CLAIMS

1. A sensor module for detecting unevenness of a surface (S), the sensor module comprising:
   - an arm assembly (1) comprising
     an arm body (1.1) having at least two ends,
     one or more surface contacting element (1.2) mounted to at least one end of the arm body (1.1);
   - a magnet assembly (2) assembled to the arm assembly (1), the magnet assembly (2) comprising at least one magnet (2.1) to generate magnetic lines of force; and
   - a magnetic sensor assembly (3) comprising a magnetic sensor (3.1) being assembled adjacent to the magnet (2.1) for sensing changes in the magnetic lines of force in response to movement of the arm body (1.1).

2. The sensor module according to claim 1, wherein the arm assembly (1) further comprises a direction controlling means (1.3) for controlling a moving direction of the arm body (1.1) toward-backward the surface (S).

3. The sensor module according to claim 1 or 2, wherein the arm body (1.1) is shaped as a bar having an end (1.1.1) and a free end (1.1.2).

4. The sensor module according to claim 3, wherein the free end (1.1.2) is configured for mounting to the surface contacting element (1.2) which is biased into contact with the surface (S).

5. The sensor module according to claim 1, wherein the magnet assembly (2) is assembled to the arm assembly (1) in a manner that an arrangement of magnetic lines of force generated from the magnet (2.1) is correlated with the moving direction of the arm body (1.1).

6. The sensor module according to claim 2, wherein the direction controlling means (1.3) comprises a moving guide (1.3.1) assembled to the arm body (1.1), and a fixing guide (1.3.2) assembled to the arm body (1.1), wherein the moving guide (1.3.1) and the

fixing guide (1.3.2) cooperate to guide the arm body (1.1) moves toward-backward the surface (S) in a direction perpendicular to the surface (S).

7. The sensor module according to claim 1, wherein the surface contacting element (1.2) is selected from one or more of wheel, roller, ball, track, and caterpillar.

8. The sensor module according to any one of the preceding claims, wherein the arm assembly (1) further comprises a biasing assembly (1.4).

9. The sensor module according to claim 8, wherein the biasing assembly (1.4) comprises a surface contacting element support (1.4.1), an extended portion (1.4.2) extending downwardly from the surface contacting element support (1.4.1).

10. The sensor module according to claim 9, wherein the biasing assembly (1.4) further comprises an axis (1.4.3) extending from the extended portion (1.4.2) in a direction parallel to the arm body (1.1), a spring (1.4.4) provided on the axis (1.4.3) and an abut portion (1.4.5) provided at an end of the spring (1.4.4) for abutting the spring (1.4.4) in a compressed manner.

11. The sensor module according to claim 1 or 5, wherein the magnet (2.1) is selected from any one of magnet strip, magnet bar, round shaped magnet piece, semicircle shaped magnet piece, oval shaped magnet piece, square shaped magnet piece and triangle shaped magnet piece.

12. The sensor module according to claim 1, 5 or 11, wherein the magnet (2.1) is a magnet strip provided on a surface of the arm body (1.1).

13. The sensor module according to claim 1, 5 or 11, wherein the magnet (2.1) is a round shaped magnet piece provided in the magnet assembly (2).

14. The sensor module according to any one of claims 2 to 13~~the preceding claims~~, wherein the sensor module further comprises a processor (4) being in communication with the magnetic sensor assembly (3) for receiving sensing data from the magnetic sensor (3.1) and converting to unevenness profiles of the surface (S).

15. The sensor module according to claim 14, wherein the magnetic sensor assembly (3) comprising:
    - the magnetic sensor (3.1);
    - a magnetic sensor holder (3.2) provided for holding the magnetic sensor (3.1) to be in proximity and face the magnet (2.1); and
    - a circuit (3.3) electrically connected to the magnet sensor (3.1) for receiving the sensed data from the magnetic sensor (3.1) and sending the sensed data to the processor (4).

16. The sensor module according to any one of claims 1 to 3, wherein
    - the arm body (1.1) is rotatably assembled to the magnet assembly (2); and
    - the direction controlling means (1.3) comprising a rotating guide (1.3.3) and a fixing rod (1.3.4), the rotating guide (1.3.3) rotatably assembled to the end (1.1.1) of the arm body (1.1) and slidably assembled to the fixing rod (1.3.4) through a hole (1.3.3.1) provided on the rotating guide (1.3.3), and an end of the fixing rod (1.3.4) is assembled to the magnetic sensor assembly (3).

17. The sensor module according to claim 1, wherein the surface contacting element (1.2) is biased into contact with the surface (S) by means of a torsion spring provided between the arm body (1.1) and the magnetic sensor assembly (3).

18. The sensor module according to claim 1, wherein the magnet assembly (2) comprising:
    - the magnet (2.1); and
    - a rod (2.2) having an end (2.2.1) rotatably assembled to the arm body (1.1) and another end (2.2.2) rotatably assembled to the magnetic sensor assembly (3),

    wherein the magnet (2.1) is a magnet rotary which is provided at a position where the rod (2.2) is assembled to the magnetic sensor assembly (3).

19. The sensor module according to claim 15, wherein the magnetic sensor assembly (3) comprises a magnetic sensor frame (3.4) to which the magnetic sensor (3.1) is attached, and the circuit (3.3) mounted to the magnetic sensor frame (3.4) and electrically connected to the magnet sensor (3.1) for receiving the sensed data from the magnetic sensor (3.1) and sending the sensed data to the processor (4).

20. The sensor module according to claim 19, wherein the magnetic sensor frame (3.4) is in L-inverted shape having an end (3.4.1) rotatably assembled to the magnet assembly (2) and another end (3.4.2) assembled to the direction controlling means (1.3).

21. The sensor module according to claim 19 or 20, wherein the magnetic sensor (3.1) is attached on the magnetic sensor frame (3.4) at a position proximity to the magnet (2.1).

22. An apparatus for detecting unevenness of a surface (S), the apparatus comprising the sensor module according to any one of claims 1 to 21 which is assembled to a driving tool for driving the sensor module along the surface (S) to be detected.

23. The apparatus according to claim 22 which is used for detecting unevenness of a pipe, wherein the apparatus comprising a plurality of sensor modules which are arranged around a circumference of an external surface of the pipe.

24. The apparatus according to claim 23, wherein the sensor modules are arranged in pairs in a manner that each sensor module is arranged opposite each other.

25. The apparatus according to claim 24, wherein at least four pairs of the sensor modules are arranged around the circumference of the external surface of the pipe.

26. The apparatus according to any one of claims 22 to 25 further comprises at least one auxiliary sensor which is selected from a carburization sensor, a crack sensor, and a thickness measurement sensor.

27. A method for detecting unevenness of a surface (S), the method comprising steps of:
    a) inspecting the surface (S) by using the sensor module according to any one of claims 1 to 21 to obtain data of changes in the magnetic lines of force;
    b) sending data obtained from a) to a processor of the sensor module; and
    c) converting data received from b) to distance changed from an initial position to a detected position to determining unevenness profiles of the surface (S).

28. The method according to claim 27 further comprises a step of amplifying the signal of data of changes in the magnetic lines of force before the step of converting data.

29. The method according to claim 28 wherein the step of amplifying the signal of data of changes in the magnetic lines of force is performed by using a gateway.

30. Use of the sensor module according to any one of claims 1 to 21 for detecting unevenness of a surface.