CLAIMS

1. A marker detection system which detects a magnetic marker laid in a road by using a sensor unit in which a plurality of magnetic sensors which measure strength of magnetism are arranged, each of the magnetic sensors of the sensor unit being individually provided with a magnetic-field generation part which generates a magnetic field in accordance with a current passed, the system comprising:

a storage part which stores characteristic information of each of a plurality of the magnetic-field generation parts indicating a magnetic output characteristic, which is a relation between the current passed to the magnetic-field generation part and magnetism with which the magnetic-field generation part acts on a corresponding magnetic sensor of the magnetic sensors;

an estimation part which estimates a magnetic differential value A of each of the magnetic-field generation parts, the magnetic differential value A is an amount of change of the magnetism acting on the corresponding magnetic sensor due to a current differential value A, which is an amount of change of the current passed to the magnetic-field generation part, by referring to the characteristic information of each of the magnetic-field generation parts stored by the storage part; and

a calibration part which calibrates the each of the magnetic sensors so as to enhance uniformity in sensitivity, which is a ratio between an output differential value A, which is an amount of change of a sensor output outputted by the corresponding magnetic sensor in accordance with a change of the current by the current differential value A acting on the magnetic-field generation part, and the magnetic differential value A estimated by the estimation part for the magnetic-field generation part corresponding to the magnetic sensor.

2. The marker detection system according to claim 1, wherein the characteristic information of each of the magnetic-field generation parts stored by the storage part is information of a combination of a current differential value, which is the amount of change of the current passed to the magnetic-field generation part, and a magnetic differential value, which is the amount of change of the magnetism with which the magnetic-field generation part acts on the corresponding magnetic sensor of the magnetic sensors.

3. The marker detection system according to claim 1 or 2, wherein the magnetic-field generation parts individually provided to the plurality of magnetic sensors are connected to form a relation electrically in series to each other.

4. The marker detection system according to any one of claims 1 to 3, further comprising a detection part which detects the magnetic marker via a calculation process with a differential value between the magnetic sensors as an input value, the differential value being a difference between a sensor output value of one of the magnetic sensors or an operation value based on the sensor output value, and a sensor output value of an other of the magnetic sensors or an operation value based on the sensor output value of the other of the magnetic sensors.

5. The marker detection system according to any one of claims 1 to 4, wherein the magnetic-field generation part includes a coil with an electric wire wound therearound to generate the magnetic field in accordance with energization to the coil.

6. The marker detection system according to claim 5, wherein the magnetic sensors each includes a magnetic wire as a magnetically sensitive body and a coil with an electric wire wound around the

magnetic wire, and

the coil of the each of the magnetic sensors and the coil of the magnetic-field generation part have common specifications except a number of winding.

7. A method of operating a marker detection system which detects a magnetic marker laid in a road by using a sensor unit in which a plurality of magnetic sensors which measure strength of magnetism are arranged, each of the magnetic sensors of the sensor unit being individually provided with a magnetic-field generation part which generates a magnetic field in accordance with a current passed, and the marker detection system including a storage part which stores characteristic information of each of a plurality of the magnetic-field generation parts indicating a magnetic output characteristic, which is a relation between the current passed to the magnetic-field generation part and magnetism with which the magnetic-field generation part acts on a corresponding magnetic sensor of the magnetic sensors,

the method comprising:

a magnetic estimation step of estimating a magnetic differential value A of each of the magnetic-field generation parts, the magnetic differential value A is an amount of change of the magnetism acting on the corresponding magnetic sensor due to a current differential value A, which is an amount of change of the current passed to the magnetic-field generation part, based on the characteristic information of each of the magnetic-field generation parts stored by the storage part; and

a calibration step of calibrating the each of the magnetic sensors so as to enhance uniformity in sensitivity, which is a ratio between an output differential value A, which is an amount of change of a sensor output outputted by the corresponding magnetic sensor in accordance with a change of the current by the current

differential value A acting on the magnetic-field generation part, and the magnetic differential value A estimated at the magnetic estimation step for the magnetic-field generation part corresponding to the magnetic sensor.

8. The method of operating the marker detection system according to claim 7, wherein the characteristic information of each of the magnetic-field generation parts stored by the storage part is information of a combination of a current differential value, which is the amount of change of the current passed to the magnetic-field generation part, and a magnetic differential value, which is the amount of change of the magnetism with which the magnetic-field generation part acts on the corresponding magnetic sensor of the magnetic sensors.

9. The method of operating the marker detection system according to claim 7 or 8, further comprising:

a sensor characteristic acquiring step of acquiring characteristic information of the each of the magnetic sensors indicating a sensor output characteristic, which is a relation between the magnetism acting on the each of the magnetic sensors and the sensor output outputted by the each of the magnetic sensors, by measuring an amount of change serving as a reference of the sensor output of the each of the magnetic sensors when the magnetism acting on the sensor unit is changed by a reference amount;

a magnetic measurement step of measuring the magnetism acting on the corresponding magnetic sensor corresponding to the magnetic-field generation part when the current passed to the magnetic-field generation part is changed and acquiring an output differential value B, which is an amount of change of the sensor output outputted by the corresponding magnetic sensor in accordance with a current differential value B, which is an amount of change

of the current passed to the magnetic-field generation part; and

a magnetic output characteristic acquiring step of estimating a magnetic differential value B corresponding to the output differential value B acquired at the magnetic measurement step with reference to the characteristic information indicating the sensor output characteristic of the corresponding magnetic sensor, acquiring a combination of the magnetic differential value B and the current differential value B as the characteristic information indicating a magnetic output characteristic of the magnetic-field generation part, and storing the combination in the storage part.

10. The method of operating the marker detection system according to claim 9, wherein the characteristic information of the corresponding magnetic sensor is information of a combination of a magnetic differential value C corresponding to the reference amount and an output differential value C, which is an amount of change serving as a reference of the sensor output outputted by the corresponding magnetic sensor, and

the sensor characteristic acquiring step includes a magnetic sensor calibration process of making a ratio between the magnetic differential value C and the output differential value C of the each of the magnetic sensors closer to be uniform.

11. The method of operating the marker detection system according to any one of claims 7 to 10, wherein the marker detection system is the marker detection system described in any one of claims 1 to 6.