A

Seminar report

On

Animatronics

Submitted in partial fulfillment of the requirement for the award of degree
Of Electronics

SUBMITTED TO: SUBMITTED BY:

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Preface

I have made this report file on the topic **Animatronics**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

CONTENTS

INTRODUCTION

The first use of Audio-Animatronics was for Walt Disney's Enchanted Tiki Room in Disneyland, which opened in June, 1963. The Tiki birds were operated using digital controls; that is, something that is either on or off. Tones were recorded onto tape, which on playback would cause a metal reed to vibrate. The vibrating reed would close a circuit and thus operate a relay. The relay sent a pulse of energy (electricity) to the figure's mechanism which would cause a pneumatic valve to operate, which resulted in the action, like the opening of a bird's beak. Each action (*e.g.*, opening of the mouth) had a neutral position, otherwise known as the "natural resting position" (*e.g.*, in the case of the Tiki bird it would be for the mouth to be closed). When there was no pulse of energy forthcoming, the action would be in, or return to, the natural resting position.

This digital/tone-reed system used pneumatic valves exclusively--that is, everything was operated by air pressure. Audio-Animatronics' movements that were operated with this system had two limitations. First, the movement had to be simple--on or off. (*e.g.*, The open and shut beak of a Tiki bird or the blink of an eye, as compared to the many different positions of raising and lowering an arm.) Second, the movements couldn't require much force or power. (*e.g.*, The energy needed to open a Tiki Bird's beak could easily be obtained by using air pressure, but in the case of lifting an arm, the pneumatic system didn't provide enough power to accomplish the lift.) Walt and WED knew that this this pneumatic system could not sufficiently handle the more complicated shows of the World's Fair. A new system was devised.

In addition to the digital programming of the Tiki show, the Fair shows required analog programming. This new "analog system" involved the use of voltage regulation. The tone would be on constantly throughout the show, and the voltage would be varied to create the movement of the figure. This "varied voltage" signal was sent to what was referred to as the "black box." The black boxes had the electronic equipment that would receive the signal and then activate the pneumatic and hydraulic valves that moved the performing figures. The use of hydraulics allowed for a substantial increase in power, which was needed for the more unwieldy and demanding movements. (Hydraulics were used exclusively with the analog system, and pneumatics were used only with the tone-reed/digital system.)

There were two basic ways of programming a figure. The first used two different methods of controlling the voltage regulation. One was a joystick-like device called a transducer, and the other device was a potentiometer (an instrument for measuring an unknown voltage or potential difference by comparison to a standard voltage--like the volume control knob on a radio or television receiver). If this method was used, when a figure was ready to be programmed, each individual action--one at a time-- would be refined, rehearsed, and then recorded. For instance, the programmer, through the use of the potentiometer or transducer, would repeatedly rehearse the gesture of lifting the arm, until it was ready for a "take." This would not include finger movement or any other movements, it was simply the lifting of an arm. The take would then be recorded by laying down audible sound impulses (tones) onto a piece of 35 mm magnetic film stock. The action could then instantly be played back to see if it would work, or if it had to be redone. (The machines used for recording and playback were the 35 mm magnetic units used primarily in the dubbing process for motion pictures. Many additional units that were capable of just playback were also required for this process. Because of their limited function these playback units were called "dummies.")

Eventually, there would be a number of actions for each figure, resulting in an equal number of reels of 35 mm magnetic film (*e.g.*, ten actions would equal ten reels). All individual actions were then rerecorded onto a single reel--up to ten actions, each activated by a different tone, could be combined onto a single reel. For each action/reel, one dummy was required to play it back. Thus for ten actions, ten playback machines and one recording machine were required to combine the moves onto a new reel of 35 mm magnetic film. "Sync marks" (synchronization points) were placed at the front end of each individual action reel and all of the dummies were interlocked. This way, during the rerecording, all of the actions would start at the proper time. As soon as it was finished, the new reel could be played back and the combined actions could be studied. Wathel, and often times Marc Davis (who did a lot of the programming and animation design for the Carousel show) would watch the figure go through the motions of the newly recorded multiple actions. If it was decided that the actions didn't work together, or something needed to be changed, the process was started over; either by rerecording the individual action, or by combining the multiple actions again. If the latter needed to be done, say the "arm lift action" came in too early, it would be accomplished by unlocking the dummy that had the "arm-lift reel" on it. The film would then be hand cranked, forward or back, a certain number of frames, which changed the start time of the arm lift in relation to the other actions. The dummies would be interlocked, and the actions, complete with new timing on the arm lift, would be recorded once again.

With this dummy system, the dialogue and music could also be interlocked and synched-up with the actions. Then the audio could be listened to as the figure went through the actions. This was extremely helpful in getting the gestures and actions to match the dialogue.

The other method used for programming a figure was the control harness. It was hooked up so that it would control the voltage regulation relative to the movements of the harness. Wathel tells horror stories of sitting in the harness for hours upon end, trying to keep every movement in his body to a minimum, except for the several movements they wanted for the figure. This method had the advantage of being able to do several actions at once, but obviously due to the complexities, a great deal of rehearsal was required.

There was also a harness for the mouth movements. Ken O'Brien, who was responsible for programming most of the mouth movements, used a transducer at first for the mouth programming. Later they designed a harness for his head that controlled the movement of the jaw," remembered Gordon Williams, recording engineer on the AA figures for the Fair. "It was easier for him to coordinate the movement, because he could watch the movement at the same time that he was doing it."

WHAT IS ANIMATRONICS

Animatronics is a combination of animation and electronics. What exactly is an animatronic? Basically, an animatronic is a mechanized puppet. It may be preprogrammed or remotely controlled. The animatronic may only perform a limited range of movements or it may be incredibly versatile.

The scare created by the Great White coming out of the water in "Jaws" and the tender otherworldliness of "E.T." are cinematic effects that will not be easily forgotten. Later animatronics was used together with digital effects. Through the precision, ingenuity and dedication of their creators, animatronic creatures often seem as real to us as their flesh-and-blood counterparts

FORMATION OF ANIMATRONICS

Step 1: Design Process

During the design process, the client and the company developing the animatronics decide what the character will be,its appearance total number of moves, quality of moves, and what each specific move will be. Budgets ,time lines and check points are established. Many years have been spent to ensure that this critical step is as simple as possible. Once this critically important stage is solidified and a time line is agreed upon, the project moves to the sculpting department.

Step 2: Sculpting

The sculpting department is responsible for converting two-dimensional ideas into three-dimensional forms. This team can work from photos, artwork, videos, models, statuettes and similar likenesses. Typically, the client is asked to approve the sculpting before it goes to the molding department.

Step 3: Moldmaking

The molding department takes the form created by the sculptor and creates the molds that will ultimately produce the character skins. Molds can be soft or hard, single or multiple pieces, and reusable or non-reusable. To get the sculptor's exact interpretation, mold making is both an art form and an elaborate technical process. The process can be very time-consuming and complicated. It can be so unnerving that some animation mold makers even refer to it as "black magic."

After the mold is finished and cured, it is ready for skin making. Fiberglass shells are simultaneously being laid up to form the body and limb shapes. Some of these shapes are reusable stock pieces, but the majority of shells are custom made for each character.

Step 4: Armature Fabrication

Meanwhile, various body armatures are being created and are assembled in the welding metal-fabricating areas. Each of the robot's movements axis points must have an industrial-rated bearing to provide action and long life. Each individual part requires a custom design and fabrication. These artisans are combining both art and technology to achieve realistic, lifelike moves.

As the armature takes shape, the actuators, valves, flow controls and hoses are installed by the animation department. The technicians select those components carefully in order to ensure the durability and long life. As it's assembled, each robotic move is individually tested and adjusted to get that perfect movement.

Step 5: Costuming

The costume, if there is one, is usually tailored to the character and its movements. Animation tailoring can be a very difficult tedious process considering the variables. The outfit has to allow for easy acces to the character's operating mechanisms. It must also "look" normal after movement has taken place. The costume must be designed to provide hundreds of thousands of operations without wearing out and without causing the skin areas(i.e. around the necks or wrists) to breakdown as well.

Step 6: Programming

Finally, if it is an animated character the electronic wizard move in to connect the control system into valve assembly in the preparation for programming. Programming is the final step, and for some animations it is the most rewarding. Programming can be done either at the manufacturing facility or at the final installation site. In programming, all the individual moves are coordinated into complex animated actions and nuances that bring the character to "life."

JURASSIC PARK

Long before digital effects appeared, animatronics were making cinematic history. But it was in Jurassic park that the best possible combination of animatronics and digital effects were used together. Spinosaurus was a new dinosaur animatronic created for "Jurassic Park III" by Stan Winston Studio (SWS). SWS worked with Universal Studios and the film's production team to develop the Spinosaurus design. Below lies the discussion of the amazing process that creates and controls a huge animatronic like this dinosaur!

- Jurassic Machines
- Dinosaur Evolution
- In the Beginning
- Creature Creation
- Putting it together
- Making it Move
- Monster Mash

4.1. Jurassic Machines

The "Jurassic Park" series is known for the realism of its creatures, both the animatronic and digital versions. When the original "Jurassic Park" came out in 1993, it set a new standard for the realistic portrayal of dinosaurs, creatures that have never been seen alive by man. "Jurassic Park II: The Lost World" continued to improve the vision, and "Jurassic Park III," the latest movie in the series, raised the bar once again.

An animatronic of the legendary Tyrannosaurus rex (T. rex) being built

The animatronic Spinosaurus in action

Most of the dinosaur animatronics used in "Jurassic Park III" are new. For example, the Velociraptors were redesigned to more closely resemble what paleontologists think a Velociraptor looked like. The Tyrannosaurus rex was redone too, but is no longer the star of the franchise. That distinction now passes to Spinosaurus, a monster that dwarfs even the mighty T. rex. This is the largest animatronic SWS has ever built, even bigger than the T. rex that Winston's team built for the original "Jurassic Park"!

Below lies the amazing Spinosaurus statistics:

- It is 43.5 feet (13.3 m) long -- almost as long as a bus -- and weighs 24,000 pounds (10,886.2 kg/12 tons).
- It is powered entirely by hydraulics, even down to the blinking of the eyes. This is because the creature was made to work above and below water.
- There are 42 hydraulic cylinders and approximately 2,200 feet (671 m) of hydraulic hoses.
- The creature moves on a track that is 140 feet (43 m) long and made from a pair of 12-inch (30.48 cm) steel I-beams.
- All pivots use roller-bearing construction.
- All large steel pieces were cut using waterjets.
- The creature is completely remote-controlled.

4.2. Dinosaur Evolution

The Spinosaurus, which is the largest meat-eating dinosaur ever discovered, is based on a real dinosaur that paleontologists have recently discovered. This basis in reality can be both good and bad for the design crew. The good side is that they have a solid foundation to start with. The bad side is that it provides a very specific set of criteria that must be matched. Building the Spinosaurus, or any other animatronic, requires several major steps:

- Put it on paper.

- Build a maquette (miniature model).
- Build a full-size sculpture.
- Create a mold (from the sculpture) and cast the body.
- Build the animatronic components.
- Put it all together.
- Test it and work out any bugs.

A complicated animatronic could take up to two years from conception to completion. However, deadlines and budgets typically don't allow for a timeline like that. According to John Rosengrant, SWS effects supervisor for "Jurassic Park III," the Spinosaurus took less than a year to go from the drawing board to the finished product. Rosengrant supervised a crew of about 75 SWS designers, engineers and artists who worked on "Jurassic Park III" animatronics, and approximately 30 of them worked on developing the Spinosaurus.

4.3. In the Beginning

The first two steps in creating an animatronic are the sketches and the miniature model.

Put it on Paper

The first thing that happens with any animatronic is that an artist creates preliminary sketches of the creature. The Spinosaurus sketches were developed by working closely with expert paleontologist Jack Horner and the crew working on "Jurassic Park III." The sketches are analyzed and changes are suggested. Eventually, the artist creates a detailed illustration of the creature. In the case of Spinosaurus, SWS went from preliminary sketch to final design in about three weeks.

Build a Maquette

From the final paper design, a miniature scale model called a maquette is created. Fashioned out of clay, the first maquette SWS made of Spinosaurus was one-sixteenth scale. This initial maquette is used to verify that the paper design is accurate. If there are any problems, they are corrected and a new paper design is made.

Jurassic Park III Director Joe Johnston and the one-fifth-scale maquette of the Spinosaurus

Next, a one-fifth-scale maquette is made. This sounds small, until you realize the sheer size of the Spinosaurus. The one-fifth-scale model was about 8 feet (2.4 m) long! The larger maquette allows the designers to add more surface detail. This maquette is then used to produce the full-size sculpture.

Big as Life

Once the sketches and models are done, the full-size building begins.

Build a Full-size Sculpture

For the animatronic dinosaurs in the original "Jurassic Park," SWS had to build the full-size sculpture by hand, a time-consuming and laborious process. Advances in computer-aided manufacturing (CAM) allow them to automate a significant part of this step.

The maquette is taken to Cyber F/X, where it is scanned by a 3-D digitizer. This is nothing like a normal computer scanner. There are a variety of methods used in 3-D digitizers, but the one that was used for Spinosaurus is called laser scanning.

Laser scanning takes precise measurements of the maquette by bouncing beams of laser light off its surface. As the laser scanner moves around the maquette, it sends over 15,000 beams per second. The reflected light from the beams is picked up by high-resolution cameras positioned on either side of the laser. These cameras create an image of the slice (cross section) of the object that the laser is scanning. A custom computer system collects the cross sections and combines them to create a perfect, seamless computer model of the maquette.

Cyber F/X then used the computer model to mill the life-size model of the Spinosaurus from polyurethane foam. This very rigid foam is cut to the correct shape through a proprietary process called CNC-Sculpting®. This process, developed by Cyber F/X, takes the data from the full-scale computer model and divides the model into manageable chunks. The data for each chunk is then sent to the foam-sculpting machine, where a life-size section of the dinosaur is created by whittling away pieces of foam from a large, solid block using tiny spinning blades. Once all the sections are done, the SWS team assembles the pieces like a giant 3-D jigsaw puzzle. This creates a very basic full-sized model. A lot of work still needs to be done and it is handled by a team of sculptors at Stan Winston Studio. They hand-carve the foam to add all the incredible details that make it seem real.

Molding and Casting

A set of molds are made of the full-sized sculpture. The molds are made from an epoxy that is very durable and has strong bonding characteristics.

Once the components of the animatronic are ready, much of the frame work is test fitted inside the molds before the foam rubber skin is cast. In conjunction with this step is the fabrication of the foam-running core, which is created by lining the inside of the mold with precise layers of clay to represent the skin thickness. When the clay lay-up is completed, the surface of the clay is fiberglassed to create the foam-running core. After the clay is cleaned out, the foam-running core is bolted into the mold and creates a negative space between the foam-running core and detailed surface of the mold. When filled with foam rubber, this negative space becomes the skin.

The purpose of this process is twofold:

- It makes the skin movement seem more natural
- It controls the skin's thickness and weight

4.4. Creature Creation

Build the animatronic components

Building the various components used in the animatronic usually takes the longest time. Most of the creatures that are developed at Stan Winston Studio require parts that you're not going to find at your local hardware store. This means that SWS has to build almost everything themselves. They do take advantage of any existing products when possible, usually by repurposing parts of a common device to fill some of their uncommon needs.

Working on the head of Tyrannosaurus rex

Basically, there are four main categories that the work splits into, with development happening simultaneously across the categories:

Mechanical –

SWS engineers design and build the mechanical systems, which includes everything from basic gears to sophisticated hydraulics. An interesting fact about the Spinosaurus animatronic is that nearly all of the mechanical systems used in it are hydraulic.

Electronic –

Another group develops the electronic control systems needed to operate the animatronic. Typically starting from scratch and creating their own custom circuit boards, these engineers are essentially building giant remote-controlled toys. Almost all of the movement of the Spinosaurus will be manipulated by specialized remote-control systems known as telemetry devices.

All hydraulic systems are installed and checked.

Structural –

All of the electronic and mechanical components need something to attach to and control, and the skin must have a frame to maintain its shape. This is done by building a plastic and steel frame. To increase the realism, and because it is the natural way to design it, the frame of the Spinosaurus, as well as most other creatures made by SWS, resembles the actual skeleton of the beast. This skeletal frame is largely comprised of graphite, a synthetic material known for its strength and lightness.

Surface –

The "skin" of the Spinosaurus is made from foam rubber, which is a very light, spongy rubber that is made by mixing air with liquid latex rubber and then curing (hardening) it. While there are other compounds, such as silicone and urethane, that are stronger and last longer, foam rubber is used because it is much easier to work with. The solution is poured into each mold and allowed to cure. As mentioned earlier, parts of the frame are embedded with the foam rubber at certain points. To further strengthen the skin, a piece of fabric is cut to size and embedded in the foam rubber after it is poured into the mold. Once cured, each piece of skin is pulled from its mold.

4.5. Putting it Together

When all the components are done, it's time to build the Spinosaurus. The frame is put together and then the mechanical systems are put in place. As each component is added, it is checked to ensure that it moves properly and doesn't interfere with other components. Most of the electronic components are then connected to the mechanical systems they will control. The controls have been tested with the mechanical systems prior to final assembly, but the systems are checked again.

The "skeleton" of the Spinosaurus

Parts of the skin that have embedded pieces of the frame in them are put in place when the frame is assembled. The other skin pieces are fastened in place on the frame once the mechanical and electronic components are installed. Assembling the skin is a very laborious process. As each piece is added, the team has to check to make sure there are no problems - such as unwanted folds buckling, stretching, too tight.

Whenever one of these problems occurs, the skin must be adapted or attached differently. Also, there are places where you do want the skin to fold or hang loose or travel in a certain way, and it must be adjusted to achieve that effect. One of the tricks that SWS uses to make the Spinosaurus and other dinosaurs seem more realistic is to attach bungee cords between areas of skin and the frame. During movement, these bungee cords simulate tendons under the skin, bunching and stretching.

Painting the skin

The skin is mostly "painted" before it is attached to the frame. Stan Winston Studio does not use actual paint, though. Instead, a specially formulated mixture that is akin to rubber cement is used. Tints are added to the mixture to get the correct color. Rosengrant says that they use this mixture in place of traditional paint because it bonds more strongly with the foam rubber and stretches with it as the animatronic moves. Once the animatronic is complete, the team has to test it and work out any problems.

Making it Move

The people that control an animatronic are called puppeteers, because that is all that an animatronic is -- a sophisticated puppet. These puppeteers are skilled actors in their own right and will spend some time with the animatronic learning its range of movements. Rosengrant calls this "finding the performance." The puppeteers are determining what movements make the animatronic look angry, surprised, hungry or any other emotions or moods that are called for in the script.

The telemetry device for controlling the arms

Eight puppeteers operate the Spinosaurus:

- Basic head/body - swivels head, opens and closes jaws, moves neck back and forth, makes body sway from side to side
- Tongue slide levers - moves tongue up and down, side to side and in or out
- Eye joystick control - eyes move, eyelids blink and eye ridge moves
- Front arms - full range of motion; hands open and close
- Cart/body - moves creature back and forth on track
- Breathing potentiometer - inflated bladder inside chest cavity simulates breathing
- Tail - full range of motion
- Body raise slider - raises and lowers body

Rosengrant was the coordinator, and he made sure that all of the other puppeteers are working in concert to create a realistic and believable motion. The telemetry devices used to control the Spinosaurus range from simple handheld units, reminiscent of a video-game joystick, to bizarre contraptions you wouldn't find anywhere else. For example, the puppeteer who controls the arms has a device that he straps onto his own arms. He then acts out the movement he wants the Spinosaurus to make, and the telemetry device translates his motion into a control signal that is sent to the circuit board controlling the mechanical components that comprise the arm system of the Spinosaurus

4.6. Monster Mash

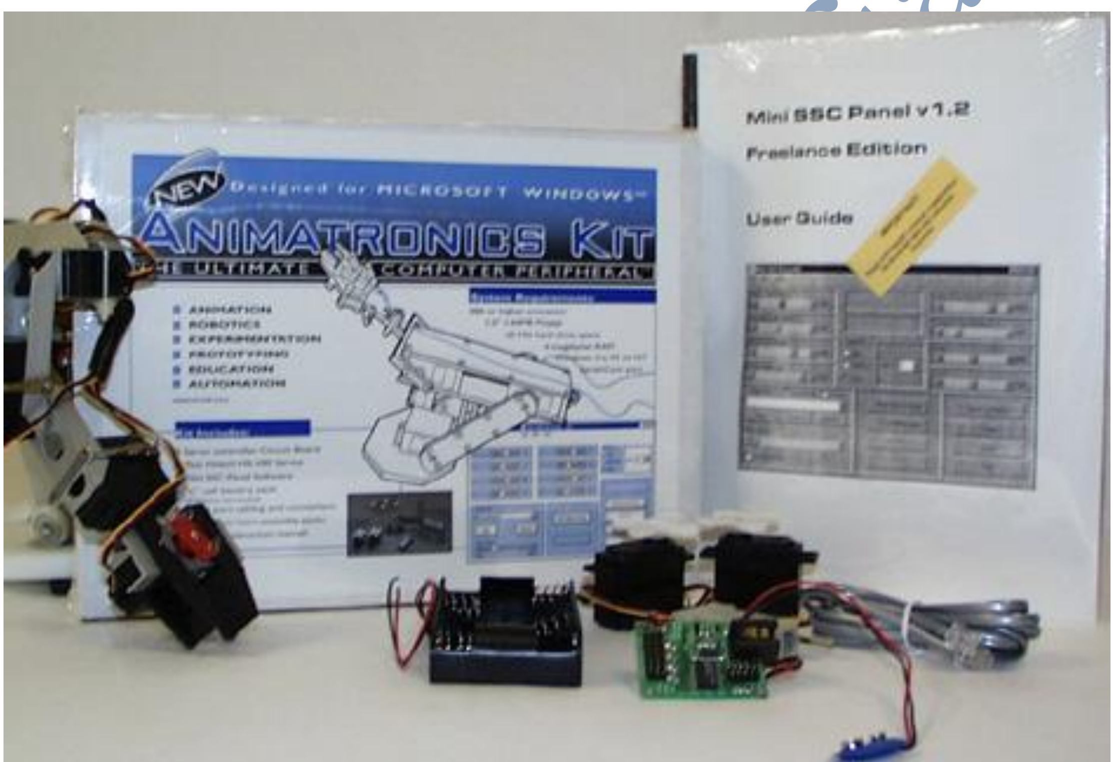
Because the Spinosaurus animatronic is controlled by radio-frequency (RF) devices, certain precautions must be taken when it is in use. Any other device, such as a cell phone, that operates using RF technology must be turned off in the vicinity of the animatronic. Otherwise, improper signals can interfere with the control signals. This could have disastrous effects when dealing with a 12-ton monster. Clean power is important for the same reason. The Spinosaurus has a dedicated uninterruptible power supply (UPS) so that a power surge or brownout would not cause it to go out of control.

Rosengrant calls the Spinosaurus a "hot rod" animatronic. Everything on the Spinosaurus has more power than usual. The hydraulics have larger cylinders than normal and provide approximately 1,000 horsepower. The Spinosaurus is such a powerful machine that it can literally tear a car apart. When the tail is whipped from one side to the other, it reaches 2 Gs at the tip (1 G is the force of Earth's gravity).

BUILDING YOUR OWN ANIMATRONICS

WHAT IS AN ANIMATRONICS KIT?

Everything you need (except batteries and imagination) is included in our easy-to-use kit. Connect the cable to your PC's serial port, install the software and you're ready to start. No soldering or programming skills required. If you can use Windows you can use this Animatronics Kit . The software allows you to record the movements of hobby servos (up to two billion moves) and play them back exactly as recorded. Make your creation come to life!



Kit Includes:	System Requirements:

Servo controller circuit board	486 or higher processor (Pentium recommended)
Two Hitech HS-300 hobby servos	8 megabytes of RAM (32 recommended)
Mini SSC Panel v1.2 software	3.5" 1.44MB floppy
Battery Pack	Windows 3.x, 95, 98 or NT
Two servo horn assembly packs	Available serial port
Illustrated Instruction manual	20 Megabytes of hard drive space

Mini SSC Panel v1.2 software

The Mini SSC Panel v1.2 software is a Windows based computer program that allows you to explore the exciting world of animatronics (a combination of animation and electronics) with ease. With this program, you can control the movements of standard hobby servos attached to just about any creation you can imagine. Create robot figures that move on your command or puppets that seem to come alive. The possibilities are endless.

What is the Mini SSC Panel?

The Mini SSC Panel is a graphical user interface allowing you to easily control standard hobby servos attached to a serial servo controller (SSC) circuit board. This interface provides setup, movement control and movement recording/playback features.

What's new in the Freelance Edition?

New features include:

- "Sleep" Mode
- Playback Looping
- Editable recordings
- "Script Manager"
- Servo Labeling

- Recording and Playback step readout
- Smoother Playback
- Enhanced user guide and help system

<u>Using the Software:</u>

The Control Panel

The Control Panel is the first screen to contain servo motion controls. You use common Windows scroll bars to control the servos attached to your SSC(s). The Control Panel is an excellent tool to calibrate your animatronic creation.

Use the Control Panel to:

- Test SSC/servo connections and functionality
- Test the minimum bounds of your servos
- Test the maximum bounds of your servos
- Determine the "Home" position of your servos
- Experiment with different speeds
- Devise recording strategies and positioning techniques

The Recorder

The interface to record animatronic projects is a flexible and easy-to-use. With the Mini SSC Panel v1.2 Freelance Edition you can combine small sub-recordings into larger more robust animatronic productions using our "Script Manager." By creating smaller recordings and compiling them into larger "Scripts" you can focus on each detail of your animation. For instance, once you have the gripper on your robotic arm working exactly the way you want, you can use that piece over and over again in your final script to keep your movements consistent.

Script Manager

One of the most exciting features of the Mini SSC Panel v1.2 Freelance Edition is the Script Manager. The Script Manager allows you to group smaller sub-recordings into larger, more robust animation productions.

CONCLUSION

Creating a good animatronic figure that is able to perform constantly without fail requires many special skills and lots of technical know how. Before assuming the task of creating an animatronic figure, you should have a strong hold on how these things are constructed and be willing to spend a pretty penny on equipment and materials.

Animtronics has now developed as a career which may require combined talent in Mechanical Engineering , Sculpting / Casting , Control Technologies , Electrical / Electronic , Airbrushing , Radio-Control etc.But the realistic creatures that it can create are amazing and is rewarding to its creator.

REFERENCES

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