

# Multidisciplinary Technology of Animatronics: A Review

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**Abstract** - Animatronics is a developing technology which involves the disciplines of Mechanical Engineering, electronics engineering and animations to produce real life size replicas of the object working on robotic technology. Animatronics technology creates animated objects working on mechanisms which will seem and sense alive. These objects are more realistic compare to the robotic machines. The basic mechanism of these machines is a combination of different mechanical and electronic components. They can be powered by electrical motors, pneumatics or hydraulics, and their controlling mechanism can be manual controlled or computer controlled.

The animatronics objects are made of mechatronics structure with fully functional and controlled mechanisms covered with detailed and colored skins. The alive nature of the animatronics object is result of artistically designed costuming of the object. Animatronics provide real life mirage to the non living structures. This paper provides review on different aspects of animatronics like. In this work, wide overview of animatronics with different present and future applications of the field of animatronics is rectified.

**Keywords:** Robotics, Animatronics, Electronics,

## I. INTRODUCTION

This field is related to robotics, but the appearance of animatronics objects in is more alive. Animatronics falls under the broad category of mechatronics, which is combination of mechanical, electronics and electrical engineering disciplines. The animatronics is based on concept that mechatronics components can be designed and implemented to simulate animated objects or characters. In the other words the engineering and animation can provide real like objects together Fig shows, flow diagram of animatronics [2].



Fig.1 Flow Diagram of Animatronics

In animatronics the object is combinations of different aspects like on hydraulic, pneumatic or electrical means,

mechanism, robotic, anatomy and animation. In entertainment industry the regular objects are animals, plants, birds, dinosaurs etc and in medical industry organ like tongue, vocal organs, hands, feet are the common objects which are produced by animatronics technology. These objects are programmed to repeat specific actions like physical movements, playing audios etc to assists users or to make dramatic effects. [2].

Animatronics requires knowledge of many disciplines like mechanical engineering, electrical engineering, electronics engineering, art, anatomy etc. The complete animatronic project require vast amount of knowledge in each field mentioned above.

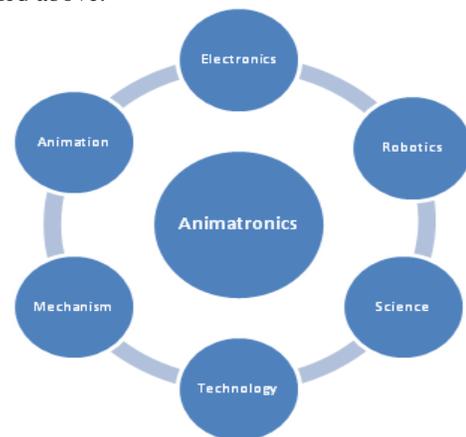


Fig.2 Scope Of Animatronics.

## II. ROBOTICS AND ANIMATRONICS

Like robotic Animatronics also has mechanism for the movements but the main difference between robotics and animatronics is their appearance. The robot has same mechanism as that of animatronic object (animatron) but robots has look of machine and animatrons are not. The humanoid robots has much similarities to the animatronics creatures but their functionality is different. The robots have versatile functionality and animatrons has very limited functionality.

### 1. Robotics

Robots are just a machines built to carry out some difficult tasks which are considered to be hazardous, difficult or

impossible for human beings. The robots are dedicated to specific work or series of works for which they are programmed. Robots can be also used for tasks where use of human beings can be costly or time consuming.

In robotics, the emphasis is given on the task which is to be completed and all design and development of robot is concentrated on its functionality and not on the appearance of the robot.

## 2. Animatronics

Animatronics is a branch of robotics that is used to create a robots that seems to real-life character which as motion, expression, emotions and audio as well.

In animatronics objects the appearance and costuming of the machines is important and crucial task. Unlike robotic the costuming has equal importance as that of mechanism.

## III. ORIGINS OF ANIMATRONICS

The origins of animatronics can be traced back to ancient China; Chinese history says that in third century BC, an artist named Yan Shi presented a King Mu of Zhou with an life size animatron. This object is believed to be walk, sing and dance. It might be myth in the history but this story shows that the concept of animatronics was present in the human mind centuries ago. In earlier years of Leonardo da Vinci as engineer and artist, he built the Automata Lion and a bird which is one of the earliest described animatrons [5]. These earlier models are then evolved with technology and now it is converted into advanced form of technology with the help of electronics.

The cuckoo clocks are in incredible example of initial animatronics objects. These clocks has a mechanical bird which popped out on a every hour as a results of movement of mechanical linkages response to movement in hour hand of the clock. As it was associated with the audio sound it can be categorized as an audio-animatronics [1]. The huge development and implementations of animatronics is done by the Disney studios. Disney created revolution in the field of animatronics and these objects became sensation in the visitors of the Disney theme parks and later in the movie theaters.

## IV. PROCEDURE

Creating animatronics object is very critical task and involves many different methodologies consisting many difficult and important steps. To create any animatronics object or machine, following steps are to be followed.:-

### 1. Design

In design step the basic sketch or concept of the object is finalized. It is generally sketched on paper and then it gets its final and dimensioned shape in drawing software (2D or

3D). [1]. Fig 3. shows, basic sketch on paper and by software.



Fig.3 Basic sketch of figure On paper and by using Blender software [6].

### 2. Sculpting

In this stage, a sculpting of the designed sketch using clay of wax is done, the sculpting is done with care to give real life shape to the object. Usually mixture of Wax and clay is used to sculpt human size figures to avoid stiffness problems of the clay and to give soft finish to the model [2].

### 3. Modelling

This modeling department takes the form by sculptor and it works to produce skin of the character by using this mold. The moulding is usually done in single piece but for complex parts multiple piece moulds are also used. As this process is very complex it is done carefully to match exact dimensions as per the design. It is generally handmade work performed by skilled sculptures which is why this process is time consuming. Fig 4 shows, modeling process of a human model [1].



Fig.4 Modeling [1].

#### 4.Fabrication

In this stage body armature is created and assembled by bolting, screwing or welding processes. In this stage combination of art and technology contributes to the generation of live structure of object. The selections of different components of base mechanism like actuators, valves, flow controls and hoses take place in this stage. The good fabrication of mechanism leads to durable and reliable installations of animatronic objects. [1]. Fig 5 shows, armature fabrication.

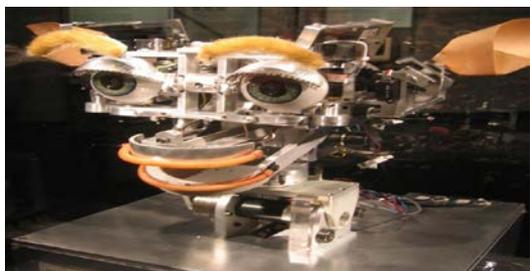


Fig.5 Armature Fabrication [6].

#### 5.Costuming

As its name suggests costuming is the process in which outer appearance of the figure is provided. It is a process of applying outer layer (skin) on animated fig, so that it may differs from an actual robots to look more real-life character. In order to give live appearance materials like wax, leather, Silicone, Polyurethane, Plaster is used. For more detailed costuming smells and colors can be also added on the skin. Fig shows, process of costuming [1], in this skin is attached on the skeleton of the figure 6.



Fig.6 Costuming [1]

#### 6.Programming

Costuming produces appearance of the fig but the control of movement and sound of the object is done in the programming stage. Programmer set the movement of the object using control system and its movements are pre recorded by the programmer as per the requirement of the application. Programming is a complex phenomenon as it includes animated actions, its timing, audio timing and control of different actuators in the mechanism [1].

As animatronics objects are motorized devices that are preprogrammed to perform single or series of tasks. The control mechanism can be manually or by remote.

### V. LAWS OF ANIMATRONICS IN ENTERTAINMENT INDUSTRY

There are some basic thumb rules are needed to be followed for the effective use of Animatronic objects presentation. Following are laws which governs the different factors in the animatrons [6];

1. Law of Distance: To get as much distance possible between character and human.
2. Law of Time: Shorter the time of view, less sophisticated a character needs to be. Which also means object appearing for more time in front of viewer need more careful costuming and design?
3. Law of Number: More number of characters are provided to hold minimum attention of audience on single character.
4. Law of Non-Human: Non-human animatronics characters are not judged as critically as human life-like one, hence human characters are needed to be designed and costumed with utmost care.

### VI. GOAL OF ANIMATRONICS AND FUTURE SCOPE

This technology is majorly used by the entertainment industry but it also have huge applications in the medical field. The aim of this technology is to achieve the efficient degree of freedom to copy human action, voice or expressions. Animatronics objects has capability of voice animation also [2]. These Machines has lower working cost then human and if carefully designed then they are capable of anything that man and animals can't do. But the main problem of these machines is their cost and complexity. These are made up of complex system, difficult to make, handle and use it.

#### Application

1. To create enthusiastic creatures, hostiles etc.
2. In theme parks and museums to attract visitors and to entertain them. [2]
3. In medical field for organ replacements.

## VII. FUTURE SCOPE

In future, it is expected to use animatronics on very large scale. The technology is continuously upgraded and in near future fully developed animatronics creatures with artificial intelligence can be developed for human assistance or entertainment. In entertainment industry demand of animatronic objects is increasing, in film industry animatronic objects not only save the money but is also allow them a creative freedom by proving dramatical actions which are otherwise not possible. These animatrons will have ability to entertain and may take safety responsibility and latter on they would capable of thinking and reasoning like human beings with the help of artificial intelligence [1].

## VIII. CASE STUDIES

1. Wild West:- 2016 released American television series showed use of animatronics robots [8] which are used in theme park to give real life experiences to visitors. This show represents unethical use of robots for the pleasure of rich and wealthy people. Use of Animatronics technology for this application though sounds impossible but its possibilities cannot be firmly denied.
2. Wireless Module Hand:- In this study a human hand is used for working in hazardous environments. This hand provides more safety in the industrial operations. This Animatronic hand is created by using wireless technology which is based on Xbee module as well as Arduino-UNO board [3]. These type of applications can be very helpful for the industrial applications.
3. Human Tongue and Vocal track:- It is a medical application of the animatronics object. This model has a movable tongue and jaw, they are connected to a fixed hyoid bone and a skull this object is able to produce sound by using auditory feedback. This object is also capable of gathering information about amount energy required to produce specific speech gestures [4].

## IX. CONCLUSION

This technology was created only few decades before but its seeds were found in the imagination of man from centuries. Till date more than 10,000 animatronic creatures have been created for different task. The animatronics has been implemented for mostly entertainment purpose but it has huge potential in medical industry also. Animatronic can be helpful for organ replacement and initial success is observed in the development of vocal organ and tongue. The more attention in this field can lead to more excellent achievement in this field.

In entertainment industry this technology is vastly used, this technology provides safety as well as creative freedom to the directors. This technology is proven to very helpful and promising in the entertainment industry.

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