Claims

1. An apparatus for detecting flaws in a wall of a metallic pipe containing a fluid, comprising:
a plurality of sensors for sensing magnetic field signals from the metallic pipe, the plurality of sensors configured to be distributed around an inner circumference of the metallic pipe without contacting a surface of an inner wall of the metallic pipe;
a collapsible supporting structure at a front side of the plurality of sensors for supporting the apparatus, wherein the collapsible supporting structure comprises a plurality of collapsible supporting petals, and wherein an axis of the apparatus is at or near an axis of the metallic pipe;
a collapsible sail mounted on and extended from bottom ends of the plurality of collapsible supporting petals, wherein when the plurality of collapsible supporting petals are in an extended state, the collapsible sail is expanded to form a shape capable for containing the fluid, and wherein when the plurality of collapsible supporting petals traverse a pipe feature, the plurality of collapsible supporting petals collapse to a compressed state and cause the collapsible sail compressed;
a processing module for receiving sensed data from the plurality of sensors; and
one or more battery modules for electrically powering the plurality of sensors and the processing module.

2. The apparatus of claim 1, further comprising a nose module for facilitating the apparatus to pass through an opening of a pipe feature.

3. The apparatus of claim 1, wherein the plurality of sensors comprise a plurality of sensor arrays, and wherein each sensor array of the plurality of sensor arrays includes a subset of the plurality of sensors.

4. The apparatus of claim 3, wherein the each sensor array of the plurality of sensor arrays comprises 16 sensors.

5. The apparatus of claim 4, wherein the distance between the sensors is about 15 mm.

6. The apparatus of claim 3, wherein the subset of the plurality of sensors are mounted on a flexible Printed Circuit Board (PCB).

7. The apparatus of claim 3, wherein the subset of the plurality of sensors are mounted on three rigid Printed Circuit Boards (PCBs).

8. The apparatus of claim 6 or 7, wherein each sensor array includes a body and a pair of flexible arms extended in opposite directions from the body, and wherein the flexible PCB and the subset of the plurality of sensors are mounted within the pair of flexible arms.

9. The apparatus of claim 8, wherein the body further comprises a connector for transmitting the sensed data to the processing module.

10. The apparatus of claim 3, wherein each sensor array is mounted on a top end of a sensor petal.

11. The apparatus of claim 10, wherein the sensor petal is pivotably mounted on a petal plate, wherein the sensor petal is configured in an extended initial state.

12. The apparatus of claim 3, wherein the plurality of sensor arrays form a continuous circumference in a proximity of a surface of the inner wall of the metallic pipe.

13. The apparatus of claim 12, wherein the plurality of sensor arrays are evenly distributed on the continuous circumference.

14. The apparatus of claim 12, wherein a distance between the sensor arrays and the surface of the inner wall of the metallic pipe is in a range of 10 cm-0.5 cm.

15. The apparatus of claim 3, wherein the plurality of sensors are included in two sensor array sets.

16. The apparatus of claim 11, wherein the sensor petal is substantially perpendicular to an axis of the apparatus when the sensor petal is in the extended initial state.

17. The apparatus of claim 11, wherein the sensor petal is collapsible when the apparatus passes through an opening of a pipe feature.

18. The apparatus of claim 1, wherein the plurality of sensors comprise metal magnetic memory (MMM) sensors.

19. The apparatus of claim 1, wherein the plurality of sensors comprise electromagnetic (EM) sensors.

20. The apparatus of claim 1, wherein the plurality of sensors comprise metal magnetic memory (MMM) sensors and electromagnetic (EM) sensors.

21. The apparatus of claim 1, wherein each collapsible supporting petal and the axis of the apparatus form an angle in a range of 65°-85° when each collapsible supporting petal is in an extended state.

22. The apparatus of claim 1, further comprising at least one tow link for connecting the processing module with the one or more battery modules, or for connecting two battery modules.

23. A method for sensing a wall of a metallic pipe containing a fluid, comprising:

positioning an apparatus at or near an axis of the metallic pipe;
arranging a plurality of metal magnetic memory (MMM) sensors on the apparatus around an inner circumference of the metallic pipe without contacting the inner circumference of the metallic pipe;
supporting, by a collapsible supporting structure, the apparatus at a front side of the plurality of MMM sensors, wherein the collapsible supporting structure comprises a plurality of collapsible supporting petals;
driving, by a collapsible sail extended from bottom ends of the plurality of collapsible supporting petals, the apparatus within the pipe by fluid flow, wherein when the plurality of collapsible supporting petals are in an extended state, the collapsible sail is expanded to form a shape capable for containing the fluid, and wherein when the plurality of collapsible supporting petals traverse a pipe feature, the plurality of collapsible supporting petals collapse to a compressed state and cause the collapsible sail to compress; and
sensing residual magnetic field signals generated from the wall of the metallic pipe.

24. The method of claim 23, further comprising identifying a defect on the wall of the metallic pipe based on sensed residual magnetic field signals.

25. The method of claim 23, further comprising sensing a second set of data of the wall from at least one electromagnetic (EM) sensor.