Development of Transmuting Bots Welcome to the World of Claytronics

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Abstract—Ever imagine of a huge gigantic building size robot, that looks like a human which have immense power of lifting and destroying anything that comes into his way. Well, all of us have a picture comes into our mind, the gift of science fiction movies i.e. the transformers. In this paper we are trying to make the concept of transformers real. In this context, the transformers in almost every science fiction movies perform two basic functions, one is having huge amount of power, and secondly it can transform into any shape and size. To provide our transformer immense power we use the power of present engineering, the hydraulics. Using the technology of hydraulics our robots can lift or crush anything of any size that comes into his way. Now the question that arises is how our robot can transform into any shape and size so quickly and without using mechanics. The answer resides in the latest technology in the field of electronics i.e. Claytronics.

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I. INTRODUCTION

From the past few decades, science fiction movies have given us a lot of thrilling and innovative that could fantasize our world. From the mighty invisible cloak to the all time favorite time machine, these science fiction movies can go beyond our thinking and produce something that can make our day. Transformers, one of the best series in the history of science fiction world have reached to a higher level of thrill and excitement. These huge gigantic robots can roam around the city, lift heavy objects like a tiny pebble and wipe it away in the air, and can transform into any shape depending on the situation. Now the question that arises out of everybody's mind is how can the human civilization ever be able to construct these giant robots known as transformers?

II. WHAT DOES TRANSFORMERS MEAN TO US?

According to a little research, the transformer that today's humanity dreams of can have three basic properties that enables them to stand on our expectations:

1. It should have enormous power so that it can lift any heavy objects easily and made them fly.
2. It should be unlimitedly shape shifting i.e. transforming into any desired shape.
3. It should be stealthy i.e. passing through every hurdle easily and secretly.

III. POWER

The basic design of our transformer should be a big giant structured robot with enormous amount of power. The first thing that can come into our mind while imaging such a thing is really huge amount of steel or iron. Despite using these heavy duty metals, let's make it much simpler and more practical. Let us use the concept of hydraulics. [1]

We are trying to build a huge building sized transformer with such a great power that it can lift very heavy metal objects easily. The latest technology that is very useful in doing this is hydraulics. This hydraulics mechanism is very simple. The whole apparatus comprises of an incompressible liquid which is some sort of oil. When one piston is pushed with some force, due to the incompressible liquid, the piston in pulled upward by a more greater force resulting in the more powerful weapon.

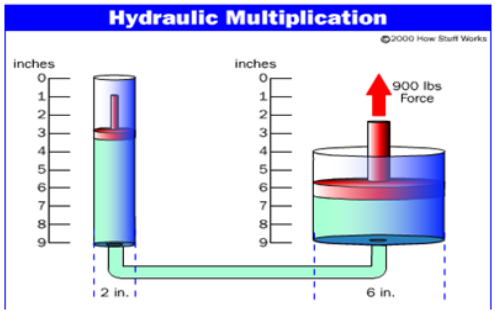


Fig1. Hydraulics mechanism

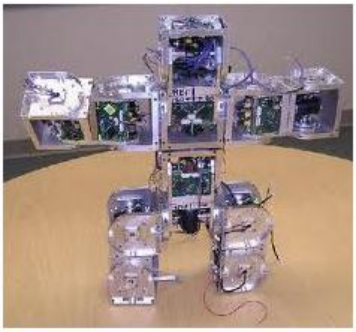
The force by which the piston lifts more weight can be easily calculated: The diameter of first piston is 2 inch, i.e. its area is $A = \pi r^2$ which is equal to 3.14 while the area of the other cylinder with diameter 6 inch is 28.26. This means the other cylinder will convert the force applied to the first cylinder 9 times more in upward direction.[2] So if a force of 100 lbs is applied to first piston the other piston will get a force of 900 lbs sufficient to lift itself along with some heavy metals. This concept of hydraulics is being applied to huge hydraulics crane which is used to load, dump or crush very huge objects like cars etc. Moreover this technology can be used to build the external structure of our transformer very strong. This consists of two huge arms that are working on the hydraulics technology similar to the crane's grabber. Then we can have a big cooling system that can act as the body of our transformer.

Fig2. Application of hydraulics mechanism in crushers and modern transformer

The first look at the simulation of our transformer prototype made it look good but not the best. We have hit a problem. The various joints in our transformer make it move and act like a human but do they made our transformer perform the most basic function that the industry wants them to do i.e. transform themselves into any shape. I don't think so. These huge gigantic robots are so bulky that they can't change their shape so easily when someone is controlling them or if they are autonomous. But as every problem has a solution this one also has one.

IV. SHAPE SHIFTERS

We are trying to build the most thrilling and exciting creature produced by science fiction, the transformers. Until now we are able to provide our transformer an enormous amount of power, but it lacks the shape shifting ability. To have this we have to draw our attention to the Carnegie Mellon University located in Pittsburg. The researchers at Carnegie Mellon University have already taken an initiative to make this dream come true. They have something that can easily transform shape, can move any surface with no surface limitations. They named it programmable matter.[4]



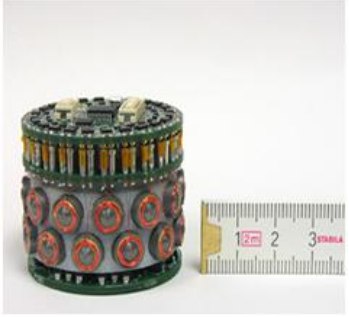


Fig 3. Catom and claytronics technology

A Programmable matter is defined as the group of tiny modular robots that are some centimeter is size. The interesting aspect about these robots is that they can communicate with each other by sort of sensors. Each unit of the programmable matter is known as catom or claytronics atom. Each catom is a self modularizing robot which consists of a computer in itself. They can move, communicate and interact with each other making a self dependent robot. Further if one of the units in this ensemble is defective there is no problem with the whole ensemble. The defected catom is just to be removed and the whole unit is working as before.

Despite of its huge success in the electronics industry, the researchers are trying to take the technology a one step further. They are trying to build such robots out of these catoms such that the robot will disassemble into many units and reassemble itself according to a whole different desired shape. At the current stage of design, claytronics hardware operates from macro scale designs with devices that are much larger than the tiny modular robots that set the goals of this engineering research.[5]

Now we have millions of self modular robots that can combine themselves into different shapes according to the program assigned. Now the major problem in these type of robots is the need for continuous supply of power that could help these robots roam in any direction at any time. Large batteries that can size up to a big crane, is not at all a solution. But there is one.

The figure below depicts an arrangement of two catoms in which some electrodes are embedded along the surface of the catoms. Through capacitive coupling, an AC signal is generated on the coupling electrodes of the tube, which is then converted to DC power by the CMOS chip that is, embed manually in the centre of each catom. The powered chip then generates voltage on the actuation electrodes sequentially, creating electric fields that push the tube forward. [7]

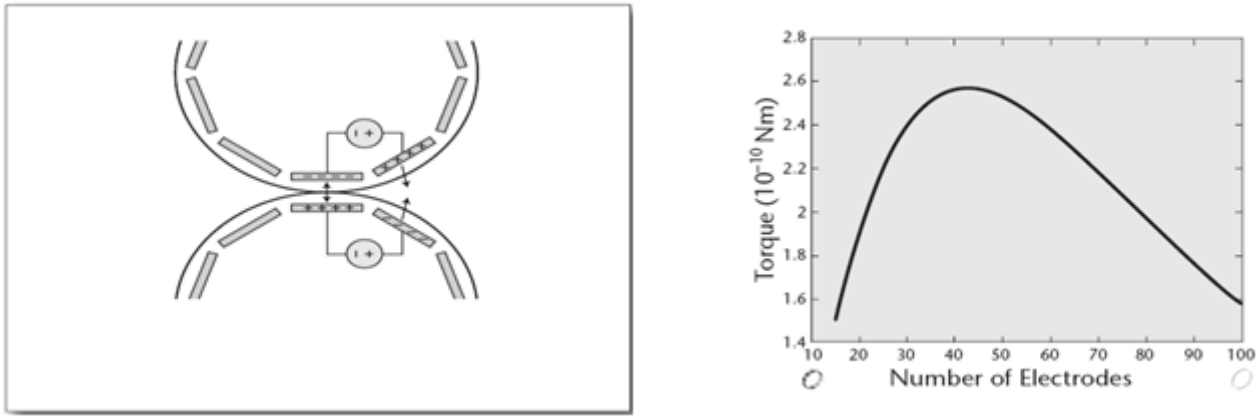


Fig4. The locomotion mechanism and torque vs. no. of electrode graph in the catoms

The force generated by the electrostatic plates is a function of catom diameter, electrode size and spacing, and applied voltage. In designing a catom of a specified size (in this case 0.7 millimeters diameter), the force generated at a fixed voltage is first calculated as a function of the number of electrodes resulting in the plot like that shown in figure.
Based on the plot, the optimal number of electrodes for a 0.7 millimeter diameter sphere is 43, or roughly one electrode every 8–9 degrees. Using this electrode count, the voltage required to move the catom vertically against gravity (assuming the catom has 1/13 the density of water) is approximately 94 volts.[8] This voltage decreases with the catom diameter because as the catom scales down in size, the torque required by the catom to move against gravity, decreases faster than the torque generated by the electrostatic force. For a catom with a 0.5 millimeter diameter the required voltage is 60 volts. This then suggests that the smaller the catom, the better it is.

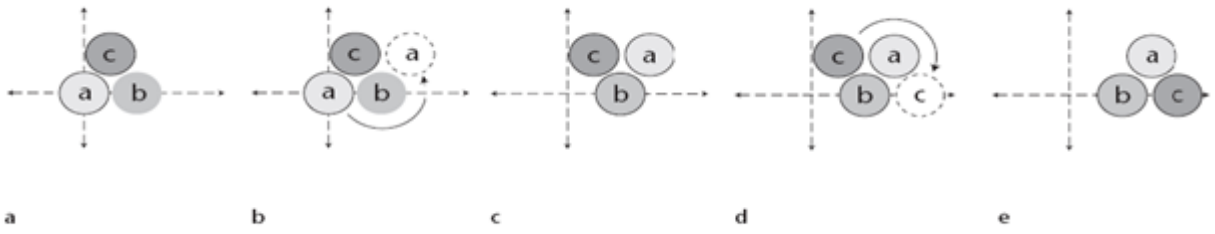


Fig5. The graphical representation of catoms in the ensemble.

V. CONCLUSION

The technology around us is advancing very rapidly with passing of time. The time is not far enough when we will see humanoid robots performing human functions and helping us in many fields. As we know many people often lose their lives while protecting us from the enemy on the borders. To prevent this we have to have something that is more powerful, gigantic and autonomous that can take place of our soldiers and help preventing any war like situation. This could save many lives of soldiers and army men. We would be able to communicate with them, give them instructions even control them without risking our own lives. The claytronics technology has made this dream nearly possible. This is the remarkable revolution in the field of electronics and computers and surely will affect our lives in the distant future.

VI. REFERENCES

[1] H. Abelson, D. Allen, D. Coore, C. Hanson, G. Homsy, T. F. Knight, R. Nagpal, E. Rauch, G. J. Sussman, and R. Weiss. Amorphous computing. *Commun. ACM*, 43(5):74–82, 2000.

[2] G. Armitage. MPLS: The magic behind the myths. IEEE Communications Magazine, 2000.

[3] R. H. Arpaci-Dusseau, E. Anderson, N. Treuhaft, D. E. Culler, J. M. Hellerstein, D. Patterson, and K. Yelick. Cluster i/o with river: Making the fast case common. In The 1999 Workshop on Input/Output in Parallel and Distributed Systems (IOPADS ’99), Atlanta, Georgia, May 1999.

[4] P. Bahl and V. Padmanabhan. Radar: An in-building rf-based user location and tracking system. In In Proceedings of IEEE INFOCOM, pages 775–784. IEEE, 2000.

[5] D. Baraff and A. Witkin. Physically based modeling. In Proceedings of SIGGRAPH 2002, Computer Graphics Proceedings, Annual Conference Series. ACM Press, 2002.

[6] B. N. Bershad, S. Savage, P. Pardyak, E. G. Sirer, M. Fiuczynski, D. Becker, S. Eggers, and C. Chambers. Extensibility, safety and performance in the SPIN operating system. In 15th Symposium on Operating Systems Principles, pages 267–284, Copper Mountain, Colorado, 1995.

[7] A. D. Birrell and B. J. Nelson. Implementing remote procedure calls. In Proceedings of the ninth ACM symposium on Operating systems principles, page 3.ACM Press, 1983.

[8] K. Bowers and G. Reshko. Routing in dynamic crystalline networks. In Project Report 15-712. Computer Science Department, Carnegie Mellon University, 2004.

[9] N. Bulusu, V. Bychkovskiy, D. Estrin, and J. Heidemann. Scalable, ad hoc deployable, RF-based localization. In Proceedings of the Grace Hopper Celebration of Women in Computing, Vancouver, British Columbia, Canada, October 2002. Institute for Women and Technology.

[10] N. Bulusu, J. Heidemann, and D. Estrin. GPS-less low cost outdoor localization for very small devices. In Technical report 00-729. Computer Science Department, University of Southern California, 2000.

[11] J. Chapin, M. Rosenblum, S. Devine, T. Lahiri, D. Teodosiu, and A. Gupta. Hive: fault containment for shared-memory multiprocessors. SIGOPS Oper. Syst. Rev., 29(5):12– 25, 1995.