Fractal robots essay

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. 1. 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. 2. Fractal Robots A Fractal Robot physically resembles itself according to the definition above. The robot can be animated around its joints in a uniform manner. Such robots can be straight forward geometric patterns/images that look more like natural structures such as plants. This patented product however has a cubic structure. The figure below shows a collection of such cubes. pic][pic] Fractal Robots start at one size to which half size or double size cubes can be attached and to each of these half size/double size cubes can be attached respectively adinfinitum. This is what makes them fractal. So a fractal cube can be of any size. The smallest expected size is between 1000 and 10, 000 atoms wide. These cubes are embedded with computer chips that control their movement. Thus they can be programmed to configure themselves into any shape. The implication of this concept is very powerful.

This concept can be used to build buildings, bridges, instruments, tools and almost anything else you can think of. It can be done with hardly any manual intervention. These robots can assist in production and manufacture of goods thus bringing down the manufacturing price down dramatically. 2. Fractal Robot Mechanism 2. 1 Simple Construction details 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 1. [pic] Figure 1 The cube therefore is hollow and the plates have all the mechanisms.

Each of these face plates have electrical contact pads that allow power and data signals to be routed from one robotic cube to another. The plates also have 45 degree petals that push out of the surface to engage the neighbouring face that allows one robotic cube to lock to its neighbour. The contact pads could be on the plates themselves or be mounted separately on a purpose built solenoid operated pad as shown in figure 2. [pic] Figure 2 The contact pads are arranged symmetrically around four edges to allow for rotational symmetry. These contacts are relayed out and only transmit power when required to do so.

If they are operating submerged, the contact pads can be forced into contact under pressure because of the petals, removing most of the fluid between the gaps before transmitting power through them. A 3D rendered image of what the robotic cube looks like in practice is shown in figure 3. [pic] Figure 3 The contact pads are not shown in figure 4. What is shown are four v shaped grooves running the length of the plate that allow the petals to operate so that the cubes can lock to each other and also each other using its internal mechanisms. The cubes have inductive coupling to transmit power and data signals.

This means that there care no connectors on the surface of the robotic cube. If the connectors are used, wiring problems may follow. Unlike contact pads, inductive coupling scale very well. 2. 2 Movement Mechanism To see the internal mechanisms, we need a cross section of the plate as illustrated in figure 4. [pic] Figure 4 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 neighbouring 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. 2. 3 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 eveloped 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 datastructures 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 datastructures, 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. 2. 3. 1 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 coverts fractally written code into machine commands for movement. The data signals are fed to a bus (fractal bus). The e3lectronics 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. 2. 3. 2 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 datastructure. 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 no: of cubes (typically around 100 cubes). All cubes communicate using a simple no: scheme. Each is identified in advance and then a no: is assigned. The first time around, the whole message and the no: is sent but the next time only the no: is sent. 3. 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. L-streamer is a little more involved to explain and requires the aid of figure 5. L-streamers are also tentacles but grown using a different algorithm. [pic] Figure 5 Basically, an L-shape of cubes numbered 4, 5, 6 in figure 2a attached to a rod numbered 1, 2, 3, and then a new cube 7 is added so that the rod grows by one cube until it looks like figure 2f.

The steps illustrated in figure 2b to 2e can be repeated to grow the tentacle to any length required. When large numbers of cubes follow similar paths, common cubes are grouped into a collection and this collection is controlled with same single commands (left, right, up, down, forward and backward) as if they were a single cube as illustrated in figure 6. [pic] Figure 6 By grouping cubes and moving them, any structure can be programmed in and synthesized within minutes. Once the pattern is stored in a computer, that pattern can be replayed on command over and over again.

The effect is somewhat similar to digitally controlled putty which is as flexible as computer software. Digitally Controlled Matter Is The Hardware Equivalent Of Computer Software. Tools mounted inside cubes are moved with similar commands. The commands to operate the tool are stored alongside the cube movement instructions making the system a very powerful programmable machine. 4. SELF REPAIR There are three different kinds of self repair that can be employed in a fractal robot. The easiest to implement is cube replacement.

Figures 7 to 10 illustrates some images taken from an animation. [pic] Figure 7 In respect of self repair, the animations show how a walking machine that has lost a leg rebuilds itself by shifting cubes around from its body. Some of the intermediate steps are illustrated across figures 2 to 4. [pic] Figure 8 [pic] Figure 9 [pic] Figure 10 Instead of discarding its leg, the robot could reconfigure into a different walking machine and carry the broken parts within it. The faulty parts are moved to places where their reduced functionality can be tolerated.

Regardless of how many cubes are damaged, with this self repair algorithm, cubes can detach further and further back to a known working point and then re-synthesize lost structures. The more cubes there are in the system, the more likely the system can recover from damage. If too many cubes are involved, then it will require assistance from a human operator. In such circumstances, the system will stop until an operator directs it to take remedial actions. Systems designed with fractal robots have no redundancy despite having built in self repair.

Every cube in a system could be carrying tools and instrumentation and thus loss of any one cube is loss of functionality. But the difference in a fractal robot environment is that the cubes can shuffle themselves around to regain structural integrity despite loss of functionality. In space and nuclear applications (also in military applications), it is difficult to call for help when something goes wrong. Under those circumstances, a damaged part can be shuffled out of the way and a new one put in its place under total automation saving the entire mission or facility at a much lower cost than simply allowing the disaster to progress.

The probability of success is extremely high in fact. Take for example a triple redundant power supply. Although the probability of each supply failing is same as the norm for all power supplies of that type, the chances of more than one failing is very much less. By the time a third power supply is added the probability becomes miniscule. The same logic applies to fractal robots when restoring mechanical integrity. Since there are hundreds of cubes in a typical system, the chance of failure is very remote under normal circumstances.

It is always possible to redundant tools and then functional integrity can also be restored. This technique gives the highest possible resilience for emergency systems, space, nuclear and military applications. There are other levels of repair. A second level of repair involves the partial dismantling of cubes and re-use of the plate mechanisms used to construct the cubes. 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.

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 11. (By reversing the process, fractal robots can be dismantled and stored away until needed.) [pic] Figure 11 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. The third scheme for self repair involves smaller robots servicing larger robots. Since the robot is fractal, it could send some of its fractally smaller machines to affect self repair inside large cubes. This form of self repair is much more involved but easy to understand.

If the smaller cubes break, they would need to be discarded – but they cheaper and easier to mass produce. With large collections of cubes, self repair of this kind becomes extremely important. It increases reliability and reduces down time. Self repair strategies are extremely important for realizing smaller machines as the technology shrinks down to 1 mm and below. Without self repair, a microscope is needed every time something breaks. Self repair is an important breakthrough for realizing micro and nanotechnology related end goals. There is also a fourth form of self repair and that of self manufacture.

It is the ultimate goal. The electrostatic mechanisms can be manufactured by a molecular beam deposition device. The robots are 0. 1 to 1 micron minimum in size and they are small enough and dexterous enough to maintain the molecular beam deposition device. 5. APPLICATIONS OF FRACTAL ROBOTS 5a. Bridge building Figure 12 One of the biggest problems in civil engineering is to get enough bridges built as rapidly as possible for mass transit and rapid development of an economy. Shape changing robots are ideal for making all manners of bridges from small to the very largest.

The bridging technology introduced here can be used to patch up earthquake damaged bridges, and they can also be used as a means for the shape changing robot to cross very rough terrain. To grow a suspension bridge, the shape changing robot grows a bridge by extending a rod and it feeds the rod using the L-shape streamer from underneath the rod. The bridge assembly machine is built principally from simple mass manufactured repeating cubes that move under computer control, and reshape into different scaffolds in a matter of seconds 5b. Fire fighting

Fire fighting robots need to enter a building through entrances that may be very small. The machines themselves may be very large and yet they must get through and once inside, they may have to support the building from collapse. To a great extent fire fighting is an art and not completely reliant technology. You need men and machine to salvage the best out of the worst possible situations and often application of a little common sense is far better than sending in the big machines. But equally there are times where only machines with capabilities far beyond what we have today are capable of rescuing a particular situation.

The application of shape changing robots is about those situations. Entering Buildings Shape changing robots can enter a building through entrances that are as small as 4 cubes. Figure 1 below shows what a robot can do to enter a room through a duct. These shape changing robots could be carrying a fire hose in which case on entering they can apply the hose immediately. [pic] Figure 13 Medical technology in the future may be applied on the spot to victims of fire using shape changing robots that are completely integrated into the obot in a machine that is fundamentally identical to the robot – only fractally smaller. Only a shape changing robot with fractal fingers and fractal tools can sift through the rubble without disturbing it further to search for survivors and bring them out alive. Using convetional methods, you always run the risk of trampling over someone with your equipment or loosening something that leads to further disturbance. 5c. Defense technology The use of new technology of fractal shape changing robots in defense applications is going to completely change the way warfare is conducted in the next millennium.

The machines even at the slow speeds shown in animated figure above can dodge incoming shells at 2 km distance by opening a hole in any direction. While most tanks and aircraft need to keep a 4 km distance from each other to avoid being hit, this machine can avoid being hit and return fire inside 2 km, while carrying a formidable array of fractal weapons integrated into a true multi-terrain vehicle, making them totally lethal to any passing war fighters, aircraft, tanks, and armoured personnel carriers; surviving shelling, rockets and missiles.

As the technology moves on to hydraulic & pneumatic technology, shell avoidance is feasible at practically point blank range. Nothing survives on extended warranties in a battlefield. With self repair, these immortal machines are no match for state of the art research directions in present day military robotic systems, which are mere toys in comparison. Figure 14 5d. Earth Quake Applications: Once a building is damaged by earthquakes, the terrain inside (and outside) the building is completely undefined.

You need true multi-terrain vehicles with walking abilities that can transform interchangeably into crawling machines to get past obstacles and reach the buildings and structures that need to be repaired. You need fire fighting robots to fight fires, you medical robots to look after the injured and you need that same machine to become the machines that will enter the buildings, erect support structures and prevent it from collapsing. Figure 15 and 16 below show how a very large shape changing robot can enter a building through a narrow window and rebuild itself one on the other side. pic] Figure 15 [pic] Figure 16 5e. Medical Applications A fractal robot system with 1 mm cubes can squirt into the human body through a 2 mm pin hole and rebuild itself inside the body into surgical instruments and perform the operation without having to open up the patient (figure 1). [pic] Figure 17 A size 1 mm is just adequate for nearest point of entry into the site of injury from the surface to perform very complicated surgery to remove cancers, cysts, blood clots and stones.

The machine reaches its objective from nearest geometric point of entry by threading itself past major blood vessels or pinching and severing them if they are not for negotiation. The smaller the machines the more readily it can be used to directly operate from the nearest entry point with the least amount of wounding to the patient. A machine like this could operate on shrapnel victims. As shrapnel is a fractal object, the wounding it causes is fractal in nature. Thus a fractal machine is needed to deal with a fractal wound.

The faster the machines operate all around the body, the more likely the patient can survive the damage. In normal use, this machine must be able to drain bad blood and fluids, detect and remove all foreign objects that have entered the body, sew up minor wounds after cleaning and medicating them, sew together blood vessels and nerve bundles using microsurgery methods before sealing major wounds, move shattered bone fragments inside the body and hold them in position for a few days while it sets back, and when necessary, perform amputations that involves cutting through flesh and bone.

This surgical robot as described is called a Fractal Surgeon. 5f. Space Exploration Space is probably one of the best application areas for fractal robots because of its cheapness, built in self repair and 100% automation possibilities. [pic] Figure 18 Space is extremely expensive and if things go wrong and there is nowhere to turn for help. Using fractal robots it is possible to build anything from space stations to satellite rescue vehicles without any human intervention. 6. LIMITATIONS • Technology is still in infancy Current cost is very high($1000 per cube for the 1st generation of cubes, after which it will reduce to $100 or so). • Needs very precise & flexible controlling software. 7. 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.