

Claims

1. An apparatus monitoring positions on an external object having at least one beacon (1(i), i = 1, 2, ..., I) attached to it, the apparatus comprising:
An image sensor (11);
5 A lens system (13) for projecting light on said image sensor (11);
A processing unit (9);
Said processing unit (9) being arranged such as to allow communication with a memory (15) storing a computer program comprising instructions and data, which computer program can be run by the processing unit (9);
10 Said lens system (13) being arranged to receive at least one light beam (5(i)) transmitted from said at least one beacon (1(i)) and transfer said at least one light beam (5(i)) to said image sensor (11);
Said image sensor (11) being arranged to form image data based on said received at least one light beam (5(i)); and
15 Said processing unit (9) being arranged to
 identify said at least one beacon (1(i)) within the image data based on the at least one light beam (5(i)),
 determine current location data of said at least one beacon (1(i)) based on said image data,
20 compare said current location data with former location data of said one or more beacons (1(i)) as stored in said memory (15) and
 to determine whether said object has moved relative to said fixed reference frame based on said comparison.
2. The apparatus according to claim 1, wherein said processing unit (9) is arranged to identify
25 said at least one beacon (1(i)) is based on image processing of said image data.
3. The apparatus according to claim 2, wherein said processing unit (9) is arranged to perform image processing of said image data based Fourier transformation.
4. The apparatus according to claim 2, wherein said processing unit (9) is arranged to perform image processed of said image data based on correlation or autocorrelation.
- 30 5. The apparatus according to claims 1 or 2, wherein the fixed reference frame is defined relative to the earth.
6. The apparatus according to any of the preceding claims , wherein the processing unit (9) is arranged to determine light intensity and/or wavelength of said at least one light beam (5(i)) based on said image data, and to derive additional data as transmitted by said at least one
35 beacon (1(i)) which modulated said light intensity and/or wavelength.
7. The apparatus according to claim 6, wherein said lens system (13) is arranged to receive a consecutive series of light beams (5(i)) transmitted from said at least one external beacon

- (1(i)) and transfer said consecutive light beams (5(i)) to said light detector (11); said light detector (11) is arranged to form consecutive pieces of image data based on said received consecutive light beams (5(i)); and said processing unit is arranged to determine consecutive light intensities and/or wavelength of said consecutive light beams (5(i)) based on said consecutive pieces of image data, and to demodulate said consecutive light intensities and/or wavelength to derive said additional data.
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8. The apparatus according to claim 7, wherein said consecutive light intensities and/or wavelength are modulated by one of amplitude modulation, frequency modulation, and phase modulation.
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9. The apparatus according to any of the preceding claims, wherein the apparatus comprises a light generating system (21) connected to the processing unit (9), the processing unit (9) being arranged to control said light generating system (21) to generate and transmit at least one outgoing light beam (6(i)) with a modulated light intensity and/or wavelength such as to contain outgoing additional data.
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10. An apparatus for communicating with at least one external beacon (1(i), $i = 1, 2, \dots, l$), the apparatus comprising:
- A processing unit (9);
- A lens system (13) connected to the processing unit (9);
- A light detector (11) connected to the processing unit (9) and to the lens system (13);
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- Said processor being arranged such as to allow communication with a memory (15) storing a computer program comprising instructions and data, which computer program can be run by the processing unit (9);
- Said lens system (13) being arranged to receive at least one light beam (5(i)) transmitted from said at least one external beacon (1(i)) and transfer said at least one light beam (5(i)) to
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- said light detector (11);
- Said light detector (11) being arranged to form image data based on said received at least one light beam (5(i)); and
- Said processing unit being arranged to determine light intensity and/or wavelength of said at least one light beam (5(i)) based on said image data, and to derive additional data as
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- transmitted by said at least one beacon (1(i)) which modulated said light intensity and/or wavelength.
11. The apparatus according to claim 10, wherein said lens system (13) is arranged to receive a consecutive series of light beams (5(i)) transmitted from said at least one external beacon (1(i)) and transfer said consecutive light beams (5(i)) to said light detector (11); said light
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- detector (11) is arranged to form consecutive pieces of image data based on said received consecutive light beams (5(i)); and said processing unit is arranged to determine consecutive light intensities and/or wavelengths of said consecutive light beams (5(i)) based on said consecutive pieces of image data, and to demodulate said consecutive light intensities and/or wavelengths to derive said additional data.

12. The apparatus according to claim 11, wherein said consecutive light intensities and/or wavelengths are modulated by one of amplitude modulation, frequency modulation, and phase modulation.
13. A beacon 1(i) comprising:
 - 5 A processing unit (25);
 - A light generating system (29) connected to the processing unit (25);
 - A memory (27) storing a computer program comprising instructions and data, which computer program can be run by the processing unit (25);
 - Said processing unit (25) being arranged to control said light generating system (29) to transmit an outgoing light beam with a modulated light intensity and/or wavelength such as to contain outgoing additional data.
14. The beacon according to claim 13, wherein said processing unit (25) is arranged to control said light generating system (29) to transmit a consecutive series of outgoing light beams (5(i)) each having its own outgoing light intensity and/or wavelength, which outgoing light intensity and/or wavelength is modulated over time, e.g. by one of amplitude modulation, frequency modulation, and phase modulation.
15. The beacon according to claim 13 or 14, wherein said beacon comprises
 - 20 A light detector (33) connected to the processing unit (25);
 - Said light detector (33) being arranged to receive at least one light beam transmitted from at least one external light source (21);
 - Said light detector (33) being arranged to form command data based on said received at least one light beam; and
 - Said processing unit (25) being arranged to determine light intensity of said at least one light beam based on said command data, and to derive additional data as transmitted by said at least one external light source (21) which modulated said light intensity and/or wavelength.
16. System comprising an apparatus according to any of the claims 1-12 and an object with one or more beacons as defined in any of the claims 13-15.
17. Method of monitoring positions on an object having at least one beacon (1(i), $i = 1, 2, \dots, l$) attached to it, the method comprising:
 - 30 receiving at least one light beam (5(i)) transmitted from said at least one beacon (1(i));
 - forming image data based on said received at least one light beam (5(i));
 - identifying said at least one beacon (1(i)) within the image data based on at least one light beam (5(i)) received from at least one beacon (1(i)),
 - determining current location data of said at least one beacon (1(i)) based on said image data,
 - 35 comparing said current location data with former location data of said one or more beacons (1(i)) and

determining whether said object has moved relative to a fixed reference frame based on said comparison.

18. Method of communicating with at least one beacon (1(i), $i = 1, 2, \dots, l$), the method comprising:

- 5 receive at least one light beam (5(i)) transmitted from said at least one beacon (1(i));
 forming image data based on said received at least one light beam (5(i)); and
 determining light intensity and/or wavelength of said at least one light beam (5(i))
 based on said image data, and to derive additional data as transmitted by said at least
 one beacon (1(i)) which modulated said light intensity and/or wavelength.