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The Future of Biomimetic Modeling, Dynamics and Control

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Abstract

The term biomimetic is relatively recent; however, the philosophy behind the term goes back to ages. Our forebears studied birds and their flights and began designing flying objects. Since the 20th century, artificial intelligence moved towards the need mimic the nature. Biomimetic is primarily a science that mimics nature. Technology is now being developed after a certain desired characteristic that is available in nature. Animitation of the shark skin has enabled the development of moving objects with low drag, example swimsuits. The advantages of modeling technology after nature cannot be overemphasized

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1. Introduction

Biomimetic implies the mimicking of nature. Biomimetic is derive from the Greek word *bios*; which implies life, and *mimesis* meaning imitation, to imitate. The word was only coined in 1957 by Otto Schmitt. It involves an in- depth observation of the dynamics, principles, mechanisms, and structures of natural objects. It is a multidisciplinary field of science therefore, engineers, biologists, chemists, physicists, and so is extensively exploring it. Consequently, the varieties of use are endless.

Nature has remarkable qualities that if harnessed for our benefits, the world would be better for it. Science is now identifying and making keen observations on those remarkable qualities that are available in nature to exploit for development. Therefore, science is identifying and observing the, physical, morphological and chemical properties of natural objects. Where a natural object possesses higher multi-functionality ion a particular sphere, scientists try to imitate that higher multi-functionality in their productions.[1-4]

2. Biomimetic Modeling

Biomimetic Modeling simply implies the identification and exploration of remarkable qualities with higher functionality in nature that has solved a perceived shortcoming, inadequacy or defect and applying it to a technological design. Natural organisms have developed well-adapted structures and materials over the yearsthrough evolution. Biomimetic is the production of new technologies inspired by natural and biological solutions at macro and nanoscales. Humans are now resorting to nature for solutions upon which to model their technology designs. Nature has easily unraveled extremely difficult engineering questions and problems. Medicine, Engineering, Physics, Energy, Chemistry, and so on are among the many scientific fields that are making use of Biomimetic. The Arts has always resorted to Nature as a reliable source of aesthetic inspiration. Natural organisms like the fauna and flora have inspired uncountable motifs in different creative art forms. The sciences have only recently recognized the necessity of modeling their productions after nature. However, nature has always provided us with a reservoir of raw materials for the development of the earth. Technological productions are now being inspired by an identified biological mechanism which is desired. Biomimeticis is an application in diverse scientific fields. The consequence of this variety is the improvement in quality of diverse technological designs[3-5]

2.1 Dynamics of Biomimetic Modeling

The aspects that have found application of Biomimetic in our existence is as varied as our problems. Though this field is relatively new, its areas of application are limitless. Some of these include:

- **Locomotion:** The impressive pointed nose and efficient mechanics of the improved Japanese high speed train

Shinkansen five hundred Series were modeled after the beak of coraciiform bird. This is to reduce the drag when in motion and enhance speed.

- **Ventilation:** Researchers studied the termite's ability to maintain stable and constant temperature and humidity in their mounds. This is despite the extremely hot temperatures outside. Researches conducted revealed that these mounds are well ventilated. The ventilation system of these termite's mounds are currently been adapted for construction and building designs. The East gate Centre, an architectural wonder in Zimbabwe keeps a regulated temperature all year. It is without artificial air-conditioners or heating system. Its ventilation system mimics the dynamics of the anthill.
- **Medical cure:** Before now, medical cure involved the use of synthetic chemicals (medicines)to that initiate a neuro reaction that would induce the relevant response for healing. With the advent of Biomimetic, researchers are modeling medical cure after the self-regeneration mechanism of living organisms.

2.2 Examples of Biomimetic modeling

Real time examples of Biomimetic modeling are enormous. New technological designs and breakthroughs are being recorded every day. Some readily available examples of Biomimetic modeling include among others:

Birds and Flight

Arguably, the leading example of Biomimetic is in the area of avian flight. The flight of the birds has always captivated man. He has been able to effectively over-come motion on land and water. However, for a very long time, motion through the air eluded his grasp. He thus idealized motion through the air and even made attempts at flying like the birds. These early attempts resulted in abysmal failures. Leonardo da Vinci is generally recognized as a pioneer in this field. He embarked on many studies on birds and human flight within the 1480s. His original designs did prove that man might be able to fly. Many designers and engineers developed on his bird-inspired designs as the years went by. Otto Lilienthal attempted some flights with his designs. They were not all together successful but he had taken human flight to the next level. In 1903, the Wright brothers made history. They flew the first man- made machine through the air with relative control. They had made the first successful flight through air. This technology went on to outline the aerial developments of twentieth century and also the technology seen within the air nowadays[5-11]

Burrs and Velcro

In 1941, Swiss engineer Georges Mestral took a walk with his dog through a field. He found that the dog's fur and his trousers had picked up burrs which stuck fast with no sign of coming off easily. Upon a detailed observation under a magnifier, he noticed the burrs had little hooks at the tip. These hooks enable them to attach to furs and or textiles and stick. Consequently, he was inspired to design the Velcro. The two-faced Velcro fastening mechanism uses a band of loose nylon (fur) against a band of little hooks (burrs). The hooks curve into loop thus forming a burr- like surface against the loose nylon which serves as fur. A synthetic reproduction of this fastening mechanism of the burrs led to the design and production of Velcro. Velcro fastening mechanism is now used in the production of shoes, bags, clothing and so on.

Kingfisher and the Japanese speed train 'Shinkansen bullet'

The Japanese speed train has a pointed bullet nose-shape that is modeled after the beak of the coraciiform bird. The pointed nose aids the train to maneuver curves comfortably at very high speeds. The pointed nose minimizes the amount of air that hits the nose of the train there by reducing drag. This has helped the speed train run through tunnels at high speed. Japan is reputed for the great speed and reliability of their trains. With speeds of over 300km/h, it would take sheer genuine engineering brilliance to keep them on their tracks without derailing. Japan's bullet trains have been designed with inspiration from a rather unlikely source: the coraciiform bird. Similar to the coraciiform bird, the Shinkansen bullet is designed with a protruding beak-shaped nose. This beak-shaped nose considerably reduces the noise decibels coming from these trains. They train consumes less energy with more speed.

Wind turbines and Megaptera Novaeangliae

The Megaptera novaeangliae weighs an astonishing thirty-six tons; nevertheless it is a prime swimmer in the waters of the ocean. These mechanical feats are greatly attributed to the jagged protrusions on the front of its fins, known as tubercles. Just like the mechanics of wings in flight, whales use their fins at varying and steepening angles to extend their carry. Fish and colleagues compared jagged blades against smooth-edged ones. They found that stall happens at a far higher angle with tubercles. They concluded that this high angle proficiency actually facilitated the whale in its tight- circle maneuver. They are therefore naturally endowed with such excellent mechanics that they encircle and entrap their prey even with their sizes. Fish therefore modeled his wind turbines with serrated-edge which gave it a higher maneuver capacity. Also, it is economical and quieter when compared with standard sleek blades.

3. Advantages of Biomimetic Modeling

- **Sustainability:** Rhe essence of Biomimetic is sustainability. It studies the dynamics, principles, mechanisms, and structures of nature to achieve this. Nature has offered its principles to inspire humanity in technological drive. They include self-regeneration in medical science, resource optimization rather than maximize, use of clean and free energy, reproduction, adaptation and evolution, thereby enhancing the bio-sphere. By following nature's principles, you can create products and processes that will seek to sustain life on earth.

- **Preservation:** Biomimetic mimics how nature provides for and solves problems in a particular habitat. Taking a cue from this, technologist can organize their production processes and systems to optimally utilize resources. This would help them tackle and eliminate unnecessary waste in the production process. After all, the main aim of development is the preservation of our universe. Nature has the best preservation mechanisms available to ensure the continuance of this universe.
- **Performance:** Naturally, evolution has ensured that only the fit survive. Nature has therefore provided adaptive features for each of its creatures to ensure survival within its habitat. Biomimicry assist you to study the successful strategies of the fighters, so you can model yours after the desired features. This increases performance of the improved technology. High performance will help a product thrive in the marketplace. This is because the new product was inspired by those strategies that enabled the organism have an edge in its habitat.
- **Energy conservation:** Natural energy is rather tasking and difficult to harness. Plants have to trap and convert energy from sunlight through a process known as photosynthesis. Animals have to search, hunt and entrap it. Since energy cannot be created, nature seems to have designed extremely energy efficient mechanisms and systems to conserve it. This are to ensure total and full optimization of acquired energy. Mimicking these efficiency strategies can dramatically reduce the energy consumption and consequent waste. Superior competence translates to energy cost savings and better profitability.
- **Affordability:** Strikingly, Nature keeps its production processes stupidly simple. It brings out the best with the least. By researching into how this structuring operates, prudence becomes the watch word. You can minimize your input without affecting quality. Biomimetics helps in maximizing the efficiency of products, designs, patterns while ensuring affordability to achieve desired functionality.
- **Development:** Biomimetics helps you identify, observe, and duplicate the strengths, merits or advantages exhibited by a natural organism to overcome a certain weakness. Which. This insight creates an inspiration for innovation and development. Biomimicry explores best alternatives that would spur developmental technologies.
- **Revenue:** Biomimetics can help you generate new revenue, and make more profits without affecting the quality of your product. By drawing inspiration from nature and applying it to your product, you will invariably be improving on your product and its profitability. This will attract both customers who care about innovation and sustainability. Biomimetics will drive profitability through natural and cheap cost effective saving measures.

4. Conclusion

The essence of biomimetic is the adoption of the natural world as source of inspiration and a benchmark in the development of new technologies. Detailed observations and analysis of principles, structures, and organisms within natural systems must be embarked upon. Consequent upon which data, results and observations made could be used as models in science and engineering of new technologies. However, the focus of Biomimetics must of necessity identify the relationships between structure and function in natural systems. This will aid scholars in the study of Biomimetics to effectively apply the reward of such study into solving human problems. It is used in many different field of science therefore engineers, biologists, chemists, physicists and many more are very intensive to explore this field to get the desired results from this. Thus, the diversities of biomimetic use are endless. Environment has extraordinary qualities that if attached for our benefits, the world would be better for the use it. Science is nowadays recognizing and creating strong observations on those amazing potentials that are available in nature to exploit for development.

References

1. R. Yang, S.C. Lenaghan, Y. Li, S. Oi, M. Zhang, Mathematical Modeling, Dynamics Analysis and Control of Carnivorous Plants, In: Volkov A. (eds) Plant Electrophysiology. Springer, Berlin, Heidelberg, (2012) 63-83.
2. A.F. Tabak, S. Yesilyurt, Experiment-based kinematic validation of numeric modeling and simulated control of an untethered biomimetic microrobot in channel, 2012 12th IEEE International Workshop on Advanced Motion Control (AMC), (2012) 1-6.
3. R. R. Nadikattu, The emerging role of artificial intelligence in modern society, International Journal of Creative Research Thoughts, 4 (2016) 906-911.
4. R. R. Nadikattu, The Supremacy of Artificial intelligence and Neural Networks, International Journal of Creative Research Thoughts, 5 (2017) 950-954.
5. J. Xu, X. Niu, Q. Ren, Modeling and control Design of an Anguilliform robotic fish, Int. J. Model. Simul. Sci. Comput., 3 (2012) 1250018.
6. K. Torabi, A.A. Moghadam, Robust control of conjugated polymer actuators considering the spatio- temporal dynamics, Proceedings of the Institution of Mechanical Engineers, Part I: Journal of Systems and Control Engineering, 226 (2012) 806–822.
7. E. Kayacan, Z.Y. Bayraktaroglu W. Saeys, Modeling and control of a spherical rolling robot: a decoupled dynamics approach, Robotica, 30 (2012) 671-680.
8. D.C. Karnopp, D. Margolis, R.C. Rosenberg, System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems, (2012).
9. H.E. Taha, M.R. Hajj, A.H. Nayfeh, Flight dynamics and control of flapping-wing MAVs: a review, Nonlinear Dynamics, 70 (2012) 907-939.

10. F.S. Heldt, T. Frensing, U. Reichl, Modeling the Intracellular Dynamics of Influenza Virus Replication to Understand the Control of Viral RNA Synthesis, Journal of Virology, 86 (2012) 7806–7817.

11. M. Reyhanoglu, J.R. Hervas, Nonlinear dynamics and control of space vehicles with multiple fuel slosh modes, Control Engineering Practice, 20 (2012) 912–918.