a non-magnetic wheel operative to maintain contact with one of the ferromagnetic surfaces;

a magnetic assembly rotatably coupled to the non-magnetic wheel, wherein the magnetic assembly comprises:

a magnetic flux producer; and

a magnetic flux distribution controller which, in cooperation with the magnetic flux producer, is operative to produce a varying magnetic force on a ferromagnetic surface adjacent to the magnetic assembly by varying an air gap distance therebetween and/or a surface area of the magnetic flux distribution controller in proximity with the ferromagnetic surface, wherein the magnetic flux distribution controller having a rotational profile defined by an entire perimeter of the magnetic flux distribution controller configured to be in proximity with the ferromagnetic surface to provide the air gap distance during rotation of the magnetic flux distribution controller.

According to another aspect of the invention, a method of operating a robot capable of performing surface transition on ferromagnetic surfaces is provided. The method comprises:

moving a mobile robot along one of the ferromagnetic surfaces by rotating wheel assemblies of the mobile robot; and

performing, by one of the wheel assemblies, surface transition between the ferromagnetic surfaces by rotating a magnetic flux distribution controller and a non-magnetic wheel coupled thereto and,

while maintaining the non-magnetic wheel in contact with an adjacent ferromagnetic surface, varying an air gap distance between the magnetic flux distribution controller and an adjacent ferromagnetic surface, and/or a surface area of the magnetic flux distribution controller in proximity with the ferromagnetic surface, to vary a magnetic force on the adjacent ferromagnetic surface, wherein the magnetic flux distribution controller having a rotational profile defined by an entire perimeter of the magnetic flux distribution controller configured to be in proximity with the ferromagnetic surface to provide the air gap distance during rotation of the magnetic flux distribution controller.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are disclosed hereinafter with reference to the drawings, in which:

Figures 1A to 1D illustrate a surface transition sequence of a mobile robot from a vertical surface to an overhead surface, according to one embodiment of the invention;

Figure 2 includes an exploded view (on left side of figure) of a non-driven magnetic wheel assembly and a front view (on right of figure) a non-driven magnetic wheel assembly according to one embodiment of the invention;

Figures 3A to 3G illustrate a various examples of a mild steel plate;

What is claimed is:

1. A mobile robot capable of performing surface transition on ferromagnetic surfaces, the robot comprises:

a chassis;

at least one driven magnetic wheel assembly rotatably mounted to the chassis and operative to drive the chassis; at least one non-driven magnetic wheel assembly rotatably mounted to the chassis,

wherein at least the driven magnetic wheel assembly or the non-driven magnetic wheel assembly comprises:

a non-magnetic wheel operative to maintain contact with one of the ferromagnetic surfaces;

a magnetic assembly rotatably coupled to the non-magnetic wheel, wherein the magnetic assembly comprises:

a magnetic flux producer; and

a magnetic flux distribution controller which, in cooperation with the magnetic flux producer, is operative to produce a varying magnetic force on a ferromagnetic surface which is adjacent to the magnetic assembly by varying an air gap distance therebetween and/or a surface area of the magnetic flux distribution controller in proximity with the ferromagnetic surface, wherein the magnetic flux distribution controller having a rotational profile defined by an entire perimeter of the magnetic flux distribution controller configured to be in proximity with the ferromagnetic surface to provide the air gap distance during rotation of the magnetic flux distribution controller.

2. The mobile robot of claim 1, wherein the magnetic flux producer is a permanent magnet or an electromagnet, and wherein the magnetic flux distribution controller is a magnetically permeable structure.

3. The mobile robot of claim 2, wherein the permanent magnet or the electromagnet is interposed between the magnetically permeable structure.

4. The mobile robot of claim 1, wherein the magnetic flux producer and the magnetic flux distribution controller are integrally provided.

5. The mobile robot of any one of claims 1 to 4, wherein the magnetic flux producer and the magnetic flux distribution controller are rotatable about a same axis of rotation which is about the centre of the magnetic flux distribution controller.

6. The mobile robot of any one of claims 1 to 5, wherein the shape of the magnetic flux distribution controller is one selected from the group consisting of a semi-circle, a tear-drop, circle with cut-out portion, a sector of a circle and an amalgamated circle with rectangle or square.

7. A method of operating mobile robot capable of performing surface transition on ferromagnetic surfaces, the method comprises:

moving a mobile robot along one of the ferromagnetic surfaces by rotating wheel assemblies of the mobile robot; and

performing, by one of the wheel assemblies, surface transition between the ferromagnetic surfaces by rotating a magnetic flux distribution controller and a non-magnetic wheel coupled thereto and,

while maintaining the non-magnetic wheel in contact with an adjacent ferromagnetic surface, varying an air gap distance between the magnetic flux distribution controller and an adjacent ferromagnetic surface, and/or a surface area of the magnetic flux distribution controller in proximity with the ferromagnetic surface, to vary a magnetic force on the adjacent ferromagnetic surface, wherein the magnetic flux distribution controller having a rotational profile defined by an entire perimeter of the magnetic flux distribution controller configured to be in proximity with the ferromagnetic surface to provide the air gap distance during rotation of the magnetic flux distribution controller.

8. The method of claim 7, wherein the one of the wheel assemblies comprises a driven wheel or a non-driven wheel.

9. The method of any one of claim 7 and claim 8, wherein the magnetic flux producer is a permanent magnet or an electromagnet, and wherein the magnetic flux distribution controller is a magnetically permeable structure.

10. The method of claim 9, wherein the permanent magnet or the electromagnet is interposed between the magnetically permeable structure.

11. The method of any one of claim 7 and claim 8, wherein the magnetic flux producer and the magnetic flux distribution controller are integrally provided.

12. The method of any one of claims 7 to 11, wherein the magnetic flux producer and the magnetic flux distribution controller are rotatable about a same axis of rotation which is about the centre of the magnetic flux distribution controller.

13. The method of any one of claim 7 to claim 11, wherein the shape of the magnetic flux distribution controller is one selected from the group consisting of a semi-circle, a teardrop, circle with cut-out portion, a sector of a circle and an amalgamated circle with rectangle or square.