Fractal Robots – Smart Future of Manufacturing Industry

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I. INTRODUCTION

The birth of every technology is the result of the quest for automation of some form of human work. This has led to many inventions that have made life easier for us. Fractal Robot is a science that promises to revolutionize technology in a way that has never been witnessed before.

The principle behind Fractal Robots is very simple. You take some cubic bricks made of metals and plastics, motorize them, put some electronics inside them and control them with a computer and you get machines that can change shape from one object to another. Almost immediately, you can now build a home in a matter of minutes if you had enough bricks and instruct the bricks to shuffle around and make a house! It is exactly like kids playing with Lego bricks and making a toy hose or a toy bridge by snapping together Lego bricks-except now we are using computer and all the work is done under total computer control. No manual intervention is required. Fractal Robots are the hardware equivalent of computer software.

II. WHAT ARE FRACTALS?

A fractal is anything which has a substantial measure of exact or statistical self-similarity. Wherever you look at any part of its body it will be similar to the whole object.

III. FRACTAL ROBOT MECHANISM

Considerable effort has been taken in making the robotic cubes as simple as possible after the invention has been conceived. The design is such that it has fewest possible moving parts so that they can be mass produced. Material requirements have been made as flexible as possible so that they can be built from metals and plastics which are cheaply available in industrialized nations but also from ceramics and clays which are environmentally friendlier and more readily available in developing nations. The robotic cubes are assembled from face plates which have been manufactured and bolted to a cubic frame as illustrated in figure

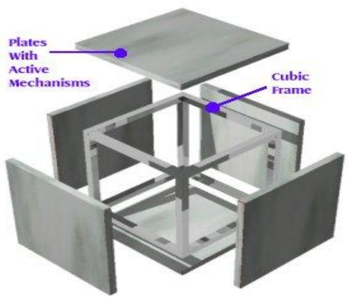

Fig. 1 : Cubic Frame

3.1. Movement Mechanism

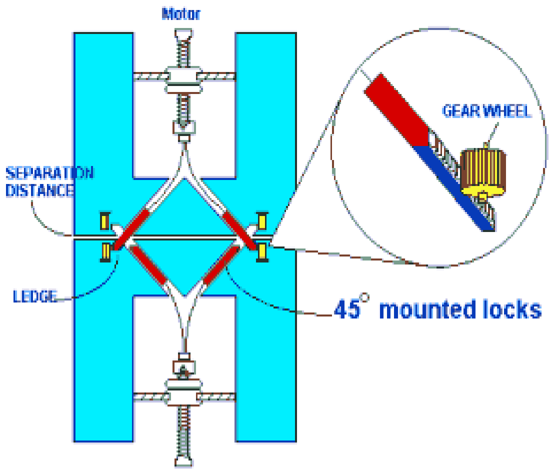

Fig. 2 : Cross-section of plate

The petals are pushed in and out of the slots with the aid of a motor. Each petal could be directly driven by single motor or they could be driven as a pair with the aid of a flexible strip of metal.

The petals have serrated edges and they engage into the neighboring robotic cube through the 45 degree slots. The serrated edges of the petals are engaged by either a gear wheel or a large screw thread running the length of the slot which slides the cubes along.

3.2. Implementation of computer control

All active robotic cubes have a limited microcontroller to perform basic operations such as the communication and control of internal mechanism. The commands to control a Fractal Robot are all commands for movement such as move left, right etc and hence the computer program to control the robot is greatly simplified in that whatever software that is developed for a large scale robot, it also applies to the smaller scale with no modifications to the command structure.

The largest component of the Fractal Robot system is the software. Because shape changing robots are fractals, everything around the robot such as tooling, operating system, software etc must be fractally organized in order to take advantage of the fractal operation. Fractal Robot hardware is designed to integrate as seamlessly with software data-structures as possible. So, it is essential that unifying Fractal architecture is followed to the letter for compatibility and interoperability. Fractal architecture dominates the functions of the core of the O.S., the data-structures, the implementation of the devices etc. Everything that is available to the O.S. is containerized into fractal data structures that permit possible compatibility and conversion issues possible.

3.3. Fractal O.S.

The Fractal O.S. plays a crucial role in making the integration of the system seamless and feasible. A Fractal O.S. uses a no: of features to achieve these goals.

1. Transparent data communication
2. Data compression at all levels
3. Awareness of built in self repair.

A Fractal O.S. converts fractally written code into machine commands for movement. The data signals are fed to a bus (fractal bus). The electronics have to be kept simple so that they can be miniaturized. Towards this end, the Fractal Robot uses principally state logic.

So its internal design consists if ROM, RAM and some counters

3.4. Fractal Bus

This is an important and pioneering advancement for fractal computer technology. A Fractal bus permits Hardware and software to merge seamlessly into one unified data-structure. It helps in sending and receiving fractally controlled data.

Computer software controls the shaping of objects that are synthesized by moving cubes around. To reduce the flow of instructions the message is broadcast to a local machine that controls a small number of cubes (typically around 100 cubes). All cubes communicate using a simple number scheme. Each is identified in advance and then a number is assigned. The first time around, the whole message and the number is sent but the next time only the number is sent.

IV. MOVEMENT ALGORITHMS

There are many mechanical designs for constructing cubes, and cubes come in different sizes, but the actual movement method is always the same.

Regardless of complexity, the cubes move only between integer positions and only obey commands to move left, right, up, down, forward and backward. If it can't perform an operation, it simply reverses back. If it can't do that as well, the software initiates self repair algorithms. There are only three basic movement methods.

- Pick and place
- N-streamers
- L-streamers

Pick and place is easy to understand. Commands are issued to a collection of cubes telling each cube where to go. A command of "cube 517 move left by 2 positions" results in only one cube moving in the entire machine. Entire collection of movements needed to perform particular operations are worked out and stored exactly like conventional robots store movement paths. (Paint spraying robots use this technique.)

However there are better structured ways to storing movement patterns. It turns out that all movements other than pick and place are variations of just two basic schemes called the N-streamer and L-streamer.

N-streamer is easy to understand. A rod is pushed out from a surface, and then another cube is moved into the vacant position. The new cube is joined to the tail of the growing rod and pushed out again to grow the rod. The purpose of the rod is to grow a 'tentacle'. Once a tentacle is grown, other robots can be directed to it and move on top of it to reach the other side. For bridge building applications, the tentacles are grown vertically to make tall posts.

V. SELF REPAIR

For this scheme to work, the cube has to be partially dismantled and then re-assembled at a custom robot assembly station. The cubic robot is normally built from six plates that have been bolted together.

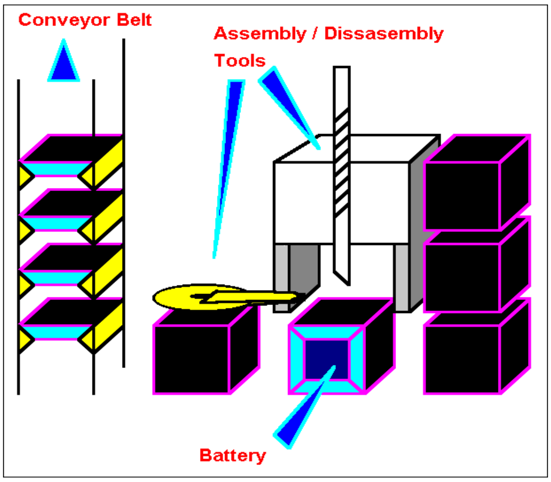

Fig. 3 : Conveyor system

To save on space and storage, when large numbers of cubes are involved, these plates mechanisms can be stacked onto a conveyor belt system and assembled into the whole unit by robotic assembly station as notionally illustrated in figure. (By reversing the process, fractal robots can be dismantled and stored away until needed.)

If any robotic cubes are damaged, they can be brought back to the assembly station by other robotic cubes, dismantled into component plates, tested and then re-assembled with plates that are fully operational. Potentially all kinds of things can go wrong and whole cubes may have to be discarded in the worst case. But based on probabilities, not all plates are likely to be damaged, and hence the resilience of this system is much improved over self repair by cube level replacement.

VI. APPLICATIONS OF FRACTAL ROBOTS

1. Bridge building
2. Fire Fighting
3. Defense Technology
4. Earthquake Application
5. Medical Application
6. Space Application

VII. LIMITATIONS

1. Technology is still in infancy
2. Current cost is very high($1000 per cube for the 1st generation of cubes, after which it will reduce to $100 or so).
3. Needs very precise & flexible controlling software

VIII. CONCLUSION

It may take about 4-5 years for this technology to be introduced and tried out all over the world. But once the first step is taken and its advantages well understood it will not take much time for it to be used in our everyday life. Using Fractal Robots will help in saving economy; time etc and they can be used even for the most sensitive tasks.

Also the raw materials needed are cheap, making it affordable for developing nations also. This promises to revolutionize technology in a way that has never been witnessed before.

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