.

25. The magnet providing determination device of claim 22 to 24,
wherein the measuring circuit is further configured to measure a strength of the geomagnetic field.
26. The magnet providing determination device of claim 25,
wherein the criterion determination circuit is further configured to determine whether the measured strength of the geomagnetic field in the pre-determined area fulfils the pre-determined criterion.
27. The magnet providing determination device of any one of claims 22 to 26,
wherein the measuring circuit is further configured to measure an orientation of the geomagnetic field.
28. The magnet providing determination device of claim 27,
wherein the criterion determination circuit is further configured to determine whether the measured orientation of the geomagnetic field in the pre-determined area fulfils the pre-determined criterion.
29. The magnet providing determination device of any one of claims 22 to 28,
wherein the pre-determined criterion comprises a criterion related to a strength of the geomagnetic field.
30. The magnet providing determination device of any one of claims 22 to 29,
wherein the pre-determined criterion comprises a criterion related to a direction of the geomagnetic field.
31. The magnet providing determination device of any one of claims 22 to 30,
wherein the pre-determined criterion comprises a criterion related to a uniformity of the geomagnetic field.

32. The magnet providing determination device of any one of claims 22 to 31,
wherein the pre-determined criterion comprises a criterion related to a
homogeneity of the geomagnetic field.
33. The magnet providing determination device of any one of claims 22 to 32,
wherein the pre-determined criterion comprises a criterion related to a variability
of the geomagnetic field.
34. The magnet providing determination device of any one of claims 22 to 33,
wherein the pre-determined criterion comprises a criterion related to whether the
geomagnetic field in the pre-determined area is similar to a geomagnetic field in another
area.
35. The magnet providing determination device of any one of claims 22 to 34,
wherein the pre-determined criterion comprises a criterion related to suitability of
the geomagnetic field at the pre-determined location for a location determination method.
36. The magnet providing determination device of any one of claims 22 to 35,
wherein the providing determination circuit is further configured to determine that
the magnet is to be provided at the pre-determined area if it is determined that the
geomagnetic field is uniform at least to a pre-determined threshold of homogeneity.
37. The magnet providing determination device of any one of claims 22 to 36,
wherein the providing determination circuit is further configured to determine that
the magnet is to be provided at the pre-determined area if it is determined that the
geomagnetic field is variable at least to a pre-determined threshold of variability.
38. The magnet providing determination device of any one of claims 22 to 36,
wherein the providing determination circuit is further configured to determine that
the magnet is to be provided at the pre-determined area if it is determined that the

geomagnetic field is suitable for a location determination method at least to a pre-determined threshold of suitability.

39. The magnet providing determination device of any one of claims 22 to 38, wherein the magnet comprises a magnetic poster.