

Special Project

Biomimicry in Design

Nature inspired camouflage mechanism

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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources.

I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission.

I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Acknowledgment

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Abstract

Mankind has always used nature as an inspiration while creating things. More often than not, solutions derived from nature have proven to be far more efficient and effective than our so-called clever ideas. Through this project, Prof. Nishant Sharma prompted me to look into nature and tackle the problem of camouflage. Cuttlefish are famous for their ability to blend almost perfectly with whatever environment they are in. By using their superior camouflage mechanism as inspiration, the aim was to design a new system which can actively adapt to the surrounding environment.

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Introduction

Biomimicry

Biomimicry is an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies.

Examples

Speedo's Fastskin

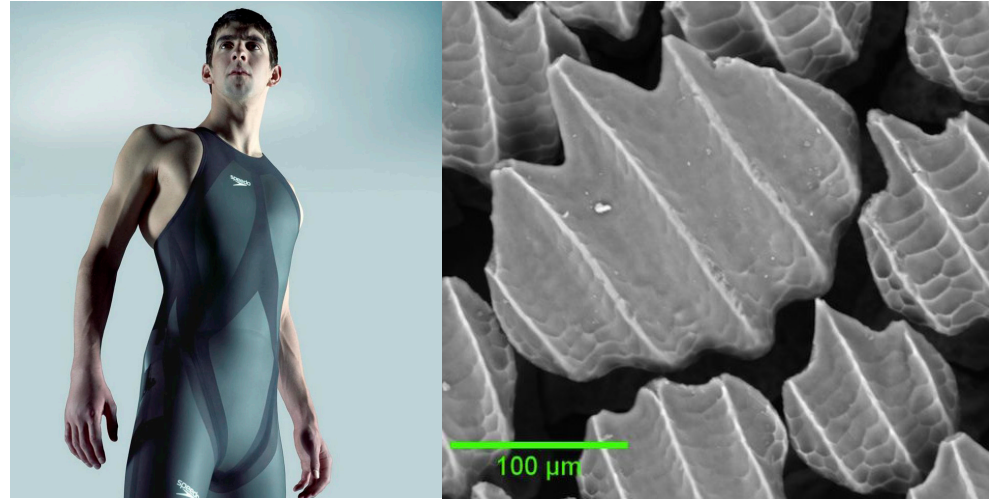


Image 1 - Speedo's Swimsuit

Image 2 - Shark skin closeup

Speedo's Fastskin line of high-tech, high-performance swimsuits were inspired by the skin of a shark--shark skin's sandpaper-like texture is thought to reduce drag, hence its usefulness in swimming gear.

These scales enable sharks to reach incredible speeds and manoeuvrability. This is because the denticles disrupt the flow of water that glides over the shark which significantly reduces drag.

Shinkansen bullet train nose



Image 3 - Shinkansen bullet train

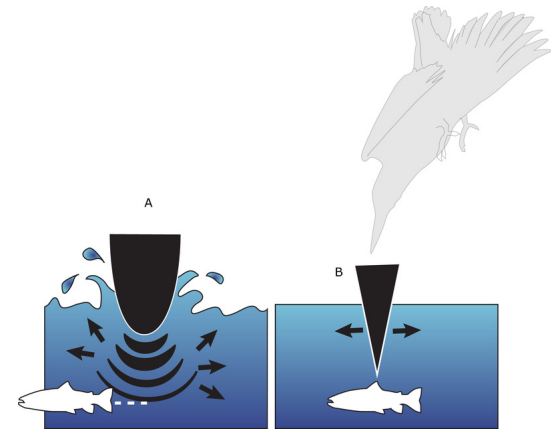


Image 4

The Shinkansen Bullet Train has a streamlined forefront and structural adaptations to significantly reduce noise resulting from aerodynamics in high-speed trains. The nose of train design is inspired from beak of kingfishers.

The beak of kingfishers allows splash-less entry into water due to the wedge shape it makes with the head that is round in cross section.

If a kingfisher had a rounded beak, such as on the left (Image 4), it would push water ahead of it, scaring or displacing the prey. Instead, the wedge-shaped beak and head (right) enters the water without a splash, increasing the chances of a successful hunt. Artist: Emily Harrington.

Hydrophobic Coating inspired from lotus leaf



Image 5 - Mud test



Image 6 - Wet test

Ultra-Ever Dry is a super hydrophobic (water) and oleo-phobic (hydrocarbons) coating that will repel most water-based and some oil-based liquids. Ultra-Ever Dry uses proprietary omni-phobic technology to coat an object and create a surface chemistry and texture with patterns of geometric shapes that have “peaks” or “high points”. These high points repel water, some oils, wet concrete, and other liquids unlike any other coating.

Beetle Juice Inspired



Image 7

The *Onymacris unguicularis* is a beetle found in the Namibian desert and has the most unique way of procuring water. Early in the morning, when the dew-enriched fog is settled over the dunes, the beetle goes to the peak and positions its body in such a way that it helps in dew formation, and slurps up the water thus formed. Using this technique is the Dew Bank Bottle. It's made in such a way that the steel body helps to assimilate the morning dew and channel it into the bottle immediately. Ideal for the nomads in the desert!



Camouflage in Nature

Animals use Camouflage

1. Leaf Insect
2. Katydid
3. Ghost Mantis
4. Dead Leaf Mantis
5. Green Caterpillar
6. Stone fish
7. Leafy Sea dragon
8. Dead leaf Butterfly
9. Egyptian Nightjar
10. Flounder



Image group 1

King of Camouflage

Mimic octopus and Cuttlefish



Image 8

The mimic octopus (*Thaumoctopus mimicus*) is an Indo-Pacific species of octopus capable of impersonating other local species. They are notable for being able to change their skin color and texture in order to blend in with their environment, such as algae-encrusted rock and nearby coral through pigment sacs known as chromatophores.

The mimic octopus possesses chromatophores as well as the unique behavior of taking shape of various objects and animals.



Image 9

Cuttlefish are sometimes referred to as the “chameleons of the sea” because of their remarkable ability to rapidly alter their skin color - this can occur within one second. Cuttlefish change color and pattern (including the polarization of the reflected light waves), and the shape of the skin to communicate to other cuttlefish, to camouflage themselves, and as a deimatic display to warn off potential predators. Under some circumstances, cuttlefish can be trained to change color in response to stimuli, thereby indicating their color changing is not completely innate

Cuttlefish

Camouflage working



Image 10

Cuttlefish have layers of skin cells which is used to generate different colors and texture. The top layers are pigmented cells that gives the most of the patterning. And three layers of color pigment cells - Yellow, red and brown. Each pigment cell is attached with the muscles. Muscles pull out the pigment cell to show the particular color.

Next is the deeper layer of florescent reflecting cells of blue, green, red and pink at the white base.

Along with color and pattern the skin can change its texture too. Pushing the bumps along the surface. the cuttlefish electric skin usually works for self defense to make it disappear into the background.



Image 11- Cuttlefish blended in the background

Skin layers of cuttlefish

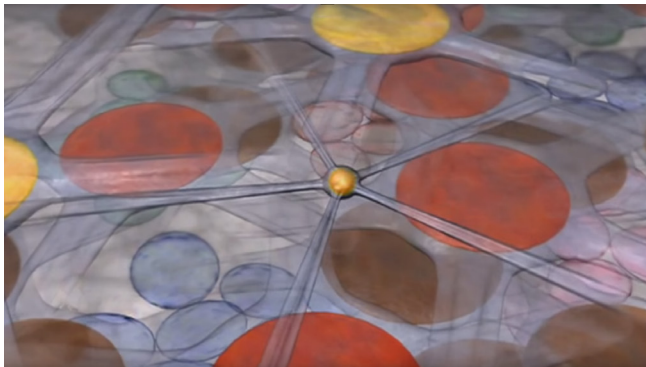


Image 12 - Single color pigment cell

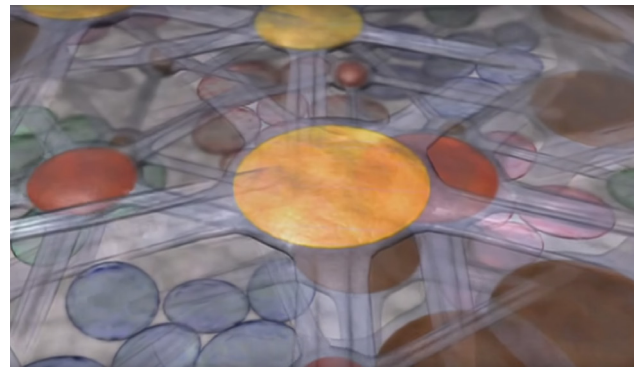


Image 13 - Cell when active

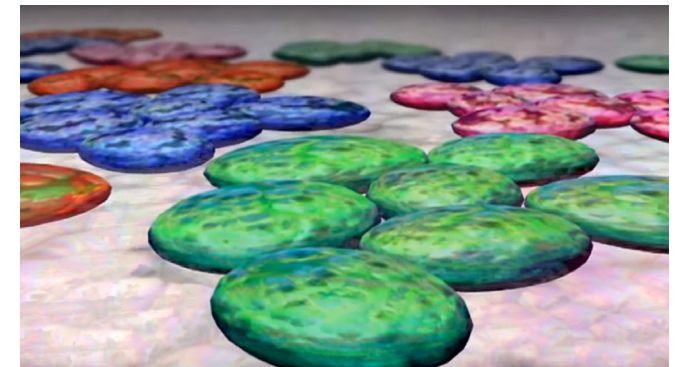


Image 14 - Fluorescent color cell on white background

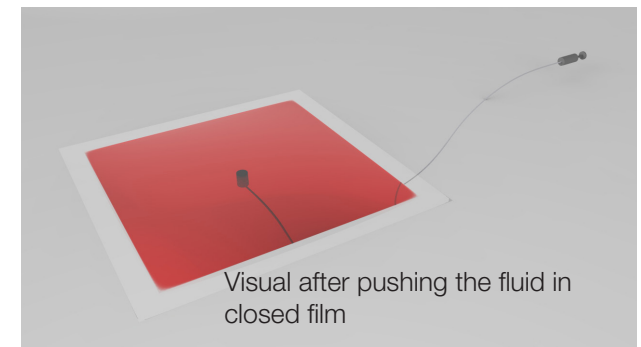
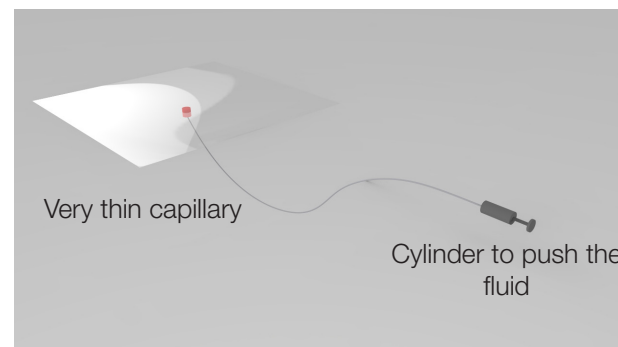
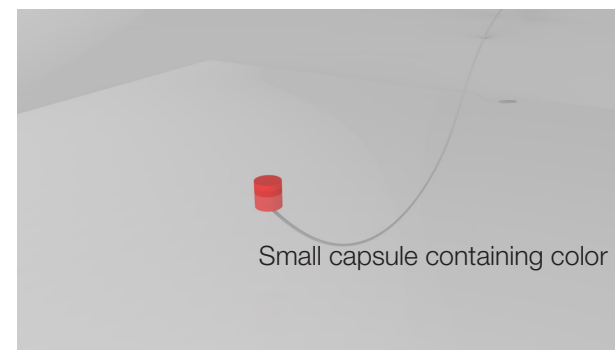
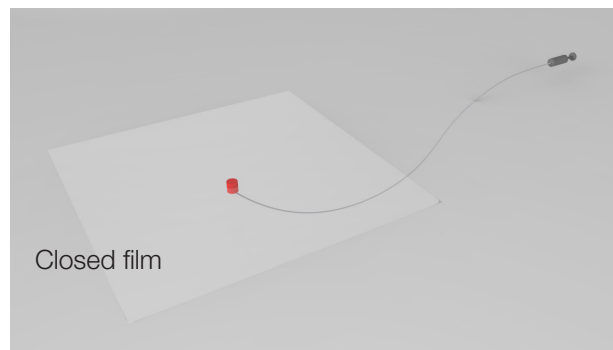
The pigments cells are connected with the muscles and directly connected to the nerve from the brain which makes the very fast to change color, pattern and texture.

The color which have to showcase, that particular cells pigments are stretched by the muscles to do so. The pattern and texture are generated as different pigment cells stretched at different location.

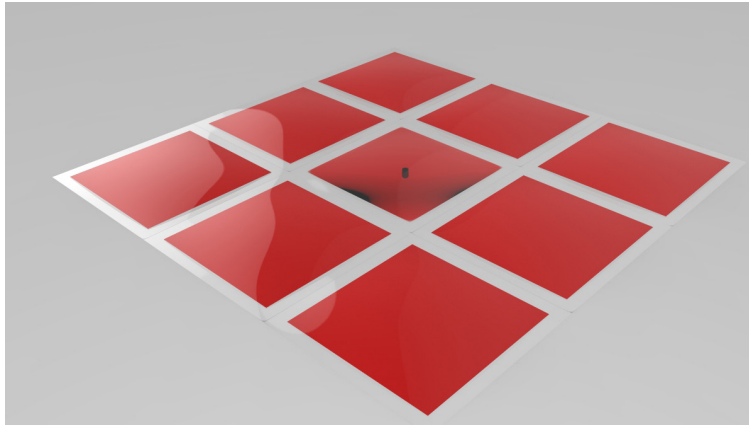
Experimentation

Idea

The idea is that fluid will be contain in a small capsule as the pigments cells in the cuttlefish skin. The capsule is attached with the transparent close chamber. The capsule is connected with a cylinder at the other end with a very fine capillary which is connected with the cylinder to push the fluid in the chamber. When the fluid pushed in the chamber it spread into the entire chamber. This represent a single unit of the entire surface such as a pixel of a Television. The entire array going to use as a display and different colors is used at different layers as in cuttlefish skin,

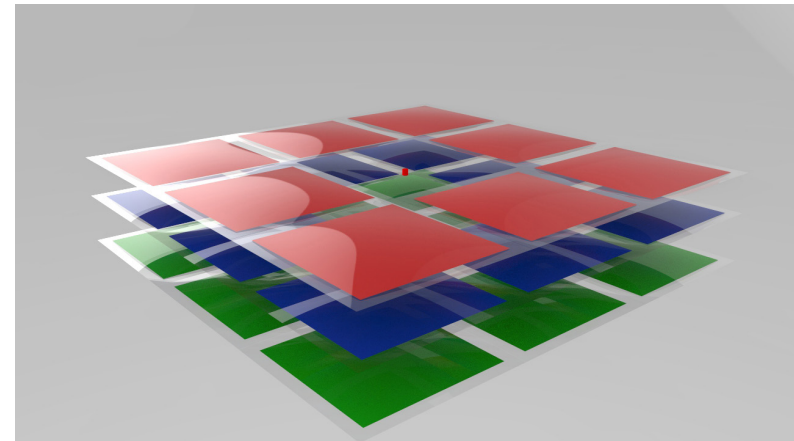


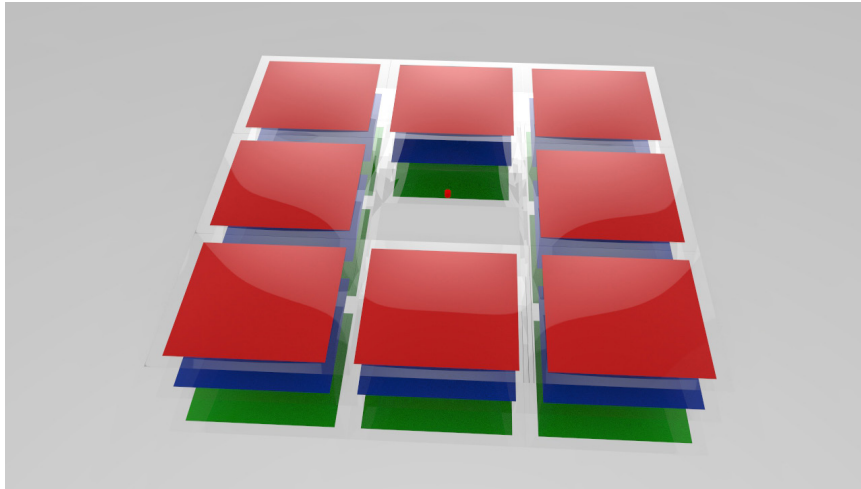
A single unit of system



Single Layer of the film with all filled with single color. The whole array will consist of thousands of such units, with the color of each unit controllable by the amount of pigment going into it.

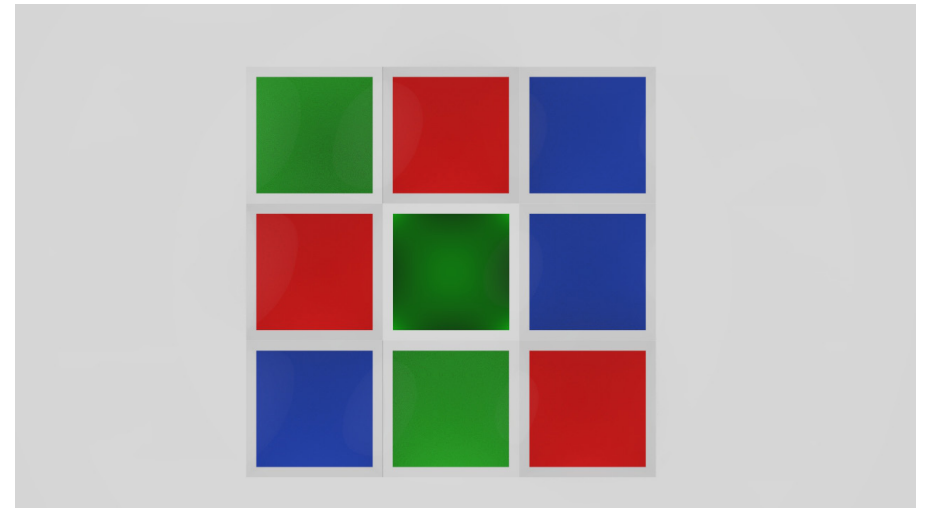
Multiple layers of film each filled with a different color. In this case, there are three layers, with the primary colors of Red, Blue and Green.



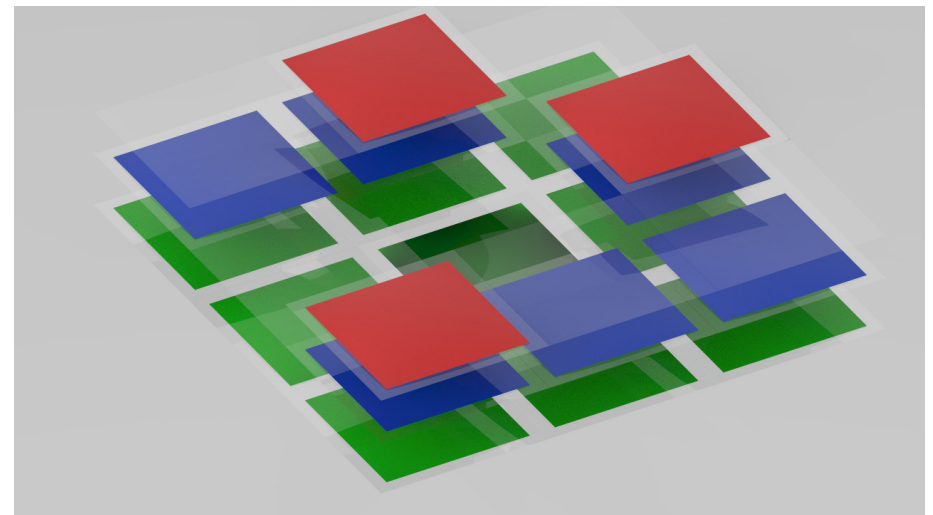
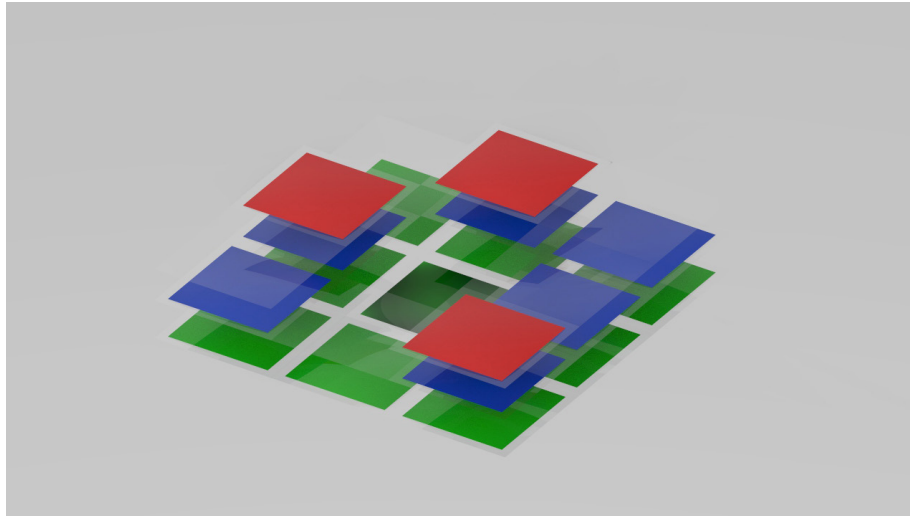


Color from each unit can be drained so that the unit from the below layer becomes visible. Depending on the amount of color remaining in each unit, different shades of the color will be visible to an observer

Multiple combinations of color values create a wide variety of shades, thus ensuring that any background image can be adapted to properly.



Deactivation of individual units displaying the color of the layer below it.



Applications

The possible applications for such a camouflage system are:

1. Military: As warfare becomes increasingly advanced and technology driven, soldiers need the next level of cloaking and protection devices to stay truly hidden in the battlefield. The camouflage mechanism can be implemented in individual gear as well as on vehicle body panels, UAVs, building rooftops etc.
2. Wildlife Observation: Unobtrusive observation of wildlife is highly important for researchers, filmmakers and so on. By camouflaging filming devices such as radio controlled cameras as well as the people themselves, it can be ensured that the organisms in their sensitive environment can be observed without disturbing them.
3. Personalization of vehicles: Instead of camouflaging, the device can be used as pigmented display panels on or inside vehicles. This allows the users to modify the appearance of their vehicles as per their mood.

Conclusion

Increasing numbers of new technological innovations draw inspiration from nature. We look to ecological processes and the designs of organisms in nature to show us possibilities never before considered. Biomimicry and generative design are gaining popularity – increasingly mirroring the cycle of evolution. Because so many of our technological innovations are based on what we see in nature, we need to realise the importance of conserving the environment. Ecological research and initiatives to preserve our animal and plant species should therefore high on our list of priorities – the survival of humanity depends on it.

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Image 3 - <https://asknature.org/strategy/beak-provides-streamlining/#.WNw1vzG0k-U>

Image 4 - <https://asknature.org/strategy/beak-provides-streamlining/#.WNw1vzG0k-U>

Image 5 - <https://www.youtube.com/watch?v=BvTkefJHfC0>

Image 7 - <http://www.yankodesign.com/2010/07/05/beetle-juice-inspired/>

Image 8 - http://www.divebuddy.com/members/photos/pic_6382_13706.jpg

Image 9 - <http://pics-box.biz/sea/page/23/>

Image 10 - <http://imgur.com/gallery/fKQkl>

Image 11 - https://www.youtube.com/watch?v=6SCrRYDOg_s

Image (12,13 and 14) - https://www.youtube.com/watch?v=L-cxg8mF_Lw

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