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Design of Inkless Marker Board using Ferromagnetic Fluids

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Abstract - Idea of an Ink-Less Marker board i.e. a marker-board combination used as a writing implement without any kind of ink in sight might have been a dream in the past, but with the use of FF[1] it is possible to achieve the same .Ink-Less marker board is a radical application of FF pertaining to the field of Ferro hydro-dynamics, as primarily there use have been restricted to medicine, space and military related fields, so to think of its application in the field of education might have been a far-off concept. Up till the present times, writing implements used have been developed quite at snail's pace leaving a wide gap for inducing a breath of innovation in the same field, besides that , present marker-whiteboard (in use predominantly) combination poses a number of problems (given under motivation heading) to its users, hence the proverb "a problem calls for an opportunity or innovation". While evaluating the problems came an idea of mind, which is , why not restrict the ink inside the board and let it come on the surface when we want to write on it and leave its surface when we want to rub it without even touching the finger tips/hands of user. It works on the effect magnetic attraction rather than the Soret effect/thermophoresis[2]. The great achievement of this innovative product is that it can work both on the surface of planet earth as well as in a zero-gravity environment (with some design specifications apart from the design for the type used on earth's surface) i.e. inside a space vehicle. Summing up the whole, ink-less marker board proves to be a cutting edge, innovative, efficient, durable and adaptive product which might leave a lasting impression in the respective field.

Keywords- FF, IMB[3]

I. INTRODUCTION

Inkless marker board on a first sight , might look as that of conventional white board or black board, apart from the addition of moving links carrying duster/dropper as the changes have been made internally.

It consists of several components stated as follows:-

1. Continuous array of pixels (which is the holding medium of FF) made of non-magnetic material as shown in Fig 1.1(a) and unit pixel design in first angle projection shown in Fig. 1.1 (b).
2. FF and CF [4] of fixed qty. individually in every pixel.
3. Bounding front and back screens (both magnetically permeable), out of the two, front screen is completely transparent and back screen is opaque.
4. Guide-ways on all four sides of the pixel array between the front and back screens.
5. Roller bearings (4 in no.) moving /reciprocating inside every guide-way carrying welded ends of horizontal and vertical links forming a rectangular shape like structure around the board.
6. Two horizontal and two vertical links on either side of board handling the coordinated movement of duster/dropper to be used at any location on board surface.
7. Duster/dropper containing a magnet (preferably neodymium) on the back side serving the purpose of rubbing.
8. Pointer on the front side acts like a cursor to move the magnet on the farther side to the desired location for the rubbing purpose.
9. Marker having the same external appearance as that of the conventional marker (currently in use) but the tip profile being different and that too made of neodymium magnet or an implanted electromagnet.

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Together with all these components assembled in proper manner, functions the inkless marker board, the details of which have been given under the heading *details of work/description of idea/how it works.*

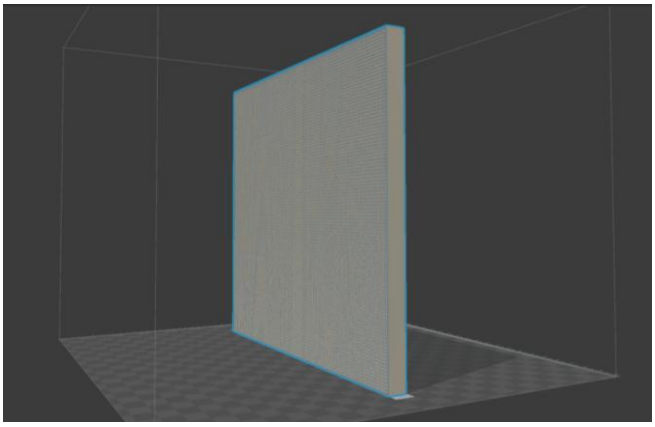

Fig. 1.1(a) Dimetric view of Pixel Array shown in 3D Builder Software ready to be fed to a 3D Printer.

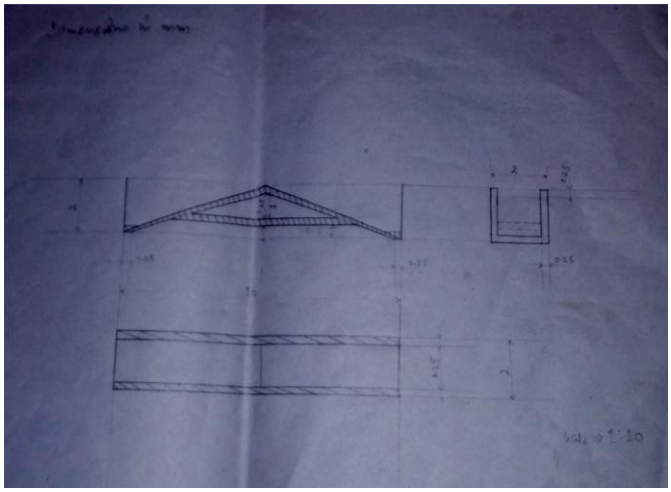

Fig. 1.1 (b) First Angle Projection of Unit Pixel of which whole pixel array is made (growth in 2D)

II. Motivation

Making writing implements directly cheap, durable as well as efficient and the education system in-directly, happen to be the point of motivation which acted as a driving force during the initial course of project work. Later on, its zero-gravity application fuelled the already ignited temptation to make this project a success (God willing) .A thought of the mind also was that this product will make the public education schemes a success. Developing my career as an entrepreneur has been my top most priority, thanks to inspirations like Steve Jobs, Elon Musk and others as well.

III. Component of the Project/Concept behind the work

The main concept behind this project in simpler terms is "the magnetization of the FF due to magnetic field". As, it is a fact that a FF gets heavily magnetized when it comes in contact with a magnetic flux/field. Scientifically speaking, it is an application from not a well-known science called Ferro-hydrodynamics. In order to illustrate the same, for e.g., if we have a typical FF (containing 5% magnetic solid of nano-scale particle size, 10% surfactant and 80-85% carrier fluid) placed in a glass jar, on the bottom side FF inside the jar gets concentrated at the location where magnet has been placed forming a dome like structure with spikes, which happens due to a phenomenon called *normal field instability*[5]. Same response of FF towards a magnetic field is exploited in Ink-less marker board. When the marker tip moves over the surface of board, FF on farther side comes to the front side instantaneously and limps back when the magnet inside the duster/dropper on the farther side is allowed to spray its magnetic flux and pull back the FF. So, the forward movement of FF gives us a sensation of writing and backward movement of FF gives us a sensation of rubbing which is shown in Fig. 1.2 "(a)", "(b)" and "(c)". Also, generally speaking there can be two types of interactions superficially i.e. magnetic and of non-magnetic type. Magnetic interaction includes duster/ dropper, marker and any other object emanating magnetic flux interacting with the FF inside the board. Non-magnetic interactions include interactions with cloth, finger, limb and other objects not emanating any kind of magnetic field/flux. Assembled design has not been shown as the product has not been patented yet to avoid any kind of misuse. Out of these, magnetic interactions other than duster/dropper and marker may prove harmful and should be avoided.

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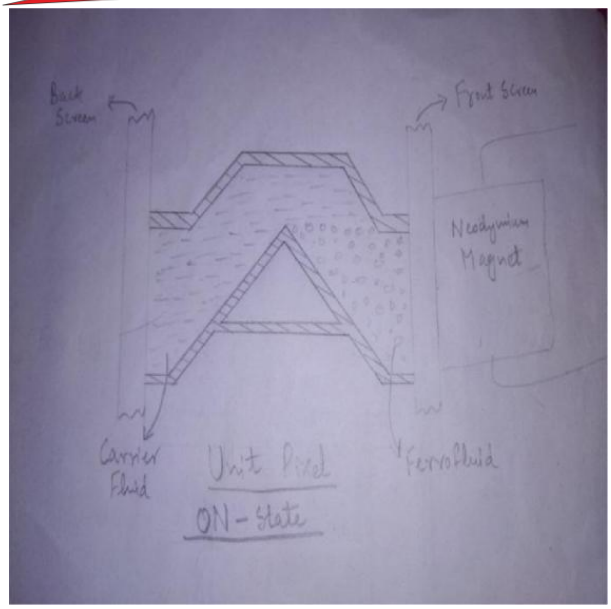

Fig. 1.2 (a) ON-state of Unit pixel showing FF towards the front screen and carrier fluid to the back screen.

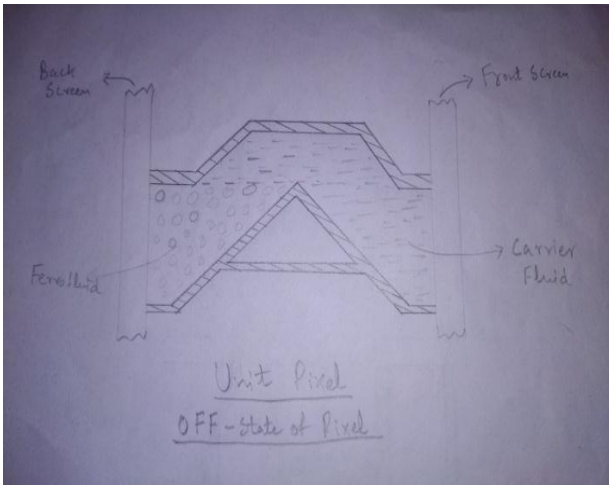

Fig. 1.2 (b) OFF-state of Unit Pixel showing FF towards the back screen and carrier fluid to the front screen.

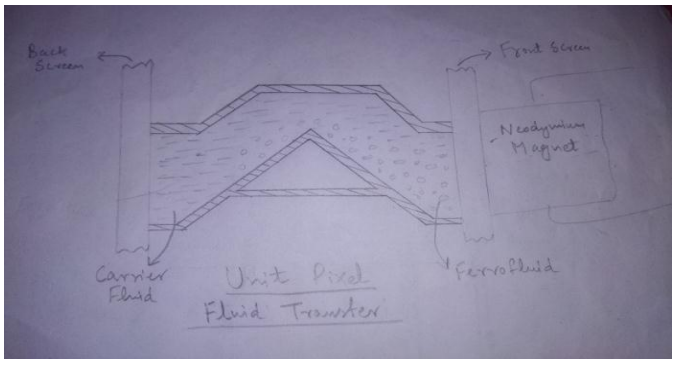

Fig. 1.2 (c) Fluid Transfer state of Unit Pixel showing FF transfer towards front screen.

IIIA. Details of the Work/Description of IDEA/How it works

The working of the Ink-less marker board can be illustrated with the help of ON, OFF and Fluid transfer-state figures with explanations.

IIIB. Applications

The areas of application include

- Education
- Space Vehicle / Zero-gravity environment
- Art and Recreation etc.

IIIC. Impact

IMB is inevitably going to change the education sector besides adding up a one more application of Ferro-fluids. First of all, its durability, efficiency as well as the *cheapness in long run cost* will affect the already existing market giants in the field of stationery manufacturing. White board manufacturing companies may also face the effect, because this time, main-frame changes have been done in the board itself. Secondly, instead of refills, replacements of markers throughout the year, one has to go for a refill of the board itself once during a set standard period formulated by the manufacturer. Thirdly, it may lead to some more explanation of FF as researchers analyze the same innovative product. Fourthly, space tech. experts may take this product to go through a space simulator and will reach at something good for space science technologists. Radical types of arts may surface with this new-way formed writing implements. Summing up the whole, the impact of this innovative product becomes clearly visible keeping in view the large customer base which in managerial terms is the golden point for this product.

IIID. Challenges

Emergence of this whole new product in the market may face various challenges as it is totally out-of-box innovation. It may happen due to inadequate/false information, rival policies etc. However, to avoid these and other types of roadblocks for its clear cut and easy way go emergence in the market, one thing should be done before the launch of this product i.e. an institution or no. of institutions (say 4-5) should be selected for its

initial testing in order to achieve at more and more ergonomically well and aesthetically beautiful final product design, which surely may wave off the customer dis-satisfaction when sold out in the market. Doing the above will land us into customer satisfaction, increased sales implying more and more profits. Besides that, it will need a simulator (zero-gravity environment) to completely test this product and check for its intricacies when used in such type of environment.

IV. Future Scope

The future scope of this product can be drawn from this fact that it is only one of its kind i.e. a FF based marker board has not been developed yet and this surely is the first one .The quality of the same product makes it able to enter into a global market as marker-boards are used in almost every country of the world. And also, if results remain to be good while using it in a zero gravity environ ,it may suffice the needs of astronauts for writing purposes while going for long voyages i.e. they don't need to take other type of writing implements to space. So, at the end, the future scope of IMB seems to be bright if executed correctly, tested properly, introduced manageably into the market and improved accordingly.

V. Conclusion

Writing Implements form a vital part of the education sector, implying a large customer base with consistency. So, there is a need to innovate to make education sector modern, cheap, reliable as well as accountable in present day world. Demand for change is inevitable. The developed product with its large applicability and durability makes it possible to leave a marked impression in its domain. Furthermore, it leaves a mark of possibility in exploiting the properties of ferromagnetic fluids in the field of applied sciences.

VI. Acknowledgment

The research presented before was not possible without the contributions of many personalities who directly or indirectly helped me to bring about this innovative product as a reality. Without their support this work presented might have been impossible to some extent to be done. First of all I would like to thank Almighty ALLAH for making me able to do this work. From my Fellow well-wishers, Prof. Saad Parvez (from NIT Srinagar, J&K, India) for his support in reviving this design from a jury of professors at NIT, Srinagar, up to its presentation in Idea Challenge-2017 (state level event) in which this innovation was awarded 2nd prize, Er. Mohammad Nayeem (H.O.D Mechanical Department, SSM CoET), Miss Ifrah Shahdad (Jr. Design Fellow, DIC@IUST) for his initial time to time review of the developing design, Er. Aatif Haqani for bringing the Virtual (Solid Works) model to fore which was a cornerstone to this whole project to whom designs with changes were supplied and made accordingly. Besides that, I would like to have a general thanks to all the people who have made this whole project a success.

VII. References and Footnotes

[1] Ferromagnetic Fluid

[2] Duhr S, Braun D (December 2006). "Why molecules move along a temperature gradient"

[3] Inkless Marker Board

[4] Carrier Fluid

[5] Explained by Rosensweig.