Animating Virtual Human for Virtual Batik Modeling

by

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CERTIFICATION OF APPROVAL

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

NORHAZNILAH @ SITI KHADIJAH BT JAAFAR

ABSTRACT

This research paper describes a development of animating virtual human for virtual batik modeling project. The objectives of this project are to animate the virtual human, to map the cloth with the virtual human body, to present the batik cloth, and to evaluate the application in terms of realism of virtual human look, realism of virtual human movement, realism of 3D scene, application suitability, application usability, fashion suitability and user acceptance. The final goal is to accomplish an animated virtual human for virtual batik modeling. There are 3 essential phases which research and analysis (data collection of modeling and animating technique), development (model and animate virtual human, map cloth to body and add a music) and evaluation (evaluation of realism of virtual human look, realism of virtual human movement, realism of props, application suitability, application usability, fashion suitability and user acceptance). The result for application usability is the highest percentage which 90%. Result show that this application is useful to the people. In conclusion, this project has met the objective, which the realism is achieved by used a suitable technique for modeling and animating.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

CHAPTER 1
INTRODUCTION

1.1 Background of study

In batik modeling, one of the important elements is model beside than cloths. At the moment, the model used is real model. So, do not have a specific an animated virtual human to for batik modeling. The difficulty with the real model is needed to find suitable models in term of figure and looks. Models with good figure and looking the price might be high. By applying a virtual reality technology into the batik modeling, it can solve the problem and a useful way in maximize the presentation of batik.

Batik is one of the traditional patterns in Malaysia. It is really synonym with Malay society, this because the utilization of batik is in Malay society. The batik pattern is focused more on the nature like a flower. Nowadays, the batik application is more in the formal ceremony.

The main focused of this project is virtual human animation, which to present the 'batik' cloth. The virtual human animation is able to walk as the real model. The types of modeling involved in this project are geometric modeling, kinematics modeling, and physical modeling. In modeling the virtual human, the techniques have used is interpolation techniques. An interpolation technique is the modification of existing models. The modification is made in term on the facial attributes and sizing parameters of body. For animate the virtual human, direct kinematics and inverse kinematics is used.

1.2 Problem Statement

1.2.1 Problem Identification

There is no such a virtual batik modeling application. Today's, when people want to see batik cloth, they need go to a batik boutique and fashion event. There are also no such an animated virtual human for batik modeling application. Current batik modeling using real model is complex in find the appropriate model in term of figure and looks. Most of the models have a good figure and looks, the payment is high.

1.2.2 Significant of the Project

This project provides a user an animated virtual human for virtual batik modeling application. It will let user see the virtual batik modeling. The virtual human animation is to present a batik cloth. User also can see the interaction between a cloth and body.

The focused animation is walking, so the virtual able walking surrounds the props with wear batik cloth. For this project, it consist of two animated models which with the different fashion.

1.3 Objectives and Scope of Study

The aim of this project is to develop an animated virtual human for virtual batik modeling.

The objectives of this project are:

- To animate the virtual human.
- To map the cloth with the virtual human body.
- To present the batik cloth.
- To evaluate the application in terms of realism, application suitability, application usability, fashion suitability and user acceptance.

Scope of study for this project includes:

- Focusing on virtual human animation.
- Mapped the cloth with the virtual human body.
- Use virtual human to show batik cloth.

1.3.1 The Relevancy of the Project

This project is relevant using virtual reality technology because in the recent year many applications have been applied with it. Many applications have been applied with virtual reality in produce a realistic animation. The application of virtual technology in the batik modeling can leads the rapid growth of batik image.

1.3.2 Feasibility of the Project within the Scope and Time Frame

The scope is focus on the animate virtual human through the implementation of virtual reality technology. The focusing in this project will on the virtual human creation and animation of the model on the stage. So, 14 weeks has been given is feasible to complete the project.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The scientific community has been working in the field of virtual reality (VR) for decades, having recognized it as a very powerful human-computer interface. In terms of functionality the virtual reality is a simulation in which computer graphics is used to create a realistic-looking world. Moreover, the synthetic world is not static, but responds to the user's input and modify the virtual world instantaneously. People like to see things change on the screen response to their commands and become captivated by the simulation. Interactivity and its captivating power contributes to the feeling of immersion, of being part of the action on the screen, that the user experiences. But virtual reality pushes this even further by using all human sensorial channels. Indeed, users not only see and manipulate graphic objects on the screen; they also touch and feel them. (Burdea and Coiffet, 2003)

Virtual reality can also be described from the simulation content point of view as unifying realistic realities with artificial reality. Computer animation technologies let users generate, control, and interact with life-like human representations in virtual world. Such worlds may be 2D, 3D, real-time 3D, or real-time 3D shared with other participants at remote locations. (Burdea and Coiffet, 2003)

The three important I's in the VR is immersion, interaction and imagination (Burdea and Coiffet, 2003). The feature of immersion and interaction are most people familiar with. There is, however fewer people are aware of imagination features. Virtual reality is not just a medium or a high-end user interface; it also has applications that involve solutions to real problems. The extent to which an application is able to solve a particular problem, that is, the extent to which a simulation performs well, depends therefore very much on the human imagination. Virtual reality is therefore an integrated trio of immersion-interaction-imagination. The imagination part of VR refers also to the mind's capacity to perceive nonexistent things (Burdea and Coiffet, 2003).

2.2 Body Modeling

2.2.1 Shape Capture

The difficulties in modeling bodies are inherent complexity of skin and muscles, as well as variety of appearance among different individuals. The issue regarding virtual bodies is that bodies should correspond to real human body shapes, in order for user to relate his own body with the virtual body on the screen. The other issue is should have an appropriate 3D representation for the purpose of cloth simulation and animation.

Realistic human body modeling requires an accurate geometric surface throughout the simulation. A variety of human body modeling methodologies is available, that can be classified into three major categories: creative, reconstructive, and interpolated. Several systems available that are optimized either for extracting accurate measurements from parts of the body, or for realistic visualization for use in virtual environments. There are several approaches to endow semantic structure to the scan data (Thalmann et al., 2004):

a) Used a series of meaningful anatomical assumptions in order to optimize, clean and segment data from a whole body range scanner in order to generate quad mesh representations of human bodies and build applications for the clothing industry (see Figure 2.1).

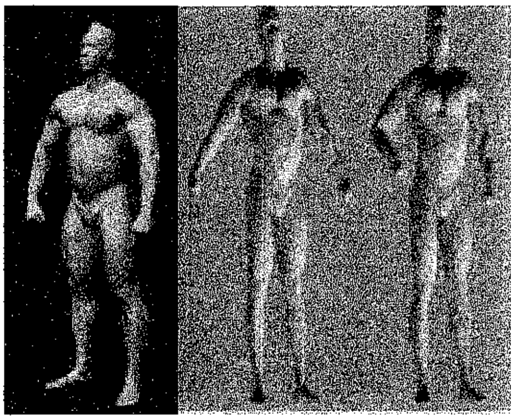
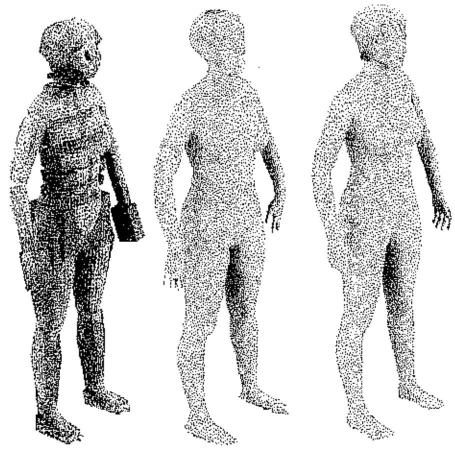


Figure 2.1: After a scanned data (left) is segmented (middle) for an estimation of the skeleton structure, the posture can be modified (right)

b) An optimization technique for estimating poses and kinematics of the human body scans. A template model is used, which is equipped with the skeleton hierarchy and the skin mesh with markers placed on it. By finding the degree of freedom that minimizes the difference marker position, the pose and kinematics of the scan could be found. Once the global proportion of the physique is captured, the displacement map is added by ray casting. Holes are filled by interpolating the rays.

c) The technique based on manually selected feature points is presented. There are two main phases of the algorithm: the skeleton fitting and the fine refinement. The skeleton fitting phase finds the linear approximation (posture and proportion) of the scanned data through skeleton-driven deformation. Based –on the feature points, the most likely joint parameters are found that minimize the distance of corresponding feature locations. The fine refinement phase then iteratively improves the fitting accuracy by minimizing the shape difference between the template and the scan model. A conformation result on a female scan data is shown in Figure 2.2.



(a) (b) (c)

Figure 2.2: (a) Conformation of a template model (b) Onto a scanned data (c) The template after the conformation

d) Using 2D images from three mutually orthogonal views to fit a deformable model to approximate the different body size of subjects. The model then can be segmented to different body parts as the subject moves.

e) Using video cameras with stereo pair for the model acquisition of body part. A person's movements such as walking or raising arms are recorded to several video sequences and the program automatically extracts range information and tracks outline of body.

f) The extraction of body silhouettes from a number of 2D views (front, side and back) and the subsequent deformation of 3D template to fit the silhouette. The 3D views are then mapped as texture onto the deformed model to enhance realism (see Figure 2.3).

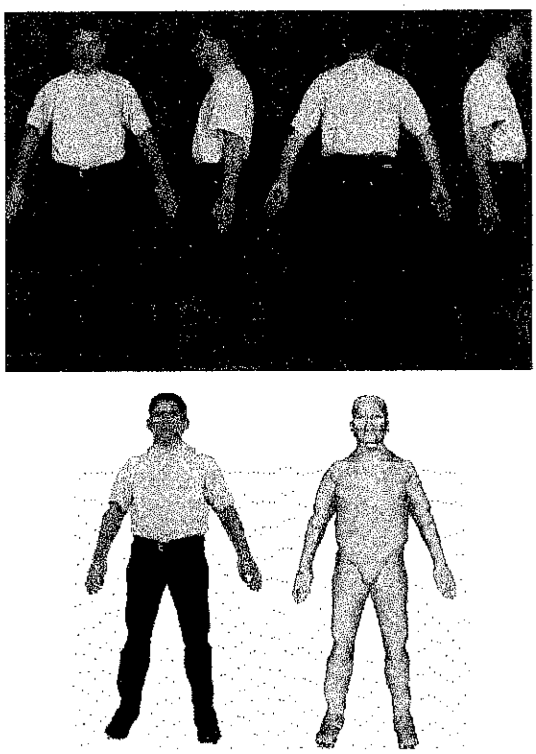


Figure 2.3: Image-based shape capture (up) Input images; (down) Reconstructed model

g) The feature-based approach where silhouette information from three orthogonal images is used to deform a generic model to produce personalized animatable model (see Figure 2.4).

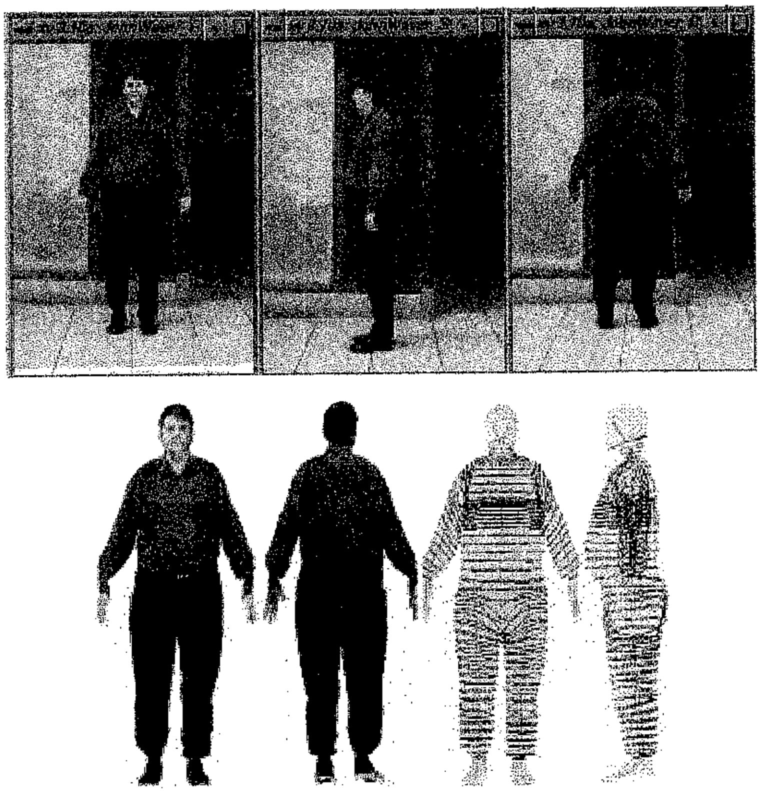


Figure 2.4: Image-based shape capture. (up) Input images; (down) Reconstructed model

2.2.2 Body regions

The main purpose of defining interest zones is to allow the user to select the part they are most interested in (see Figure 2.5).

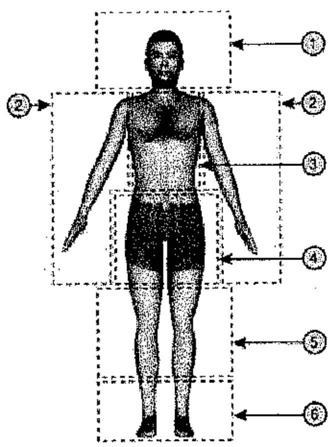


Figure 2.5: Body Interest Zones

For instance, if the virtual human is presenting a complete script on how to do cooking, but the user is only interested in listening to the presentation (and not at the motions), then the animation can be adapted to either the upper body, or even just the face and the shoulders. Another example would be the tourist guide, pointing at several locations such as theatres or parks, the user may only wish to focus on the arms and hands of the presenter (Giacomo et al.).

2.2.3 Static shape

A common problem in human modeling is how to systematically model the variety of human body shapes. In most cases, modifying existing model variously named as reference, generic or template tends to be popular due to the expenses of recovering 3D geometry. Automatically modifying shapes is desirable for at least two reasons. Firstly, it is often the case that we want to modify shapes to meet new needs or requirements. In a garment application, for example, the designer might want to create a 3D body model in a way that it satisfies a number of measurement constraints with a minimum user intervention, and in an interactive runtime setting. Secondly, automatic modification makes it easy to avoid redundancy in a crowd by blending of existing models, for instance (Thalmann et al., 2004).
There are several techniques that automate this task (Thalmann et al., 2004):

a) Anthropometric models

   Anthropometry, the biological science of human body measurement, systematically studies human variability in faces and bodies. Systematic collection of anthropometric measurements has made possible a variety of statistical investigations of groups of subjects, which provides useful information for the design of products such as clothing, footwear, safety equipment, furniture, vehicles and any other objects with which people interact.

b) Interpolation technique

The interpolation techniques or example-based approaches have been intensively used for parameterized motion blending to leverage existing motion data. This technique has applied in modeling a virtual human, the detailed explanation is on Chapter 3. The interpolation has several methods (P.Volino et al, 2004):

- The technique in generation of face models using a number of example face models obtained from image based capture, they have shown interactive blending results with control parameters such as gender and age.
- The other methods for interpolation is novel interpolation that start range scan data and use data interpolation to generate controllable diversity of appearance in human face and body models. Designer can manipulate an existing model according to changes in certain facial attribute using 'morphable face model' technique (see Figure 2.6).

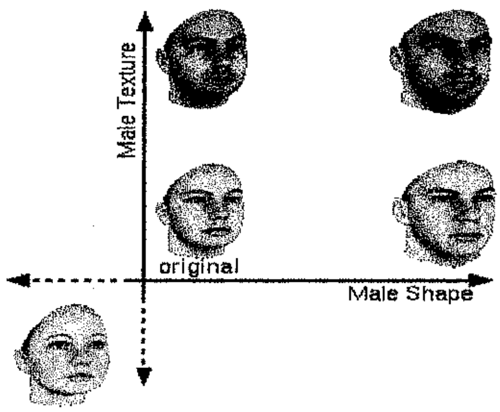


Figure 2.6: Manipulation of a face model by facial attributes

- The other automatic modeling is aimed at realistic human models whose size controllable by a number of anthropometric parameters (see Figure 2.7).

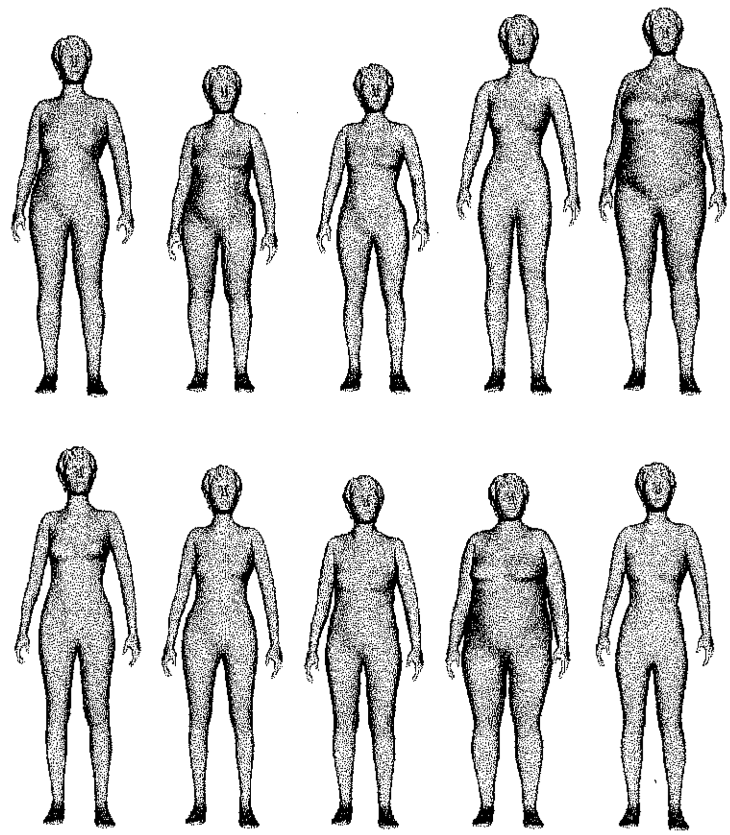


Figure 2.7: various body models generated by controlling sizing parameters.

- The modification of an individual model could be driven by statistics that are compiled from the example models (see Figure 2.7). Regression model are built upon the female scan database, using shape parameters like fat percentage as estimators, and each component of the body vector as response variables.

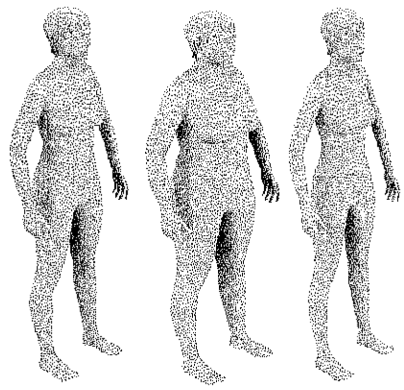


Figure 2.8: Variations of a body model according to fat percentage: (a) Original model; (b) Modification of the physique (fat percent 38%); (c) Medications of the physique (fat percent 22%).

- Manipulation several control parameters simultaneously, by learning a linear mapping from database models. Once the correspondence is established for all example models, a mapping function was found by solving for a mapping transformation that maps the body feature, such as height and weight (see Figure 2.9)

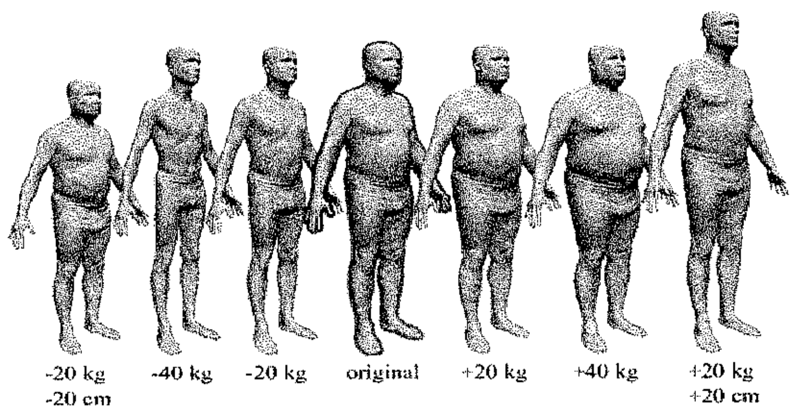


Figure 2.9: Variations of a body model by modifying the height and weight.

2.2.4 Generic bodies approach

The modification of an existing reference generic model tends to be popular to the expenses of recovering 3D geometry. Adding details or features to an existing generic model with increase the individualized shape and visual realism. Every single generic body corresponds to a different standard size: Extra Small, Small, Medium, Large, Extra Large (D.Protopsaltou et al., 2002).

2.2.5 Implicit surface

The body representation is based on 3 levels: skeleton, volume (muscles, fat and bones) and skin, as shown in Figure 2.10. The volume primitives are based on meatballs, a particular subset of implicit surface. An implicit surface is the set of points x = (x, y, z) ϵR^3 such that f(x) = 0. Implicit surfaces are typically defined by starting with simple building block function and then creating new implicit functions using the sum, minimum, or maximum of the simpler functions. They offer the opportunity of modeling and animating complex organic shapes at a fraction of the data points cost compared to more common patching techniques. The final object is constructed by blending the primitives, and as the primitives is moved and deformed the resulting blended surface changes shape. The volume primitives are categorized into two types: blendable volume which will blend with other blendable volumes in the same group; unblendable volume which will not blend with other primitives. A human body represented based on several parts. In each part, volume primitives are used to approximate the shape of internal structures which have observable effects on surface form. Each primitive is attached to its proximal joint, defined in the joint local coordinate system of the underlying skeleton. Each primitive is assigned to a group in accordance with the body part it contributes (P.Volino et al., 1996).

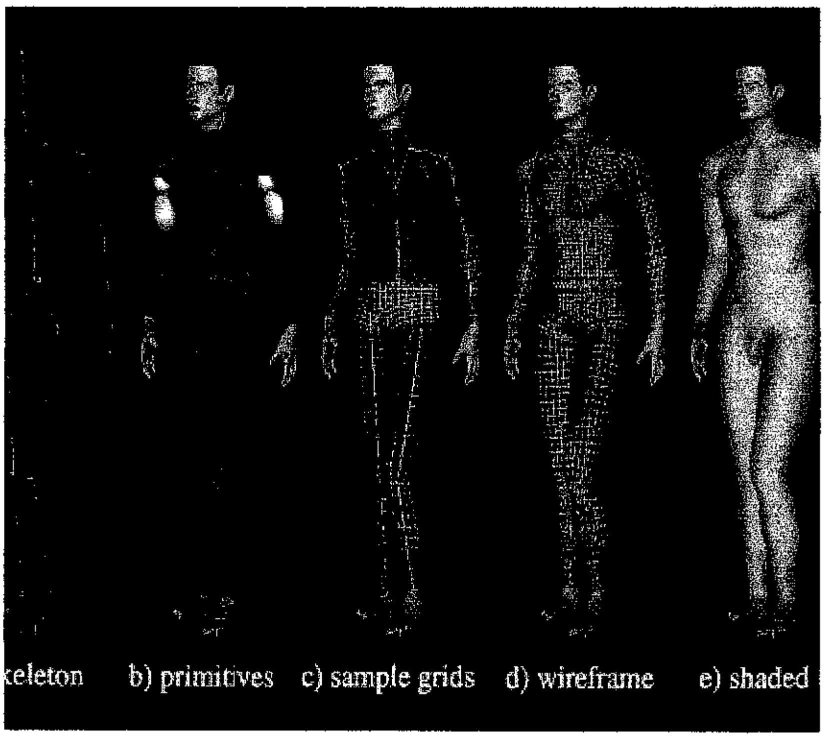
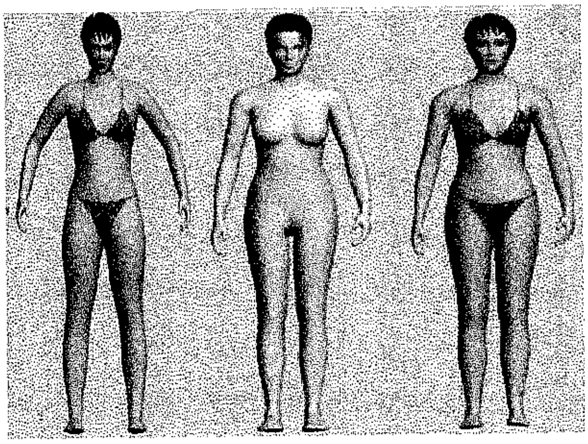


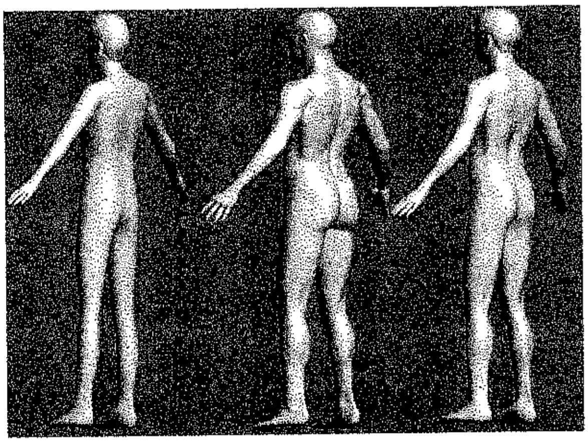
Figure 2.10: Layered human body model

2.2.6 Locating the joint centers

When applying different joint parameters during fitting the skeleton-driven deformation is used to calculate the new positions of the skin surface according to the transformation of the underlying skeleton. The most likely joint parameters, that is, scale, rotate, and translation of each bone in the hierarchy, are the ones that drive the template skin such that it best matches the *feature locations* that have been identified prior to mapping (see Figure 2.11) (Thalmann et al., 2004).



(a)



(b)

Figure 2.11: Modeler converts as well as estimates joint centers, by conforming previously worked models (left) to the target surface (middle). Results after the conversion are shown on the right.

2.2.7 Reusing the skin-to-bone data

When the body shape has been modified through displacement, the skin attachment data needs to be adapted accordingly so that the model retains smooth skin deformation capability. Generally, the deformed vertex location p is computed as

$$\mathrm{p} = \sum_{i=1}^{n} w_i M_i D_i^{-1} p_d$$

where M_i and w_i are the transformation matrix and influence weight of the *i-th* influencing bone, D_i is the transformation matrix of *i-th* influencing bone at the time of skin attachment and p_d is for each of its influencing bone (Thalmann et al., 2004).

2.3 Fast Skin Deformation

2.3.1 Skeleton-Driven Deformation

The skeleton-driven deformation is a classical method for the basic skin deformation. This technique widely used in 3D character animation.

This method works first by assigning a set of joints with weight to each vertex in the character. The location of a vertex is then calculated by a weighted combination of transformation of the influencing joints as shown on the equation:

$$P_v = \sum_i w_i \ (M_{i,C} \ . \ M^{-1}_{i,, Dress} \ . \ P_{Dress})$$

The skeletal makes use of an initial character pose, namely dress pose, where the transformation matrix of *i*th influencing joint, and the position of the vertex are defined. While this method provide fast results and is compact in memory; its drawbacks are the undesirable artifacts such as the "candy-wrapper" collapse effect around bending joints. The artifacts occur because vertices are transformed by linearly interpolated matrices. If the interpolated matrices are dissimilar, as in a rotation of nearly π radians, the interpolated transformation are degenerate, so the geometry must collapse". (Thalmann et al., 2004).

2.4 Body Animation

2.4.1 Motion control of Virtual Humans

Producing and interacting with virtual humans requires an interface and some model of how virtual human behaves in response to some external stimulus. Classifying computer animation scene involved synthetic actors according to the method of controlling motion and the kinds of actor interactions. Several methods exist for controlling synthetic actors' motion. As motion control becomes increasingly high level, it's appropriate to use a unique classification for virtual humans that include motion of the face and body (M.Cavazza et al.):

a) Pure Avatars or clones

   The virtual actors have a natural-looking body and face, and the animation correlate to the actual body and face. A popular way to animate the body uses sensors like the Ascension Flock of Birds or Polhemus Fastrack. The video sequence of the user's face may be continuously texture mapped on the virtual human's face. Users must be in front of the camera, so the camera captures the head ad shoulders, possibly with the rest of the body.

b) Guided actors

   Guided actors driven by users but do not correspond directly to the user's motion. These actors are also a type of avatar based on the concept of a real-time direct metaphor. Participants use input devices to update the virtual actor's position. These devices compute the incremental change in the actor position. This approach lets users choose from a set of menu-based predefined facial expressions or movements (animations), as shown in Figure 2.12.

Figure 2.12: Predefined expression

c) Autonomous actors

   Autonomous virtual humans should be able to demonstrate a behavior, which means they must have a manner of conducting themselves. Typically, the virtual human should perceive objects and other virtual humans in its environment through visual, tactile, and auditory virtual sensors. Based on the perceived information, the actors' behavioral mechanism will determine the actions they perform. Actors may simply evolve in their environment, interact with this environment, or communicate with other actors.

d) Interactive-perceptive actors

Interactive-perceptive actors can define as an 'actor aware of other actors is autonomous. Moreover, they can communicate interactively with other actors and real people. For communication between virtual actors, savior may also depend on the actors' emotional state. Facial emotions and speech may be coordinated between virtual actors. Nonverbal communication concerns postures and their indications of what people feel. Postures provide a means of communicating, defined arm and leg positions and body angles.

2.4.2 An Animation Interface Designed for Motion Capture

The role of performance animation is taking an increasingly important in multimedia applications and entertainment. With the rapid progress of Virtual Reality (VR) technology, the real-time motion control of synthetic actors becomes a major research direction in character animation. Real-time human motion control appeared essentially with the advent of magnetic sensor motion capture system. The real-time Anatomical Converter is a human motion capture technique converting magnetic sensor data in anatomical angles. The multi-joint is the method for the converter, to allow driving several joints using only one sensor. They identify the hardware Human Motion Capture techniques necessitate strong competences in Virtual Human modeling and animation as well as thorough knowledge of hardware and software pipelines to transform the raw data measured by the hardware into parameters suited for virtual models. An animation interface designed to conveniently control the motion capture (Tom Molet, et al). These consist of:

a) Hardware

The VR devices used to capture motion directly from a real human to whom the magnetic sensors are attached, The Flock of Birds from Ascension Technology Ltd. and two Cybergloves from Virtual Technologies Ltd. The Flock of Birds contains an Emitter and many Receivers.

b) Anatomical Converter

The Anatomical Converter is an animation designed to conveniently control the motion capture process. It is a toolkit to convert magnetic sensor data in anatomical angles. The converter consists of a new method, the multi-joint control, allowing driving several joints using only one sensor. Special care is made for convenient user/software interaction in the motion capture process. The hand and fingers motions are tracked with a data glove for hand gesture analysis. The self-seeing metaphor allows the performator to control the viewpoint location and to see the results of his/her movements mapped on the synthetic actor using a head mounted display (HMD). The anatomical converter derives the angle values the angle values from the sensor's information to set joints pf a fixed topology hierarchy (the virtual human skeleton). The virtual skeleton is the hierarchical model compromising a total of thirty two joints corresponding to seventy four degree of freedoms. Figure 2.13 gives a general view of the converter module and the related software and hardware components.

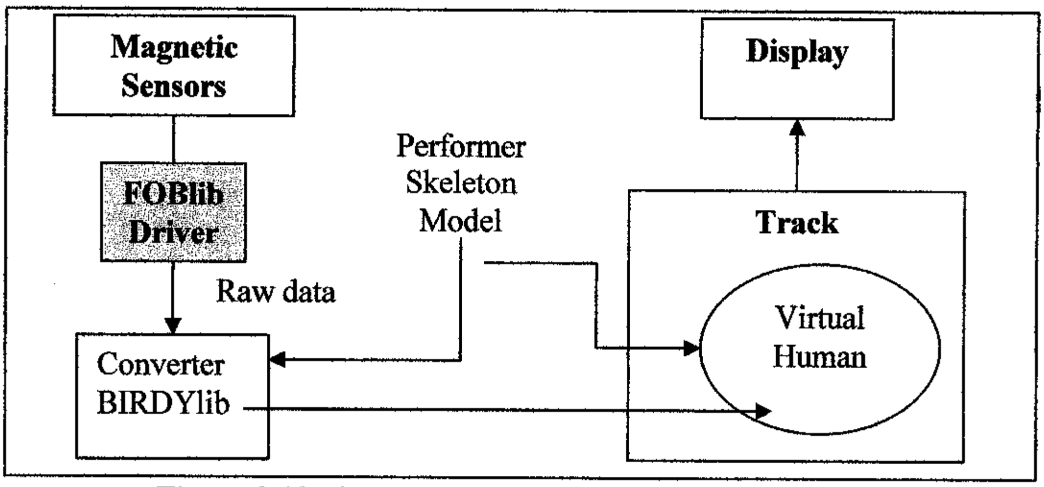


Figure 2.13: Converter library and related modules

The converter has three important stages: skeleton calibration, sensor calibration and real-time conversion.

a) Multi-joint converter

The technique used to control several human joints using a single sensor. The method has been initially created to permit the tracking of the ankle joint. In the virtual model, the ankle is composed, for accuracy regarding human anatomy, of two independent DOFs separated by a free transformation.

2.4.3 Direct Kinematics

Keyframe animation consists of the automatic generation of intermediate frames, called in-betweens, based on a set of keyframes supplied by the animator. There are two fundamental approaches to keyframe (Zhiyong Huang, 96):

:

a) The in-betweens are obtained by shape interpolation. This technique is introduced by Burtnyk and Wein. It plays a major role in film production and has been improved continuously by using more and more sophisticated mathematical tools. There is a serious problem for the image-based keyframe: the motion can be distorted due to the interpolation.

b) A way of producing better images is to interpolate parameters of the model of the object itself. This technique is called parametric keyframe animation. The parameters are normally spatial parameters, physical parameters and visualization parameters that decide the models' behavior.

Parametric keyframe animation is considered as a direct kinematics method in motion control when the interpolated parameters are defined in Joint Space of the articulated figure. Efficient and numerically well behaving methods exist for the transformation of position and velocity from Joint Space to Cartesian Space. Spline curves are used for keyframe interpolation. The term spline comes from a familiar drafting tool used in several industries. It is a thin elastic lath used to draw a smooth curve through a set of given points as in interpolation. Splines can be described mathematically as piecewise approximations of cubic polynomial functions. For animation, the most interesting splines are cardinal splines, Catmull-Rom splines and Kochanek-Bartel splines (Zhiyong Huang, 96).

2.4.4 Inverse Kinematics

Inverse kinematics is the opposite of the direct kinematics. Its problem is the determination of the joint variables given the position and the orientation of the end of the manipulator, or end effector with respect to the reference coordinate system. Inverse kinematics is an important subject in Robotics. It can be solved by various methods, such as inverse transform, screw algebra, dual matrices dual quaternian, iterative and geometric approaches (Zhiyong Huang, 96). This technique is used in the development of virtual human animation is discussed on Chapter 3.

An end effector location depends on the current state of the joint parameters. The set of non-linear equations establishing the end effector location as a function of the joint state is called the direct geometric model in Robotics. Inverting it is possible if the dimensions of Joint Space and Cartesian Space are the same. However, a general articulated structure may contain more degree of freedom in Joint Space which are highly redundant in accomplishing tasks. The inversion is not always possible. The solution is the first order approximation of the system: to linearize the direct geometric model. As a consequence of the linearization, the solution's validity of inverse kinematics is limited to the neighborhood of the current state and, as such, any desired motion has to comply with the hypothesis of small movements. The position and orientation vector of the end effector in Cartesian space is called main task (or behavior). If its dimension m (usually six: three rotations and three translations) is less than the dimension n of the Joint space, the (n-m) vectors in Joint space are projected to the null vector in Cartesian space by the linear transformation J. They do not modify the achievement of the main task. The (n-m) vector in Cartesian space is called secondary task (or behavior) (Zhiyong Huang, 96).

2.4.5 Forward Dynamic

For the direct and inverse kinematics, the solution is to find the position and orientation of the structure without regard to the forces and torques that cause the motion. On the other hand, forward dynamics takes forces and torques directly into the mechanics equation to calculate the spatial parameters of the articulated figure: position, velocity and acceleration, and uses them to update the structure at each time step. The forward dynamics belongs to physics-based modeling which is extensively used in computer graphics. Using forward dynamics, the obtained motion is realistic and conforms to the laws of physics (Zhiyong Huang, 96).

2.4.6 Dynamic Control

An important issue that arises in forward dynamics is how to control the model. Mathematically, forward dynamics translates into differential equations, which are typically posed as an initial-value problem; the user has little control other than setting up the initial configuration. This is exactly opposite to keyframes where the animator has the full control. Control of physics-based models remains an open research issue (Zhiyong Huang, 96).

A common and effective approach is to use constraint-based techniques, which allow users to specify required values for various properties of the models. One typical achievement was proposed in. The most interesting result is that the kinematic constraints permit traditional keyframe animation systems to be embedded within a dynamic analysis. Joint limit constraints are also handled correctly through kinematic constraints. A kinematic constraint consists of an explicit specification for the acceleration of some Degree of Freedoms during the current time increment, thus removing an unknown degree of freedom from the system. Within the context of mathematical formulation, a kinematic constraint consists of removing a row and column from the system of equations. Another well known work is the dynamic simulation and control scheme illustrated with a 3-D vehicle and a hopping one-legged robot. The forward dynamics based on Lagrange's formalism is developed for the complex articulated rigid objects representing the vehicle and robot. The result is compared to real measurements. Two classes of techniques are proposed. The first class is based on Proportional Integral Derivative control by constraints. It is an on-line control technique that allows the animator to interact with the animation evolution. The second class is based on optimal control where animator interaction is impossible (Zhiyong Huang, 96)

2.4.7 Procedural method

Procedural methods rely on the computer's ability to determine the kinematics based on implicit instructions rather than explicit positions. One class of procedural methods is "inverse kinematics" described above where the motion of end effector is specified by the animator, but the motion of interior links is computed algorithmically. Another typical work is walking [where a walking model is built from experimental data based on a wide range of normalized velocities. All spatial values of the model are normalized by the fundamental characteristic of the walk: the height of the thigh H t. It is the length between the flexing axis of the thigh and the foot sole whose average value is 53% of the total height of the human being. The animator only needs to define the general parameters, relative velocity, personification parameters or path curve. The walking sequence is algorithmically computed. The advantage of the procedural method is that it allows animator to control some types of specialized motion easily by specifying a few high level parameters, e.g., velocity of walking. The procedure can automatically control each degree of freedom. It is also realistic because of the use of the empirical equations. (Zhiyong Huang, 96).

2.4.8 Motion Capture

Motion capture is not a new motion control method compared to rotoscopy. It is the availability of the new VR devices that can more easily capture position and orientation in real time, e.g., Flock of Birds of Ascension Technology Ltd. and the CyberGlove of

Virtual Technologies Ltd. (see Figure 2.14). The Flock of Birds contains a Transmitter and many Receivers. The transmitter creates a magnetic field which is detectable by the surrounding environment. At the same time, the receivers, or sensors, receive the magnetic signal and send back to its electronic unit to calculate the receiver's position and orientation. Similarly, the glove is used to measure the flexion of the hand and relative positions of the fingers and inputs these data to the computer (Zhiyong Huang, 96).

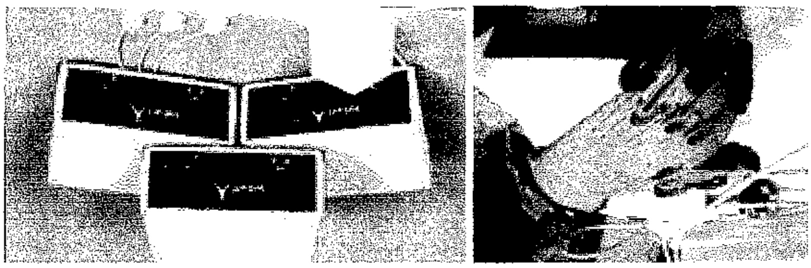


Figure 2.14: Flock of Birds of Ascension Technology Ltd., CyberGlove of Virtual Technologies Ltd.

To use a minimal number of 6-D sensors to capture full body standing postures, so, four sensors are used to create a good approximation of a human operator's position and posture, and map it on to the articulated computer graphics of a human model. Other joints are positioned by a fast inverse kinematics algorithm. The goal is to realistically recreate human postures while minimally encumbering the operator with sensor attachments. However, difference between the postures of the performer attached with six sensors and that of the resulting synthetic is clearly noticed (Zhiyong Huang, 96).

The Anatomical Converter is based on a very efficient method of capturing human motion after a simple calibration. The sensor data are converted into the anatomical rotations of a hierarchical representation of a body. Such a choice facilitates a wider use of the motion for other human models with the same proportions (Zhiyong Huang, 96).

2.4.9 Inverse Dynamic

Forward dynamics can produce physically realistic movement for the articulated figure. However, it is difficult to specify the input force and torque required for a desired movement. The force and torque are constantly changing in the simulation process. The inverse dynamics problem is to find at each joint the force and torque that generate the desired motion of the structure. It is a fundamental problem of robotics to get the force and torque for each DOF motor that drives the robot arm to perform a defined task. Various forms of motion equations for robot arm are derived mainly from Lagrange and Newton-Euler formulations. The motion equations are equivalent to each other in the sense that they describe the dynamic behavior of the same physical robot manipulator. However, the structure of these equations may differ as they are obtained for various reasons and purposes. Among many formulations, we select a kind of recursive formulation based on Newton-Euler equations for their computational efficiency. It is successfully used in robotics control. The greatest advantage is that the computation time is linearly proportional to the number of joints of the robot arm and independent of the robot arm configuration. It contains two opposing processes. The forward recursion process starts from the inertial coordinate frame to the end-effector coordinate frame to forward propagate kinematics information. The backward recursion process propagates the forces and moments exerted on each link from the opposite direction. (Zhiyong Huang, 96).

2.5 The character dressing

2.5.1 Animating Wrinkles on Clothes

Wrinkles add life to garments in fashion. Figure 2.15 illustrates how wrinkles are important for visual realism. In this section we outline the problem and the motivation behind the work. In order to capture realistic wrinkles on a real-life garment, from a mere geometric point of view, the number of triangles required can be easily up to a hundred thousand. Such a large number of triangles put cloth simulation off from interactive speeds, even with adaptive time steps, introduced recently. Apart from simulation time, the large triangle count increases the rendering time and the cost significantly. In order to avoid these, one can increase fineness of triangles only in the potential regions where wrinkling might occur. This is very well possible due to advances in the triangulation and interactive systems developed. Even then, a significant problem remains: how to estimate the regions and the orientations of wrinkles. Cloth has very large in-plane deformation stiffness compared to its ability to bend and shear. This gives rise to very stiff equations of motion. The problem of solving stiff equations is successfully dealt with by the use of an implicit method for numerical integration. Here, though the problem of stiff equations has been tackled, it has been the strong motivation for the authors behind developing the methodology specifically for wrinkles. (S.Hadap et al., 99).

Even if one wishes to have a fine triangular mesh, using robust and fast numerical solvers and having patience for long computations, it is not guaranteed that the wrinkles will be satisfactory. Accurate and fast collision detection methods, constraint methods and good deformable models have proved to give quality cloth animation. However, real-life wrinkling is a complex phenomenon. It is characterized by frictional forces (especially between body and cloth) which are difficult to model. Collision response methods and friction models developed so far have Figure 2.16: Wrinkles in fashion been rather simple for such a complex problem and robust numeric too. (S.Hadap et al., 99).

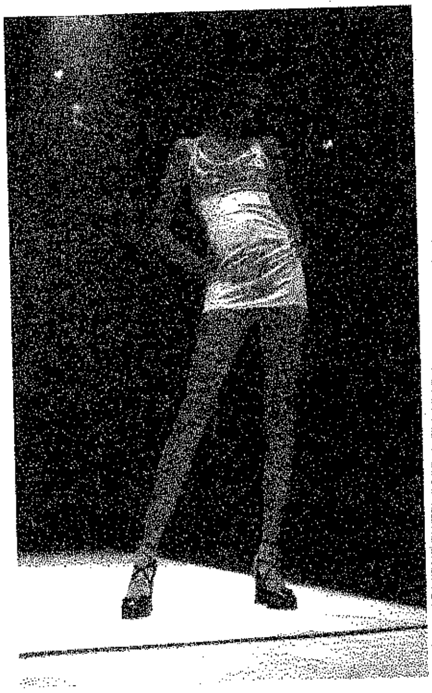


Figure 2.15: Wrinkles in fashion

- Animating cloth using coarse mesh
  We would like to animate the cloth using coarse triangular mesh (typically a few thousand triangles per garment), for the reasons mentioned in the Introduction. However, Figure 2.16 depicts how the geometry of coarse mesh would be unable to capture fine wrinkles on cloth.

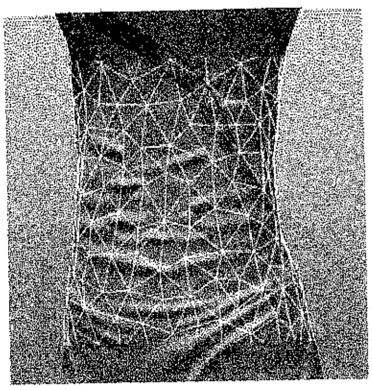


Figure 2.16: Wrinkles and coarse mesh

Real cloth has very little in-plane deformation as most of the deformations come from buckling. For the coarse mesh, setting high metric (in-plane deformation) stiff nesses will not work properly. For the vivid picture of the situation, refer to the triangles undergoing deformations in Figure 2.17A. Real cloth would wrinkle to this deformation (see typical wrinkles in Figure 3A). Consider an edge of a triangle, as shown in Figure 2.17B. In reality, the compression forces will buckle the edge as shown by dotted line. As the bending stiffness of the cloth is small, the buckled edge exerts small forces on the vertices. However, in the coarse mesh situation, the buckled edge is approximated by a straight line between the vertices. Consequently, the real life buckling is attributed to the compression of the edge. If we assume a high metric stiffness associated to this compression, the corresponding forces on the vertices will be high. This is in contrast with real cloth situation. Thus, to animate the cloth realistically with a coarse mesh, we need to set small metric stiff nesses. This allows otherwise possible wrinkling/buckling which is embedded in the deformation of triangle. Very little in-plane deformations can be looked at as area conservation property of cloth (S.Hadap et al., 99).

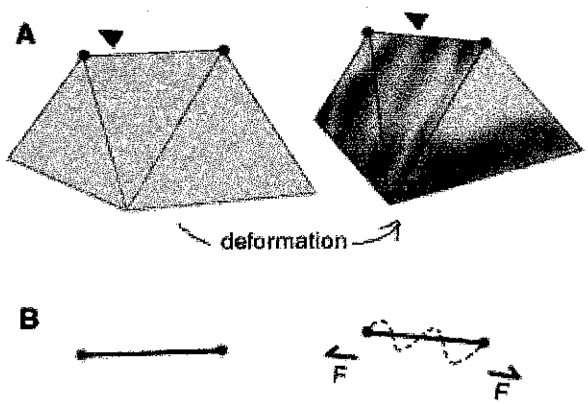


Figure 2.17: Large triangle deformation due to buckling

2.5.2 Collision management

Collisions are widely spread within all the simulated cloth, either being in contact with the body, or through contact between the wrinkles of the cloth. Thus, an efficient way of handling these numerous collisions is required. Instead of considering collisions as being dynamic "potential walls" repelling the considered objects using high and discontinuous forces, thus requiring very small time steps for precise computation, collisions are rather taken into account in a separate step as a geometrical and cinematical constraint resolution independent from the mechanical computation resulting from "continuous" forces, such as elasticity, and gravity and wind, as described above. The computation time step is in this way not altered by collisions, and the computation remains efficient despite a huge number of collisions. As soon as two elements collide, momentum transfer is performed according to the mechanical conservation laws, and taking into account bouncing and friction effects. All the collisions are processed independently in this way, during one single and common time step. Whenever elements are involved in several collisions, such as multilayer cloth, collision response is performed iteratively until all the collision constraints are resolved. This technique also allows propagation of the collision effect through the different layers of a cloth stack. Compressible viscoplasticity has been added to the collision response model, not only for simulating accurately multilayer compressibility, but also for ensuring good stability of the model in these situations. (S.Hadap et al., 99)

- **Collision detection**

  Collision and particularly self-collision detection is often the bottleneck of simulation applications in terms of calculation time, because of the scene complexity that involves a huge number of geometrical tests for determining which elements are colliding (see Figure 2.18). Depending of the way the cloth object is represented, different techniques have been developed for solving efficiently the collision detection problem, using methods based on space subdivision such as voxelisation or octree or hierarchisation, rasterisation, shortest distance tracking, or mathematical techniques suited to curved parametrical surfaces. In our case, the problem is complicated further because we are handling discretised surfaces that may contain thousands of polygons. Considering the clothing problem where garments are widely in contact with the body, collisions are not sparse at all and should be detected efficiently and accurately. Furthermore, because of all wrinkles and possible contacts between different parts of the same cloth, we have to efficiently detect self-collisions within the surfaces. This prevents the use of standard bounding box algorithms because potentially colliding regions of a surface are always touching each other by adjacency. We have developed a very efficient algorithm for handling this situation. This algorithm is based on hierarchisation and takes advantage of the adjacency which, combined with a surface curvature criteria, lets us skip large regular regions from the self-collision detection. We then get a collision evaluation time that is roughly proportional to the number of colliding elements, and independent of the total number of elements that compose our deforming surfaces (Thalmann et al., 98).

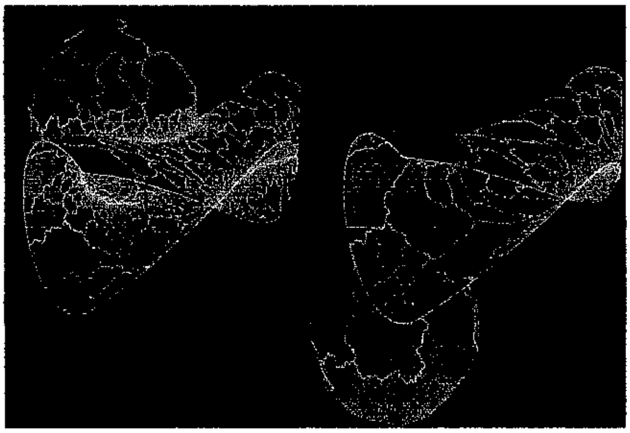


Figure 2.18: Hierarchical collision and self-collision detection using surface curvature.

This algorithm is very general and is able to deal efficiently with crumpling situations. However, the cloth often is supported by the body or other underlying cloth by contact regions involving big surfaces, and displacement between each frame remains quite small. Efficient optimizations for speed and robustness may be included in the detection algorithm. The main optimizations concern remnant collisions that are kept in memory even if they are not detected for a given number of frames, in order to ensure correct tracking of their orientations. This is linked to an incremental collision detection scheme, which tracks displacements and surface proximities, updating existing collisions between the frames and detecting new neighboring collisions. The most important feature is also orientation consistency checking and correction, which identifies collision regions and performs a statistical evaluation in order to correct wrongly oriented collisions. These solutions have been experimented successfully in difficult situations involving crumpling cloth, and they handle in a robust way situations involving multilayer garments (Thalmann et al., 96). The collision detection is used in implemented cloth animation, detailed explanation in Chapter 3.

2.5.3 Organizing the model in the H-Anim structure

The H-Anim which is standard for character representation and thus both the skeleton and the motion data have to be converted promptly. They explained the process which is "a body model that is represented by a polygonal mesh, which can be animated using skeletal deformation. The first step in body model preparation is to define the attachment of the skin surface to the joints of a skeleton, i.e. which vertex is influenced by which joint. In our current implementation, this is done using an external application. This attachment information is later used for skeletal deformation. Next, the skin mesh is segmented using the weight values defined in the attachment information. Each triangle belongs to the joint corresponding to the highest weight. During the segmentation, vertices that are located along the segment boundaries are duplicated. Needless to say, those duplicated share the same attachment information. Finally, each segment is attached to the corresponding joint in the H-Anim skeleton. The result is an H-Anim compliant human body model. During the animation, the movement of vertices that belong to a single joint is not calculated but automatically moved as they are attached to their corresponding joint. In this way, the computation is reduced to only those vertices that have two or more influencing joints, making the deformation much faster. Duplicated vertices that are on the boundaries have the same position as well as vertex normal. Subsequently, the boundaries among segments are rendered smoothly and the segmented mesh appears as a seamless body model in the rendering view port. This method combines the speed of the deformation of segmented bodies and the visual quality of seamless bodies (Thalmann et al., 2004).

2.6 Implementation detail

2.6.1 Body Manager

CG artists use authoring tools to provide the content of real-time simulations: virtual human models, objects in the scene, motion data, and many more. In their work, this modeling for creating virtual humans is partially based on a commercial graphics package, taking advantage of a broad range of features offered while avoiding redundant developments. According to them, a handful of plug-ins have been developed, are listed in Table 2.1. It is an implementation of all functionalities that are required to transform virtual human modeling to the contents of real-time applications. As a result, the user can avoid repetitive tasks and profit from the seamless integration of heterogeneous tools throughout the pipeline. (Thalmann et al., 2004).

Table 2.1: List of Plug-ins comprising the Body Manager package.

Plug-in Name	Plug-in Type	Description
FastSkin	Modifier	Performs skeleton-driven deformation using the imported attachment data from *BonesPro.*
Feature Points	Modifier	Assists users to identify feature points and contours on a geometric mesh object of *EditMesh* type.
ScanFitter	Utility	Based on the feature points defined by the *FeaturePoints* modifier and on the skeleton-driven deformation by the *FastSkin* modifier, *ScanFilte*r finds the global proportion and posture of the template model that best fits the target (scan) body model.
Offset Deformer	Modifier	When used after that ScanFitter, Offset Deformer captures the fine detail of the target scan model and

		save it as displacement map.
Quad/Tri Rearrange	Modifier	Reorganizes the vertex coordinate of geometric object of *EditMesh* type such that the quadratic elements precede triangular ones. It is primarily designed to separate and/or modify the head, hands and the feet parts from the body.
Body Manager	Utility	Offers various functionalities to convert and export body models into *H-Anim* structure standards. Also offered are the motion data import, export and conversion tools.
Spline Surface	Modifier	Performs Bezier subdivision on the target geometric object of *QuatPatch* type.
Shape Interpolator	Utility	Implements the *Modeling Synthesizer* and *Modifier Synthesizer* described in this dissertation.

2.6.2 Workflow

The pipeline of the production comprises four steps (Thalmann et al., 2004).:

1. Skeleton hierarchy is constructed.
2. The creation of the motion data.
3. Attaching the skin surface.
4. Modeling and the pre-processing of the clothes.

The overview of the production has shown in the Figure 2.19.

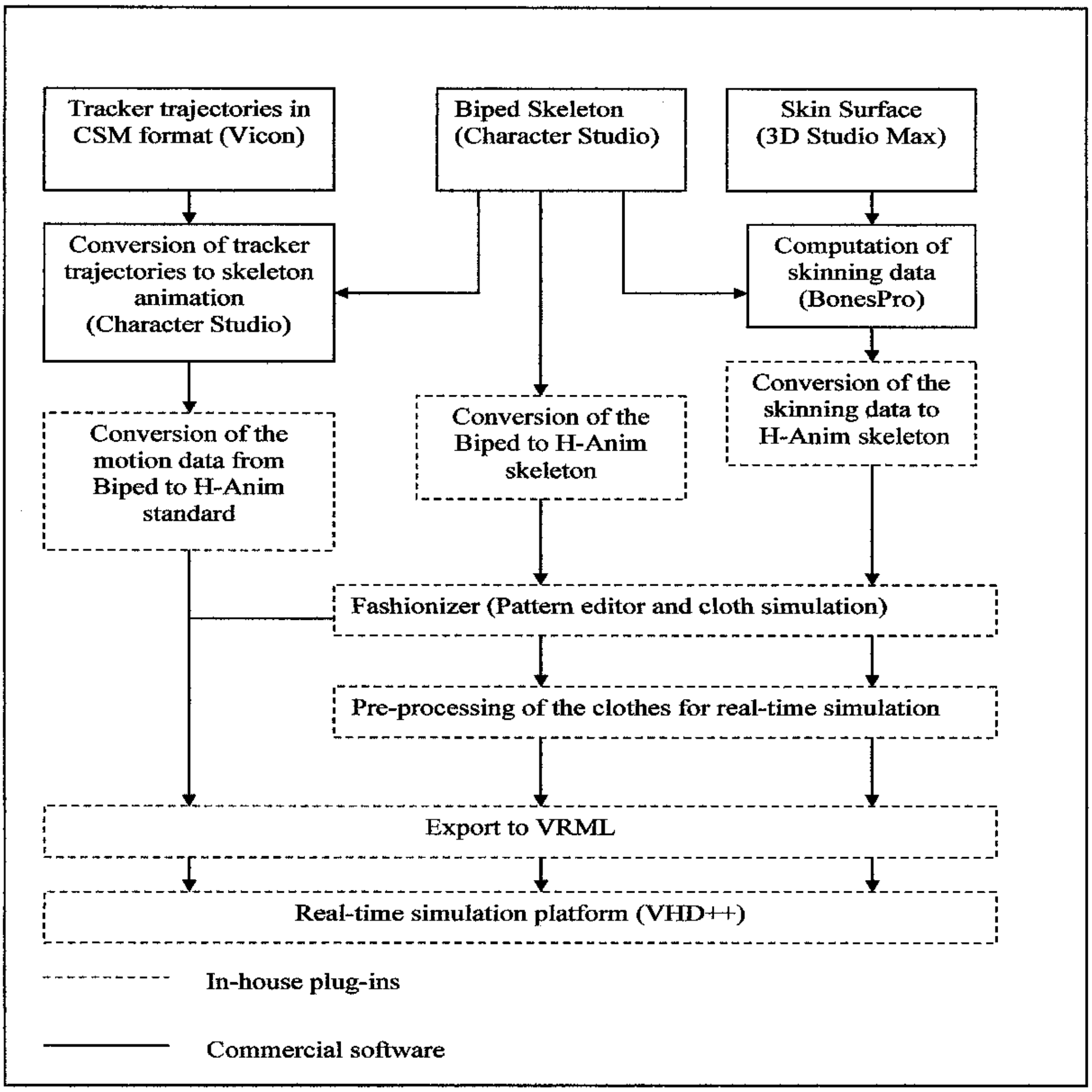


Figure 2.19: Overview of the production pipeline.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The management of this project has done systematically which is phase by phase. The methodology in manage this project is similar with System Development Life Cycle (SDLC) as shown in Figure 3.1. Using this methodology can go back at the previous phase. Especially, when in the phase need to make a modification or changes, so this needs to look at the previous phase. The first phase is conduct a research and analysis about the project. In this phase the research information about the project is gathered from the journal, books and website. During this phase preliminary report and literature review document is prepared that gives an idea about virtual batik fashion show, modeling and animating the virtual human. This important to gathered and understand information about the techniques that have used previously by virtual reality designer and animator because need to analyze and choose the best techniques. In development phase moves to the development of modeling and animating the model using the techniques have been identified at the research and analysis phase. The evaluation phase focused on evaluation from users toward the application. The details of the process and procedure are discussed below.

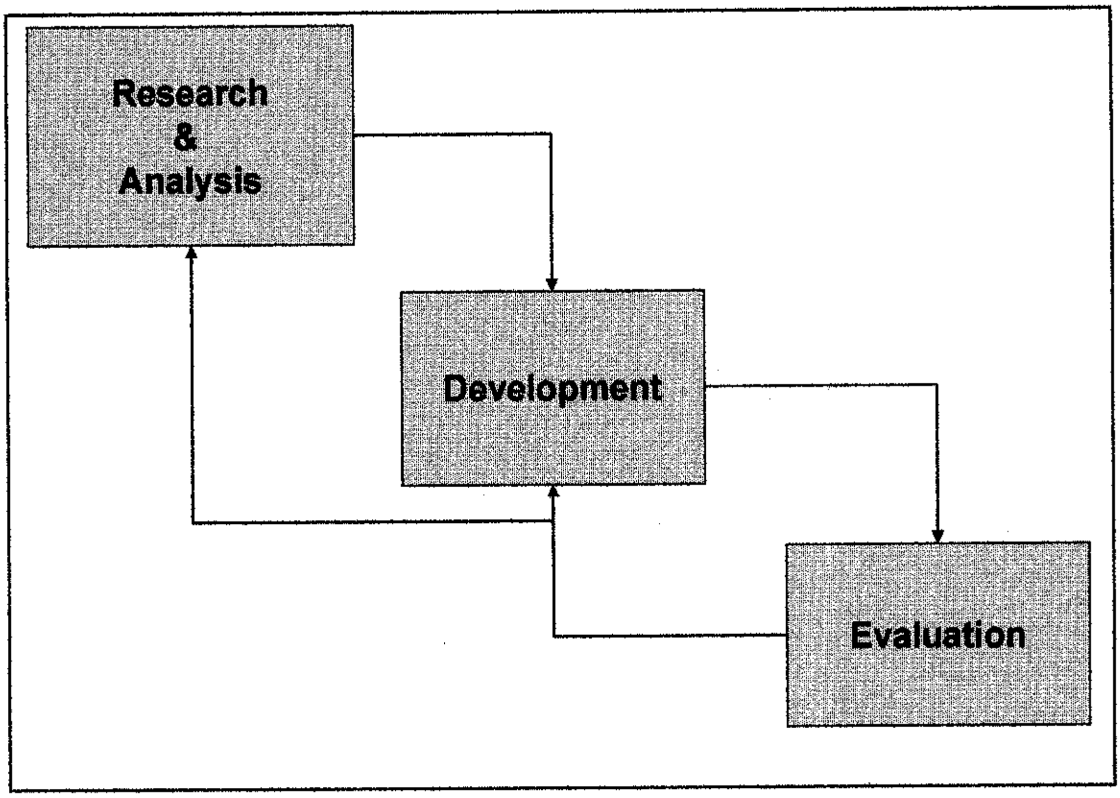


Figure 3.1: Phases of Project

3.2 Research and Analysis

The first phase is research and analysis about the project title. This phase is important as the initial stage of the project. The flow of this project is being planned for make sure it runs smoothly. The main concerns of this phase are to make a research and analyze the project.

3.2.1 Research

In this stage the project title is studied thoroughly to identify the problems on the subject of animating virtual human for virtual batik modeling area and defining the scope and objectives of this project. Through these studies the ideas and overview regarding the project requirement become clear. During this stage the area wills being focused on the project is identified. The focused areas are the virtual model animation which is able to walk with wear batik cloth, and the cloth responds to movement during an animation.

Research regarding the appropriate 3D software, modeling and animating virtual human are made based on the relevant information, which is discussion with lecturer, journals, books, and website. The appropriate 3D software is found like Poser®, 3D Studio Max™, and MAYA™. In modeling the research concerning the human modeling methodologies, the methodologies are found and can be classified into three major categories: creative, reconstructive, and interpolated. Meanwhile, the animating focused on virtual human animation techniques. The techniques are found such as direct kinematics, inverse kinematics, forward dynamic, dynamic control, procedural method, and motion capture.

3.2.2 Analysis

In analysis stage is to analyze the necessary information in achieve the project objective. The human modeling methodology chosen is interpolated. The suitable software to construct virtual human animation is Poser® 6.0. Poser® 6.0 is powerful in term of virtual human animation. There are many kinds of techniques found through the research; the useful technique is being chosen. The techniques are direct kinematics, and inverse kinematics.

3.3 Development

The second phase is development stage. In this stage the focused are on the creation of model, cloth and, props, and animation of virtual human and cloth. The main concern of this phase is to create and animate virtual human and cloth. This phase is the most time consuming as it involves a learning process and understanding of each technique applied in modeling and animating. The software used in develops the models, cloth, and props are Poser. In this phase there a re 5 stages and it is described below.

3.3.1 Modeling the virtual human

The virtual human body is taken from Poser® 6.0 (see Figure 3.2). The model is taken from the software because the considerable amount of work. The category of human body modeling methodologies used is interpolated modeling.

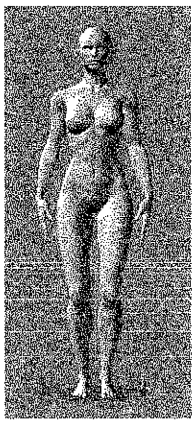


Figure 3.2: Virtual Human Body

The model consist of boned, which essential in skeleton-driven deformation technique (see Figure 3.3). This skeleton is to deform the skin of the model, which enhance realism of skin when the model walking. So, when models moving the skin deform based on skeleton or boned structure movement.

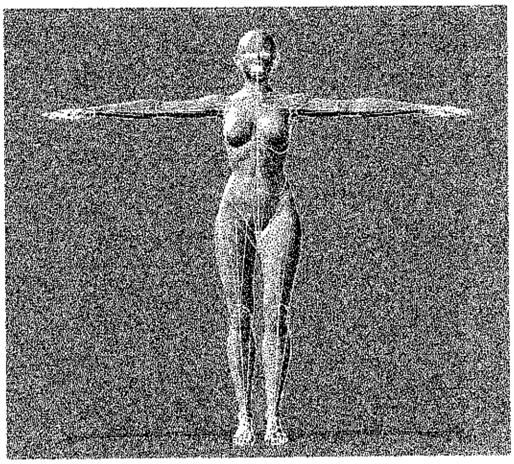


Figure 3.3: The boned components

The interpolation provides a way to leverage existing models to generate new ones with a high level of control in an interactive time. Through interpolation technique there are some modification have been made on face and body of the virtual human attributes, which is parameterized motion blending to leverage existing motion data. For the virtual human face the manipulation in term of facial attributes which are facial morphs, and ethnicity, gender, and age, (as in Figure 3.4). In the facial morphs, the attributes consists are brow ridge, cheekbones, cheeks, chin, eyes, face, forehead, jaw, mouth, nose, temples and ears.

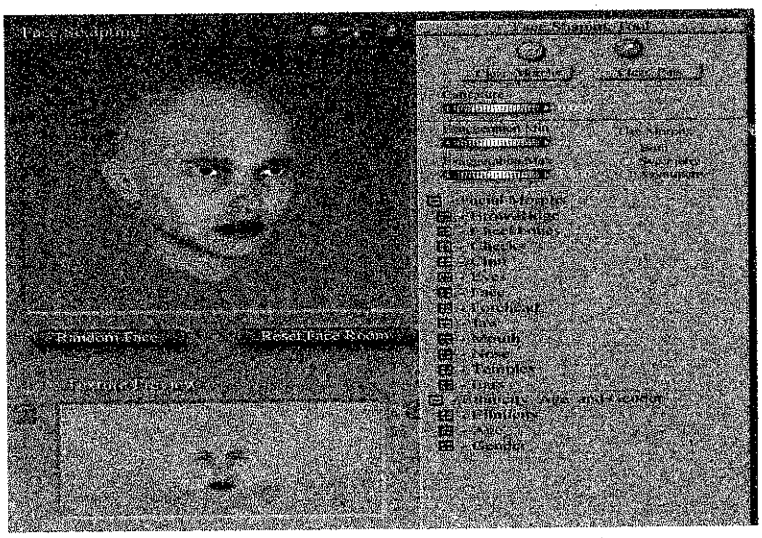


Figure 3.4: Manipulation of facial attributes

Meanwhile, for human body modification is by controlling the sizing parameters. The sizing parameters of the body part like abdomen, chest, hands, legs, hip, and so on (see Figure 3.5).

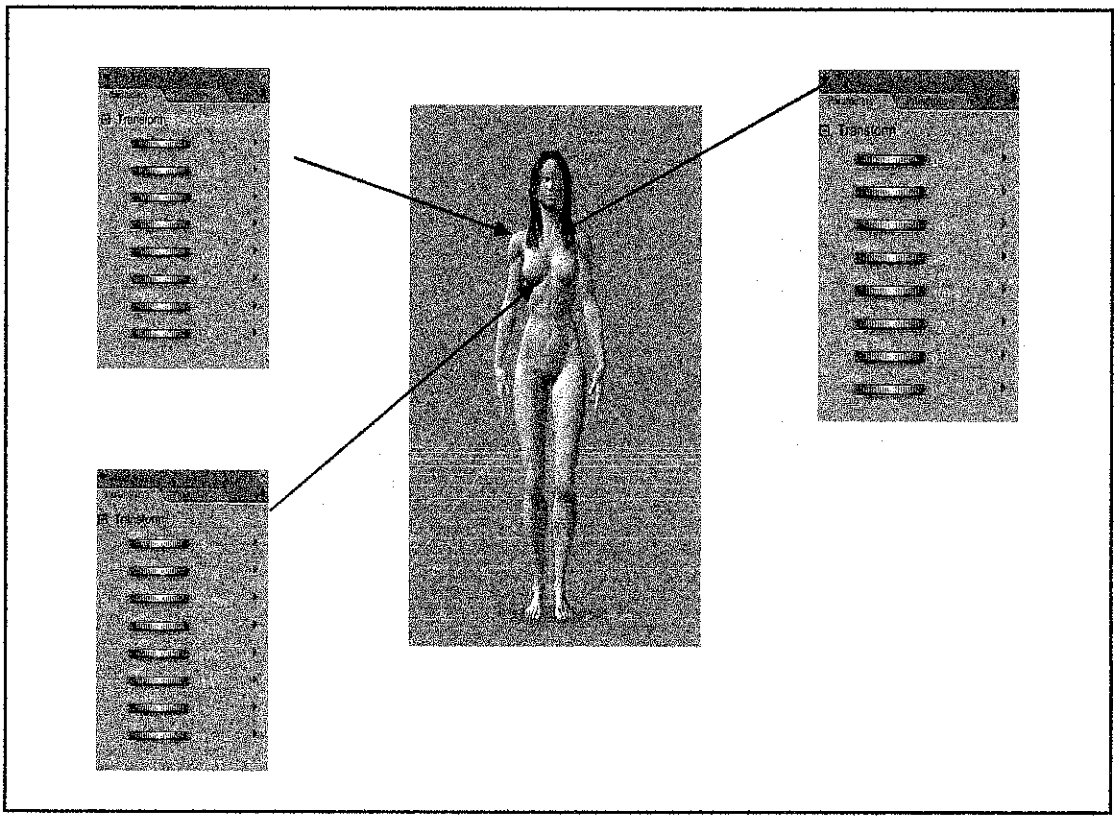


Figure 3.5: Example of the sizing parameters body parts

Two models have been modeled, each model wear a different clothes which textured with a different pattern (see Figure 3.6). This to show the batik patterns to user.

(a) (b)

Figure 3.6: The models (a) Model 1 (b) Model 2

3.3.2 Attaching cloth to the body

The cloth is also taken from the Poser 6 itself. To attach the cloth, it needs to be applied into the virtual human body. The cloth will directly position to the human body (see Figure 3.7).

Figure 3.7: The cloth attached to the body

The cloth not textured yet with batik pattern. Batik patterns are assigned to the cloth (see Figure 3.8).

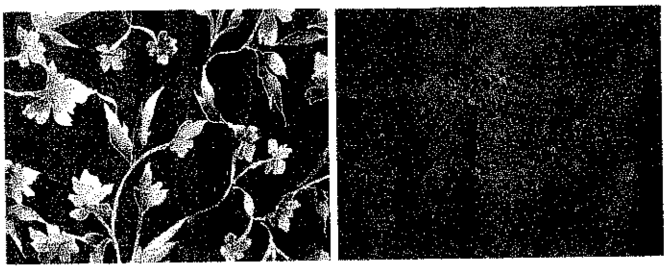


Figure 3.8: Two 'batik' patterns used to texture the cloths

The UV mapping technique is applied in textured the cloth. It is the best texturing technique, because it will produce higher realism of texture (see Figure 3.9).

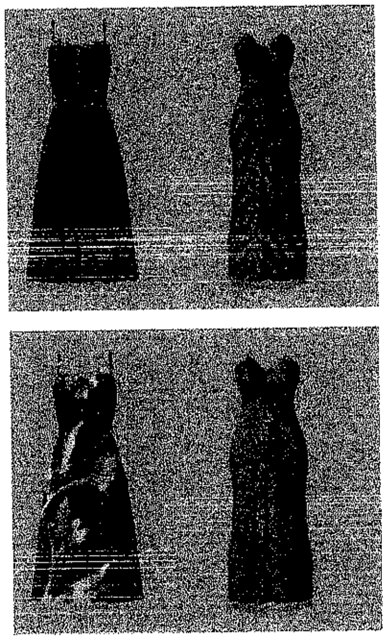


Figure 3.9: Cloth texture (up) The original textures (down) Textured with batik patterns

3.3.3 Developing the props

The props are divided into several parts which are west wall, east wall, south wall, ceiling, base, painting, and glass (see Figure 3.10). All the props are combined with arranged it based on x, y, and z axis coordination. The props coordination should accurate, in make sure it in exact position.

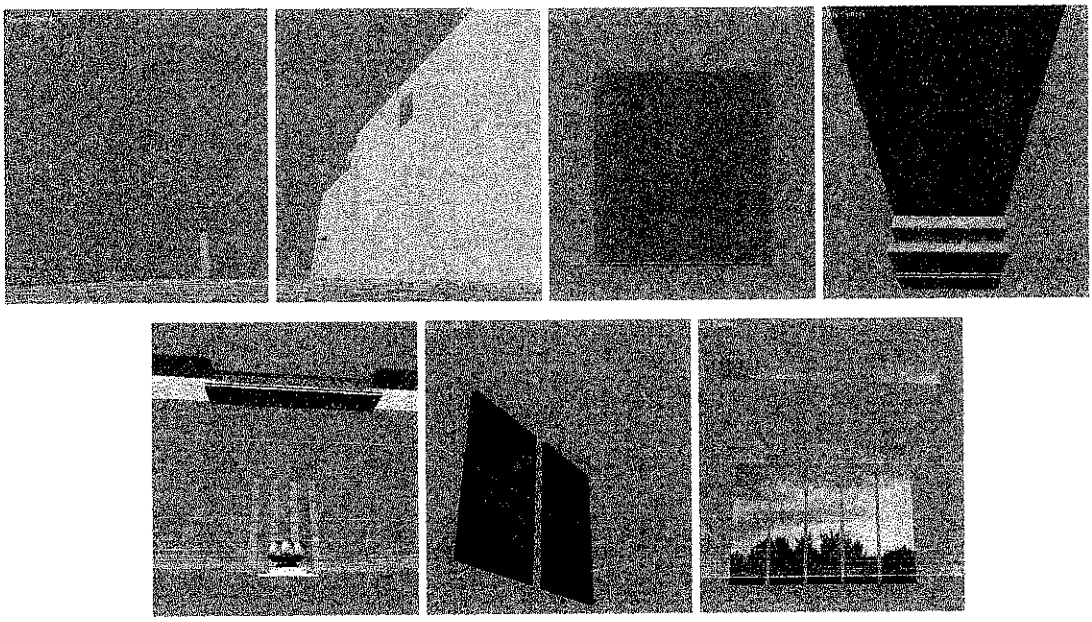


Figure 3.10: The props parts

Combination of all the props produces as a one scene, as in the Figure 3.11.

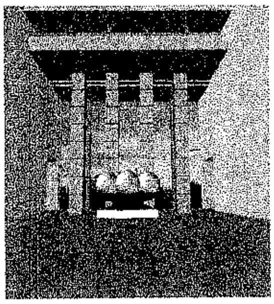


Figure 3.11: Combination of all the props

3.3.4 Animating the virtual human

The focus area in animate virtual human is walking. Before animate the models, path is created (see Figure 3.12).

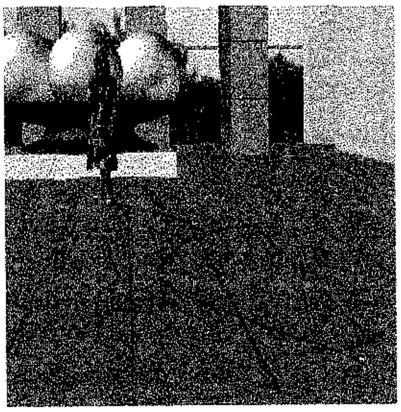


Figure 3.12: Walk path

After assign path into the scene, the modification has been made to the path (see Figure 3.13). This is for change to new direction of path. So, when walking the models follow the path.

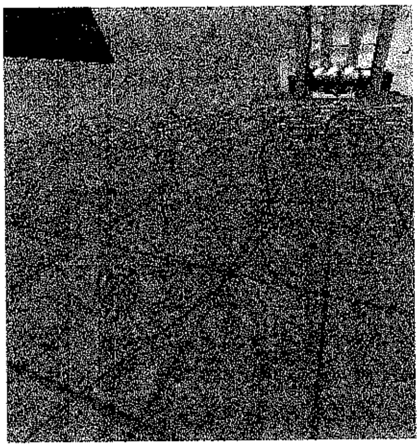


Figure 3.13: Modify walk path

In walking motion, several things are happening simultaneously, legs are in motion, joints are bending, arms are swinging, hip is swinging, and the torso might be bending or swaying from side to side. Direct Kinematics is applied by interpolate the parameters of the model object itself. In the key frame animation consist of the automatic generation of intermediate frames (see Figure 3.14).

Figure 3.14: Direct Kinematics

The automatic generation is used walk designer (see Figure 3.15).

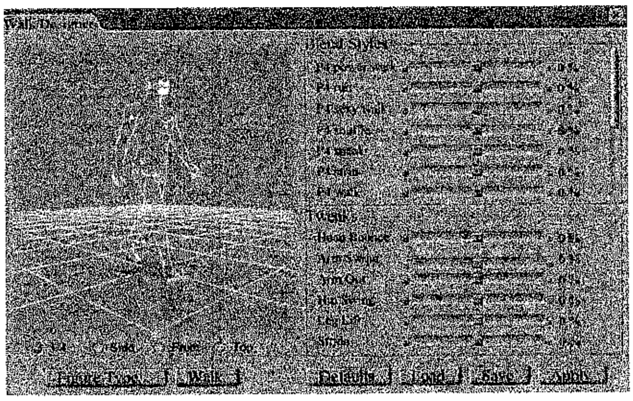


Figure 3.15: Walk designer options

In walk designer, the Blend Styles and Tweaks values is set. It consists of five different values: all the way down, halfway down, defaulted, halfway up, and the way up. The Blend Styles range from -200 to +200, while the Tweaks range from -100 to +100. The real magic of the Walk Designer comes when combining more than one Blend Style and Tweak. The parameters detail is shown Table 3.1.

Table 3.1 Parameter setting conditions for Blend Styles and Tweaks

Parameter Setting	All The Way Down	Halfway Down	Defaulted At Zero	Halfway Up	All The Way Up
BLEND STYLES					
Power Walk Used at positive values to give the targeted figure a more purposeful walk style.	Creates a jumbled chaotic walk style, so the figure looks out of appendage control.	Makes the movements look slightly out of control, as if the figure can't keep its mind on what its doing.	No Power Walk effect.	Lends a march-like quality to the walk, determined and precise movements.	Gives an excessive power stride, as that of a robot or giant who won't allow anything to stand in its way.
Run This setting differentiates between walks and runs.	Creates a whacky bouncing motion that can be seriously jumble appendages such as arms and hand positions.	Creates a skipping motion.	Creates a normalized walk.	Creates a bounding run, good for a fast race.	Creates a chaotic bouncy run, and can cause overlaps in arm-swing and positions.
Sexy Walk This lends a seductive appearance to the figure's movements.	Creates a "gimpy" walk, as if the figure has some problems controlling the sureness of its movements.	Creates a lazy walk, likened to someone walking down a country road in a very relaxed fashion.	Devoid of seductive content.	Creates a very natural sexy walk with a noticeable hip swing.	Creates a radical and almost cartoon-like sexy walk, with more his swing than the body can almost handle.

Table 3.1 Parameter setting conditions for Blend Styles and Tweaks(continued).

Parameter Setting	All The Way Down	Halfway Down	Defaulted At Zero	Halfway Up	All The Way Up
<u>BLEND STYLES</u> (continued)					
Shuffle A shuffle is defined as a walk with a relaxed attitude.	Creates a jumbled disorganized skip.	Creates an arrogant walk, as if the model were self satisfied beyond criticism.	No effect on the walk.	Creates a plodding, as if the figure were looking at the sidewalk and just ambling along.	Creates an erratic shuffle, making the figure look something is physically wrong with the legs.
Sneak Defined as a walk that remains unexpected when practiced.	Jumbles the entire upper body in a tangle.	Till pretty radical because it distorts other body parts.	No effect.	A caricature of a sneak, more like a New Orleans strut.	A cartoon struts, with the body bending back and forth radically at the hip.
Strut A strut is a display of pride, sometimes used to attract opposite sex to one's importance.	Creates a movement in the arms reminiscent of dancing.	Creates a strut that makes the arms look like they're swatting flies when the arms are extended outward.	No effect.	A real determined strut.	A strut that makes the arms look like they're shadow boxing.

Table 3.1 Parameter setting conditions for Blend Styles and Tweaks(continued).

Parameter Setting	All The Way Down	Halfway Down	Defaulted At Zero	Halfway Up	All The Way Up
TWEAKS					
Head Bounce The head bounces naturally to compensate for rhythmic impacts suffered by the lower body.	Makes the head shake violently, which would break the neck.	Creates a head bounce that makes the head shake as in signifying "yes".	No effect.	Reverse of -50%	Reverse of -100%
Arm Swing There is always arm swing in a walk, so this parameter setting just emphasizes it to various degrees.	Arm swing rather limpy.	Arm swing a little less limp.	No effect, normal arm swing.	Arms swing a little more purposefully.	Arm swing is very purposeful, as in a march.
Arm Out This parameter forces the arms away from or closer to the torso (definitely move the arms away from the torso in a walk if the model is heavy).	Arms crossed in front of chest for the entire walk.	Arms crossed in front of pelvis for the entire walk.	No effect.	Arms pushed away from the body, as if the model had very muscular arms.	Arms radically pushed away, forming a cross with the torso.

Table 3.1 Parameter setting conditions for Blend Styles and Tweaks(continued).

Parameter Setting	All The Way Down	Halfway Down	Defaulted At Zero	Halfway Up	All The Way Up
TWEAKS					
Hip Swing Used to emulate a seductive feminine walk.	Hips sway radically.	Moderate hip sway.	No movement	Hip sway opposite of -50%	Hip sway opposite of -100%
Leg Lift This parameter sets the height of the legs at their maximum.	Legs sort of slide along the ground.	Legs off the ground a little.	Normal height above ground during walk.	Legs lifted up noticeably.	Legs lifted off ground.
Stride This represents the distance covered with each step.	Walk in place.	Short stride.	Normal stride.	Above normal stride.	Very long stride.

The parameters have set up to animate the model have shown in the table below:

Table 3.2: Parameters Setting

Parameter Setting	Values Set Up
BLEND STYLES	
Poser Walk	Defaulted at zero
Run	Defaulted at zero
Sexy Walk	Halfway Up
Shuffle	Defaulted at zero
Sneak	Defaulted at zero
Strut	Halfway Up
TWEAKS	
Head Bounce	Defaulted at zero
Arm Swing	Defaulted at zero
Arm Out	Defaulted at zero
Hip Swing	Halfway Down
Leg Lift	Defaulted at zero
Stride	Defaulted at zero

When see the virtual human walking motion that designed by walk designer in details, the motion is not really smooth, so this need a modification. The virtual human walking animation consists of 500 frames. In improved the walking motion, the edition for each parts of body is made at every 500 frames. The edition each parts of body is based on the x, y, and z scale, and twist, bend, and side-by-side criterion. In Figure 3.16 shows the edition at the hand part.

(a) (b)

Figure 3.16: The edition on each hand points.

(a) Before the edition (b) After the edition

Inverse Kinematics (IK) is one of the familiar techniques used in virtual human animation. Kinematics refers to the movement of chained elements. The human body is concerned are the links between shoulder, upper arm, lower arm, and hand, or that between the thigh, shin, and foot. With IK enabled for lib, the end elements higher in the chain are moved and rotated. IK set up dependencies between parts of a figure to simulate more realistic movement. The IK technique is applied in this walking animation which to increase the realism of motion (see Figure 3.17).

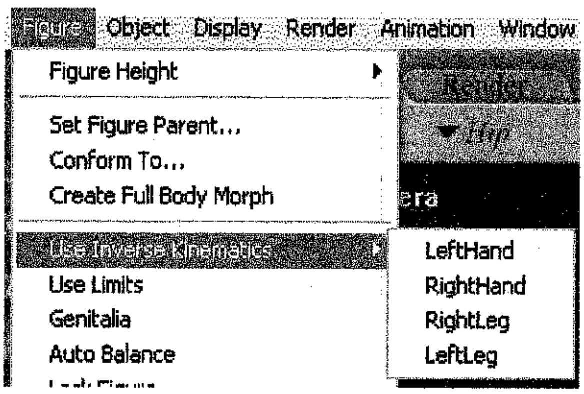


Figure 3.17: Applied Inverse Kinematics

The body part have applied with IK are the left hand, right hand, left leg, and right leg. The IK of that body parts is coded using Phtyon Script.

Left leg:

ikChain LeftLeg lThigh lShin lAnkle lFoot

Chain Name

Right leg:

ikChain RightLeg rThigh rShin rAnkle

Chain Name

Right hand:

ikChain RightHand RightForearm RightShoulder RightCollar

Chain Name

Left hand:

ikChain LeftHand LeftForearm LeftShoulder LeftCollar

Chain Name

Using IK, it will make an inversion of the related body part movement and the parts links with it (see Figure 3.18).

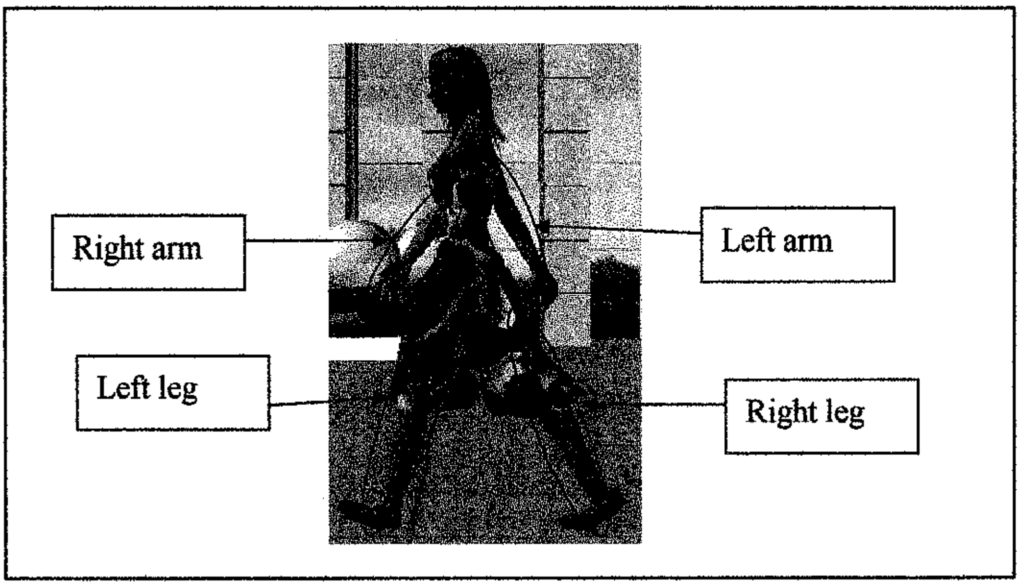


Figure 3.18: Inverse Kinematics parts

3.3.5 Mapping and animating the cloth

When applied the walking motion, the cloth doesn't map exactly with body. It doesn't map because it is not in the correct position (see Figure 3.19).

Figure 3.19: Cloth not exactly map with body

To map the cloth exactly to the body and animate the cloth is by simulate it. To simulate cloth the new simulation is created as shown in the Figure 3.20.

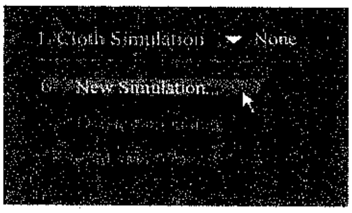


Figure 3.20: New Simulation

The simulation settings box will appear (shown in Figure 3.21), for simulation range the values for start frame set to 1 and end frame set to 500, this because it consist 500 frames. Meanwhile, for cloth draping, the drape frames set to 20. This setting adds twenty frames before the animation begins, to drapes the dress naturally on the character before dynamic calculations start.

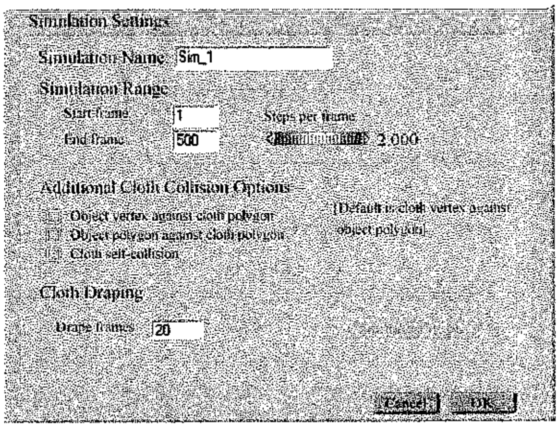


Figure 3.21: Simulation Settings

After create a simulation, the next step is to turn prop into a cloth object. So, the dress is clothify (shown in Figure 3.22).

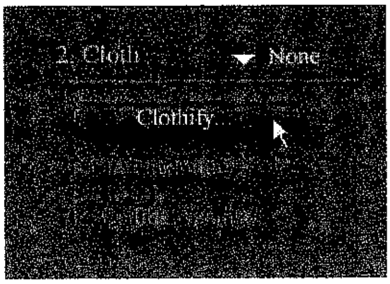


Figure 3.22: Clothify

When click the clothify button, the Clothify box opens as shown Figure 3.23, expands a pop-up menu, then the dress prop is selected. This turns the prop into cloth.

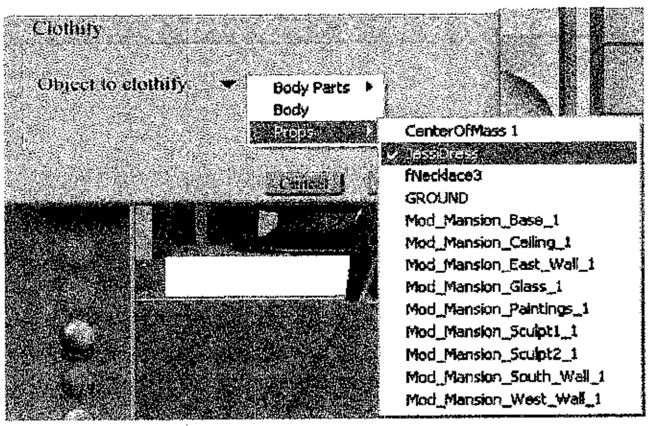


Figure 3.23: Object to clothify

Next, is to tell the computer what object used to collide with the cloth. This is done by selecting the Collide Against button as shown in Figure 3.24.

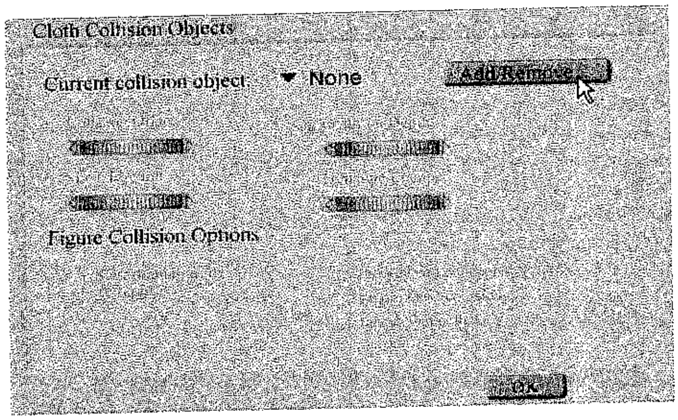


Figure 3.24: Cloth Collision objects

After that, the Add/Remove button is clicked. Then, hierarchical list of all objects open in the scene, and object need to collide against the cloth is choose (see Figure 3.25). The right hand, left hand, right feet and left feet is unchecked, because to reduce in term of collision detection complexity which influenced the time taken in calculates simulation.

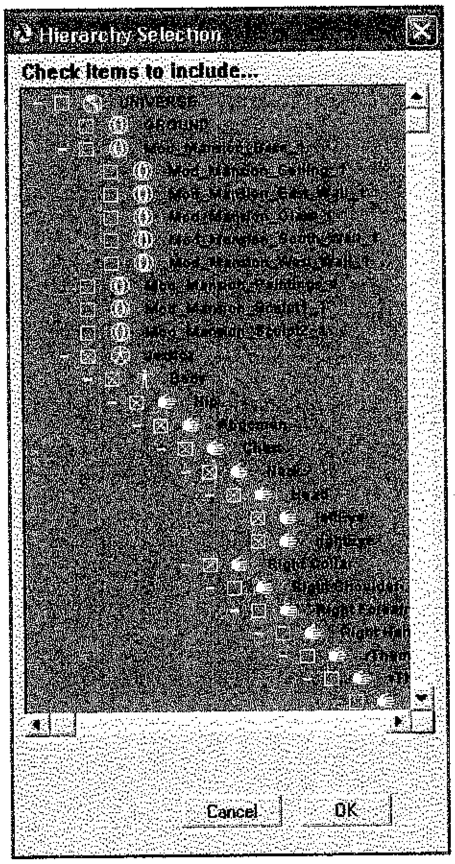


Figure 3.25: Collide objects

As in Figure 3.25, the Cloth Collision Objects dialog has four parameters dials: *Collision Offset, Collision Depth, Static Friction,* and *Dynamic Friction.*

- Collision Offset/Collision Depth: The range is from 0.1 cm to 10 cm. Collision Offset/Depth emulates cloth thickness (Offset + Depth).
- Static Friction/Dynamic Friction: Friction is the result of one material coming into contact with another. Static friction is the value for objects at rest, while objects in motion evidence dynamic friction.

The suitable values is set to the Cloth Collision Objects parameters, which are Collision Offset set to 1.000, Collision Depth set to 1.000, Static Friction 0.500, and Dynamic Friction set to 0.100.

"Start draping from zero pose" is checked in the Figure Collision Options dialog, as shown in Figure 3.26. This setting is applicable because the first frame of the animation has the figure in zero "Default" pose. The ignore hand collisions and ignore feet collisions is checked because the cloth not come into contact with hand and feet body parts.

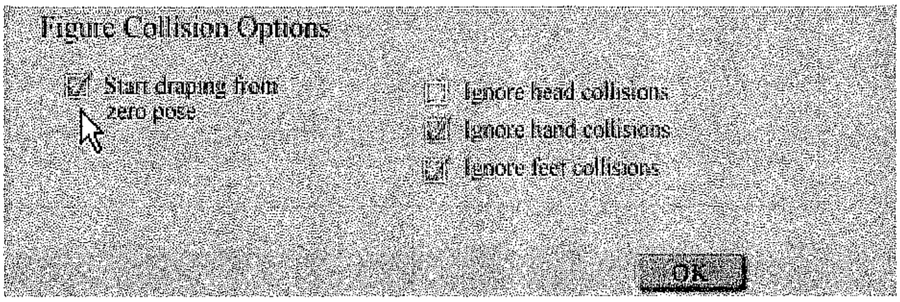


Figure 3.26: Collisions Option dialog box

The most important parameters for controlling what type of cloth the Cloth object is to emulate are nine parameter dials: Fold Resistance, Sheer Resistance, Stretch Resistance/Damping, Cloth Density, Cloth Self-Friction, Static Friction, Dynamic Friction, and Air Damping (see Figure 3.27).

- **Fold Resistance:** Use a higher value, when the cloth is stiff and unbendable to a large degree. Lower values allow more bending.
- **Sheer Resistance:** When the cloth has the ability to bend (sheer) side to side, lower values is use here. Higher values prevent sheering dynamics.
- **Stretch Resistance/Damping:** Lower Stretch Resistance values to stretch cloth, and higher values to prevent stretching.
- **Cloth Density:** The parameter dial to set relative weight whether light (low value) or heavy (higher value).
- **Cloth Self-Friction:** The parameter to set how easily the cloth slide over itself. Lower values set the sliding easier than higher values do.
- **Static Friction:** To parameter to set how easily the cloth slides over solid objects. Lower values increase the sliding, while higher values cause more friction between the cloth and solid objects.

- **Dynamic Friction:** This value is similar to Static Friction, with the difference being that the setting refers to the cloth in motion.
- **Air Damping:** This is the cloth's resistance to air when it is in motion.

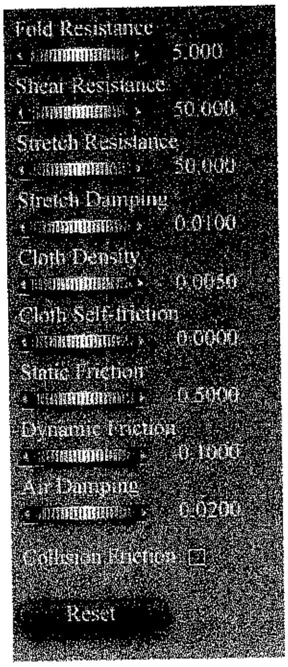


Figure 3.27: Dynamic Controls parameter

The values that set to each of the dynamic control parameters are shown in Table.

Table 3.3: Dynamic control parameters

Parameter	Values Setting
Fold Resistance	5.000
Sheer Resistance	50.000
Stretch Resistance	50.000
Stretch Damping	0.0100
Cloth Density	0.0050
Cloth Self-friction	0.0000
Static Friction	0.5000
Dynamic Friction	0.1000
Air Damping	0.0200

Lastly, calculate simulation of the cloth, which click the calculate simulation button in Dynamic Controls setting (see Figure 3.28).

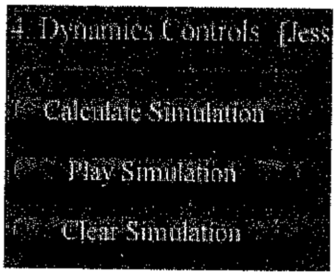


Figure 3.28: Calculate simulation

During calculate simulation, it will drape the cloth, which is for mapped cloth correctly with the body (see Figure 3.29).

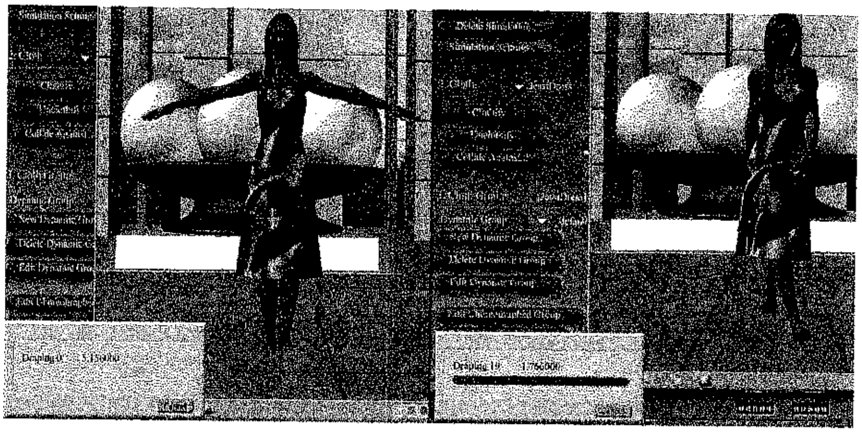
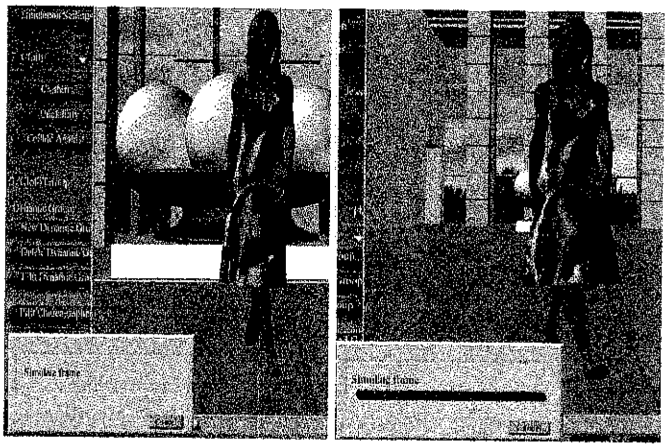


Figure 3.29: Draping the cloth (a) Draping start (b) Draping completed

Once Poser® completed the draping calculations and starts calculating dynamic, it simulated the cloth which the dress be posed correctly. This for make sure the cloth move based on body movement and when the body moved, the cloth mapped correctly and move based on the body movements (see Figure 3.30).



(a) (b)

Figure 3.30: Simulating cloth (a) Simulating start (b) Simulating completed

The body penetrates a cloth because do not has a collision detection. The collision detection is to prevent the animated objects from passing through each others as they speed along. Thus, the body not penetrates a cloth (see Figure 3.31).

(a) (b)

Figure 3.31: Collision detection of the cloth (a) Before applied a collision detection (b) After applied collision detection

The type of the cloth used is dynamic cloth. Using dynamic cloth, the realism of cloth movement is high. This is because it realistically drapes and moves as the figure moves. Dynamic cloth moves as the figure moves because it can respond with the movement during an animation (see Figure 3.32).

Figure 3.32: The cloth movement

3.3.6 Adding a sound

Sound edited using Sound Forge® 6 software (see Figure 3.33). After complete edit the sound, then save it as a *wav, this because to import sound into the Poser, it just required *wav. Then, the sound can be imported into the Poser®.

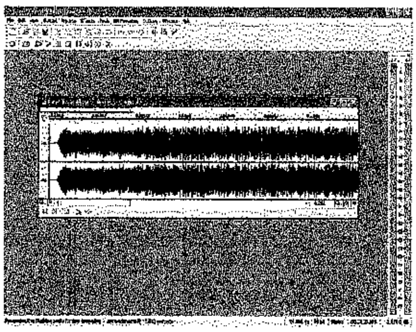


Figure 3.33: Editing the sound

3.3.7 Make movie

After modeling and animating the models completed, the scene need to be rendered. In rendering is used Poser® Firefly engine support (see Figure 3.34). Firefly provides Poser® users with a high-quality micropolygon rendering engine capable of extremely accurate, photorealistic output.

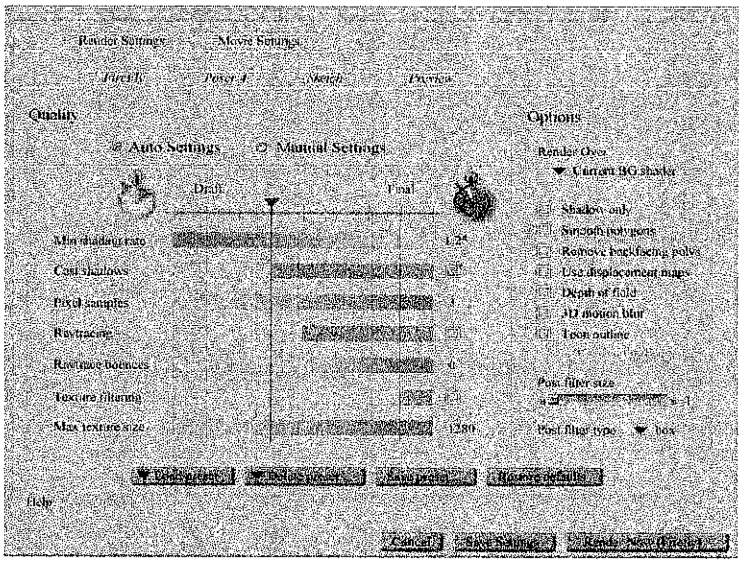
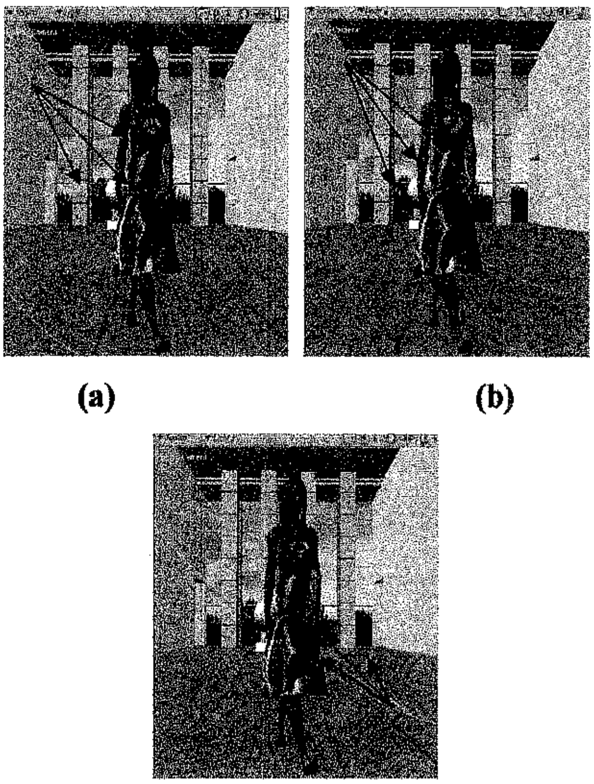


Figure 3.34: Firefly options

It consists of three direction lights (see Figure 3.35).



(a) **(b)**

(c)

Figure 3.35: 3 directions of light (a) Light 1 (b) Light 2 (c) Light 3

Value each lights need to change for increase brightness of the scene. Changes made in the light properties (see Figure 3.36). The default value for the shadow is 1.000, so the value change to 0.200, this for decrease the shadow influence to the objects.

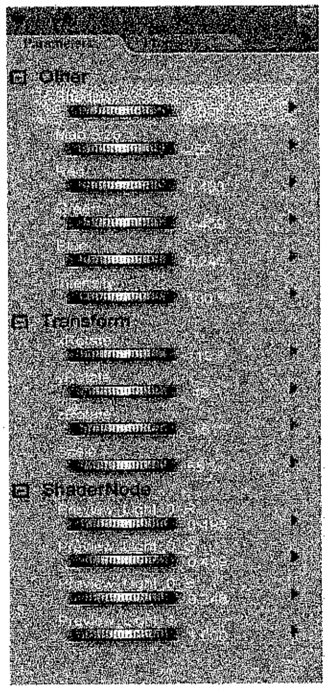


Figure 3.36: Light properties

The value of shadow been changed because when render the scene with 1.000 value, the scene become dark. After the modification value to 0.200, the scene becomes bright (see Figure 3.37).

(a) **(b)**

Figure 3.37: The two scenes with different shadow value (a) Shadow setting 1.000 (b) Shadow setting 0.200

In the development phase, the last process is make movie (see Figure 3.38). In the movie setting, the format set to *avi and renderer set to Firefly.

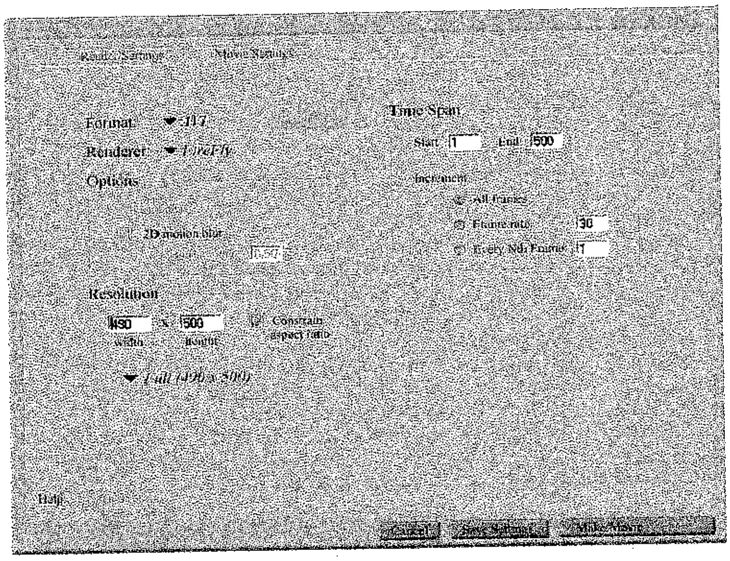


Figure 3.38: Movie settings

3.4 Evaluation

The last phase is the evaluation. Evaluation is carried out by the 30 users. The evaluation is conducted to analyze the application and to get feedback from the users. The method of evaluation includes interviews and questionnaires. The interview session with users is to get their spontaneous feedback on the given open ended session. The questionnaires sampling that will be given to a group of users to get their feedback on the close ended question by giving ratings.

3.5 Hardware and Software Requirement

3.5.1 Hardware

In develop this kind of project it required a high performance of personal computer. The performance is important, because it influenced taken to simulate and render the virtual human animation. The requirements for Windows are:

- Windows 2000 Professional or XP
- 500 Mhz Pentium class or compatible (700MHz or greater recommended)
- 256 MB system RAM (2 GB of RAM is recommended)
- 500MB free hard disk space
- 24-bit color display, 1024 x 768 resolution
- CD-Rom drive

3.5.2 Software

There are two main software used in develop this project. The software is Poser® 6.0 and Sound Forge 6.

- Poser® 6.0

Poser 6 is the powerful animation software. It is as a way to provide fast and accurate for character design. It also delivers the power of interactive 3D figure design, offering infinite opportunities to portray human diversity, form and expression. Design with the human form for art, illustration, animation, comics, web print, education, medical visualization, game storyboarding, and more.

- Sound Forge® 6.0

Sound Forge is an award-winning two-track digital audio editor that includes a powerful set of audio processes, tools, and effects for manipulating audio. This software used for editing a sound, like cut, copy, and delete.

CHAPTER 4

RESULTS & DISCUSSION

4.1 Data Gathering and Analysis

Data is gathered through the evaluation phase. In the evaluation phase, there are 30 users being called to view the application. From their testing on the application, the user required to answer a set of questionnaires regarding the application.

The considered scopes in the questionnaires are realism of virtual human, realism of virtual human movement, realism of virtual environment, usability of application, suitability of application, and user acceptance. The purpose of questionnaires is to examine accomplishment each of the project main objective. All the gathered data will be presented in the graph, pie chart, and explained. For the pie chart, the legend represents the scaling in the questionnaire, which ranges from 1 to 5, with 1 being the lowest and 5 being the highest.

Sample questionnaires can be referred in Appendix A.

4.1.1 Realism of the virtual human looks

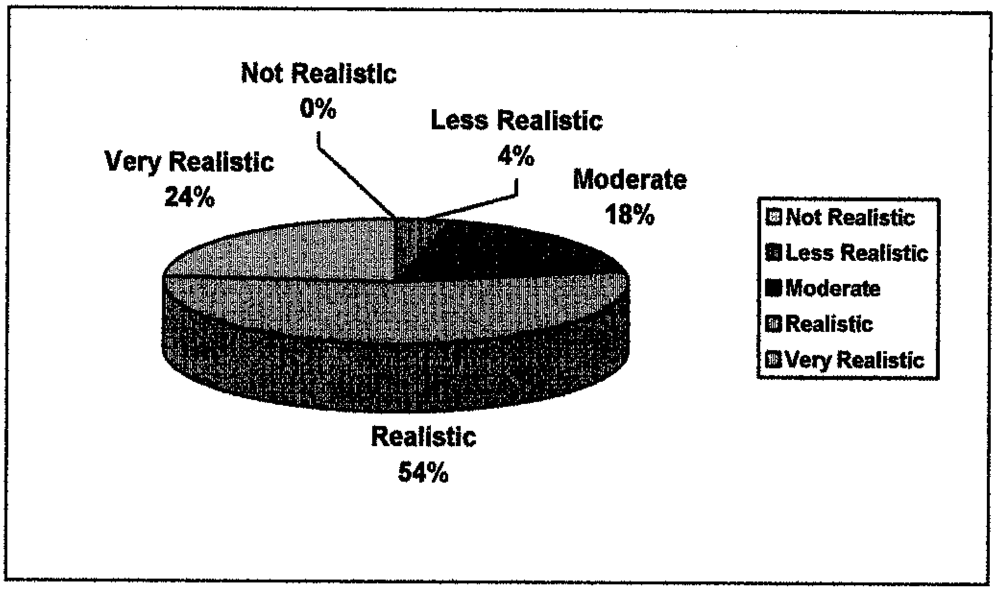


Figure 4.1: The realism virtual human looks

The pie chart above as shown in Figure 4.1 is represents the respond from the user towards the realism of virtual human looks.

A scale of 4 and 5 are considered a great respond from users. The pie chart shows that the percentage of responded scale a 4 and 5 are 54% and 24%. The percentage a user responded a moderate scale of 3 is 25%. Meanwhile, 0% and 4% a users responded a low scale of 1 and 2.

The highest percentage is a realistic level. This means that the overall virtual human looks which are hair, face, body shape, hands and legs are realistic.

4.1.2 Realism of virtual human movement

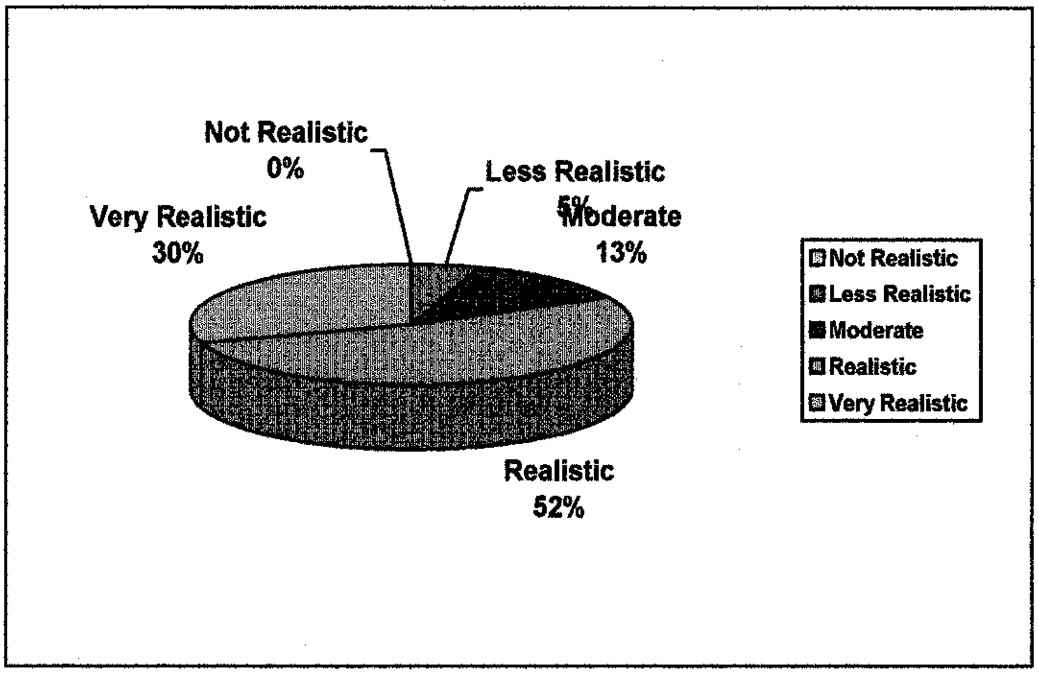


Figure 4.2: Realism of virtual human movement

The pie chart above as shown in Figure 4.2 is represents the respond from the user towards the realism of virtual human movement.

A scale of 4 and 5 are considered a great respond from users. The figure pie chart shows that the percentage of responded scale a 4 and 5 are 52% and 30%. The percentage a user responded a moderate scale of 3 is 13%. Meanwhile, 0% and 5% a users responded a low scale of 1 and 2.

The highest percentage is a realistic level. This means that the movement of each virtual human body parts is real.

4.1.3 Realism of props

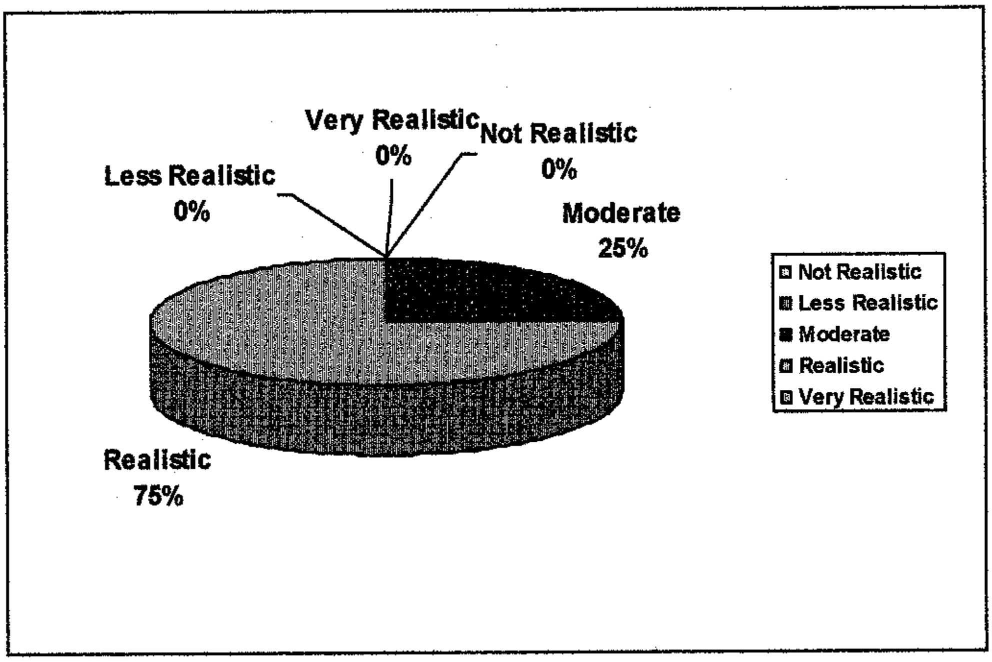


Figure 4.3: Realism of props

The pie chart above as shown in Figure 4.3 is represents the respond from the user towards the realism of props looks.

A scale of 4 and 5 are considered a great respond from users. The pie chart shows the percentage of responded scale a 4 and 5 are 75% and 0%. The percentage a user responded a moderate scale of 3 is 25%. Meanwhile, 0% and 0% a users responded a low scale of 1 and 2.

The highest percentage is a realistic level. This indicated that the look of virtual environment is real.

4.1.4 Application Suitability

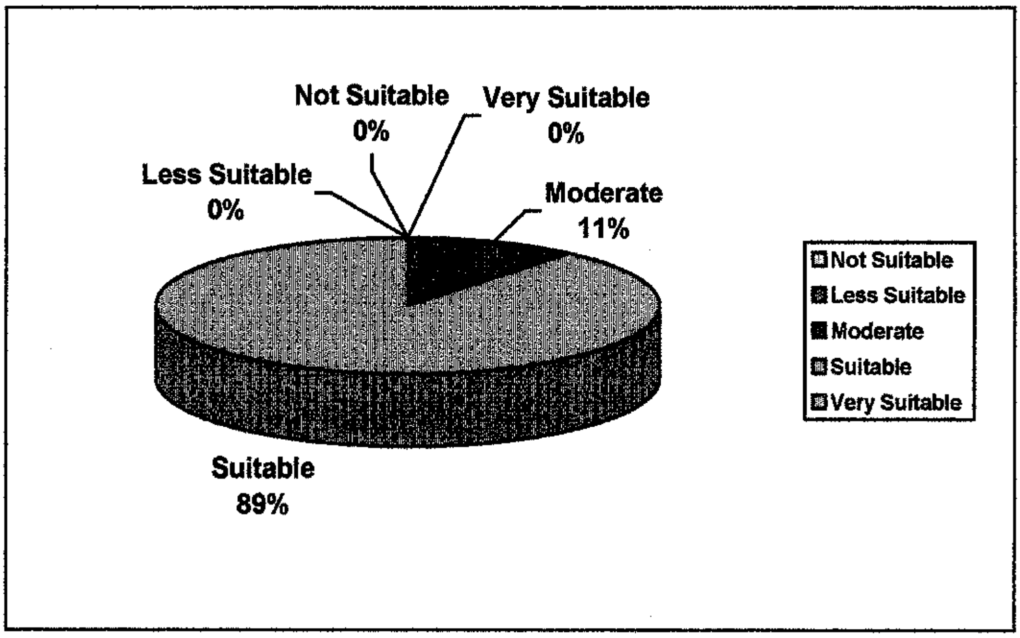


Figure 4.4: Application Suitability

The pie chart above as shown in Figure 4.4 is represents the respond from the user towards the suitability of application.

A scale of 4 and 5 are considered a great respond from users. The figure 4.4 shows that the percentage of responded scale a 4 and 5 are 89% and 0%. The percentage a user responded a moderate scale of 3 is 1%. Meanwhile, 0% and 0% a users responded a low scale of 1 and 2.

The highest percentage is a suitable level. This means that the application is suitable as an alternative to promote the batik.

4.1.5 Application Usability

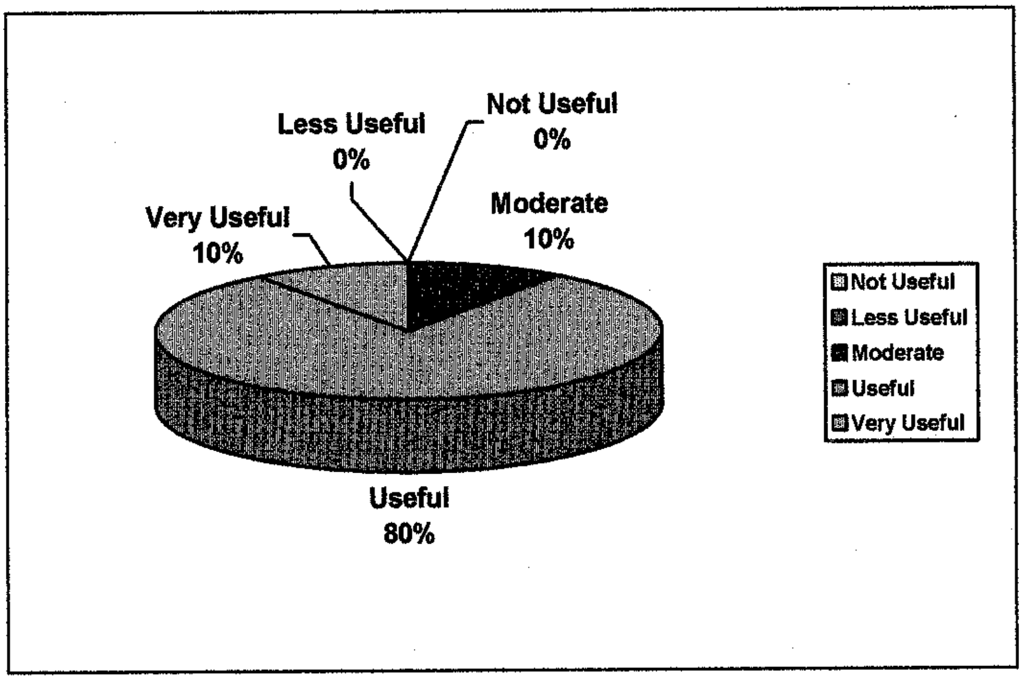


Figure 4.5: Application Usability

The pie chart above as shown in Figure 4.5 is represents the respond from the user towards the realism of props looks.

A scale of 4 and 5 are considered a great respond from users. The pie chart shows that the percentage of responded scale a 4 and 5 are 80% and 10%. The percentage a user responded a moderate scale of 3 is 10%. Meanwhile, 0% and 0% a users responded a low scale of 1 and 2.

The highest percentage is a useful level. This means that the application is useful to people. It also indicated the user agreed with the significant of virtual reality application being applied in batik modeling.

4.1.6 Suitability of fashion

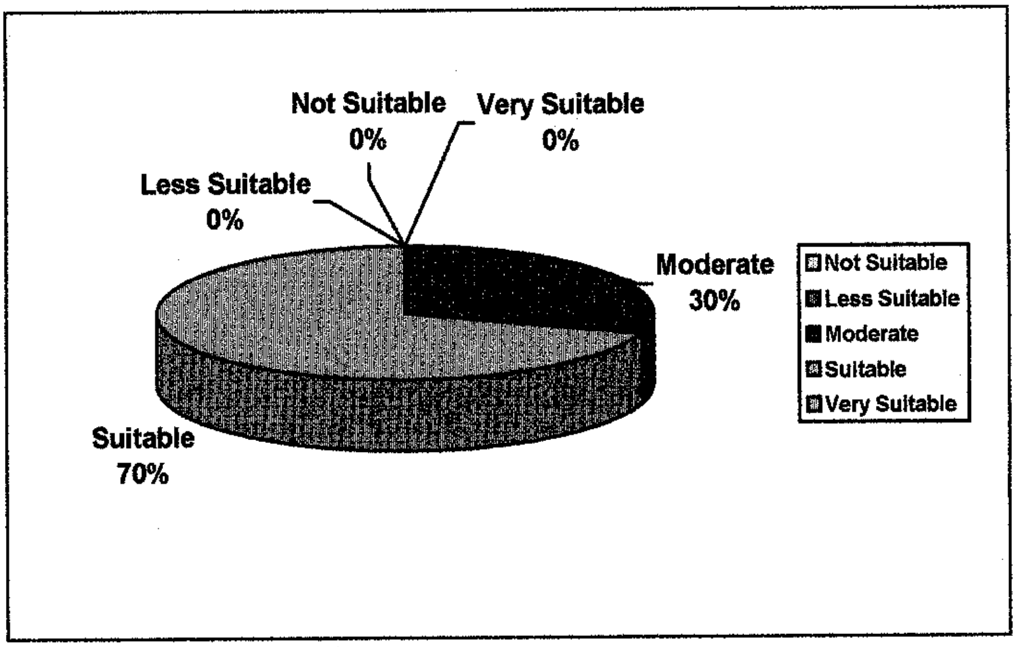


Figure 4.6: Suitability of the fashion

The pie chart above as shown in Figure 4.6 is represents the respond from the user towards suitability of fashion.

A scale of 4 and 5 are considered a great respond from users. The pie chart shows that the percentage of responded scale a 4 and 5 are 70% and 0%. The percentage a user responded a moderate scale of 3 is 30%. Meanwhile, 0% and 0% a users responded a low scale of 1 and 2.

The highest percentage is a suitable level. This means that the fashion is suitable with virtual human.

4.1.7 User Acceptance

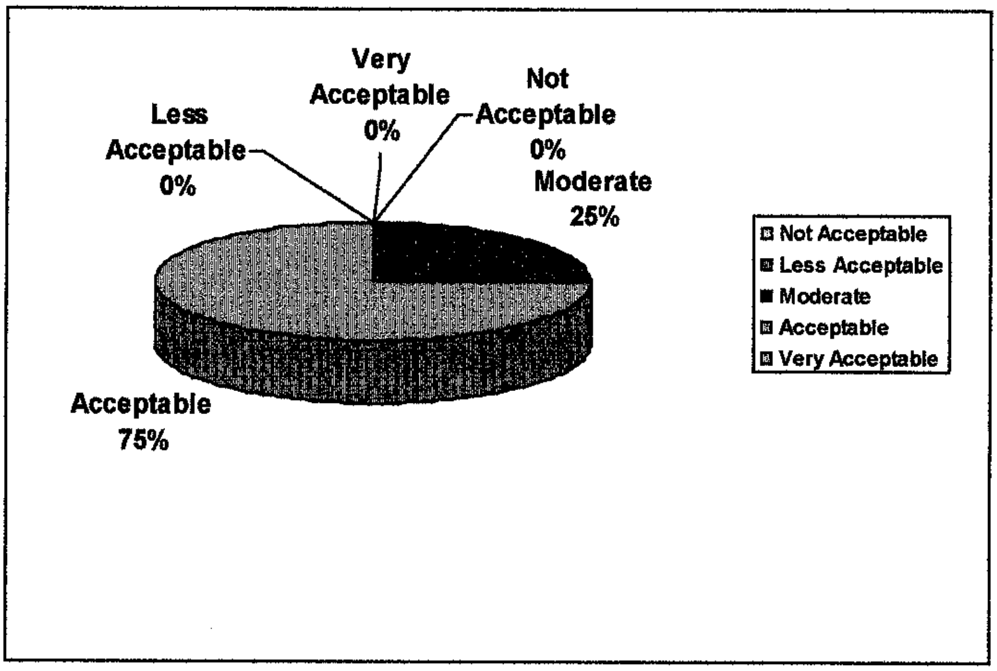


Figure 4.7: User Acceptance

The pie chart above as shown in Figure 4.7 is represents the user acceptance toward the application.

A scale of 4 and 5 are considered a great respond from users. The figure pie chart shows that the percentage of responded scale a 4 and 5 are 75% and 0%. The percentage a user responded a moderate scale of 3 is 25%. Meanwhile, 0% and 0% a users responded a low scale of 1 and 2.

The highest percentage is an acceptable level. This means that the user can accept this kind of application.

4.1.8 Overall Results

The figure below shows the overall results for the answered from the evaluator (see Figure 4.8).

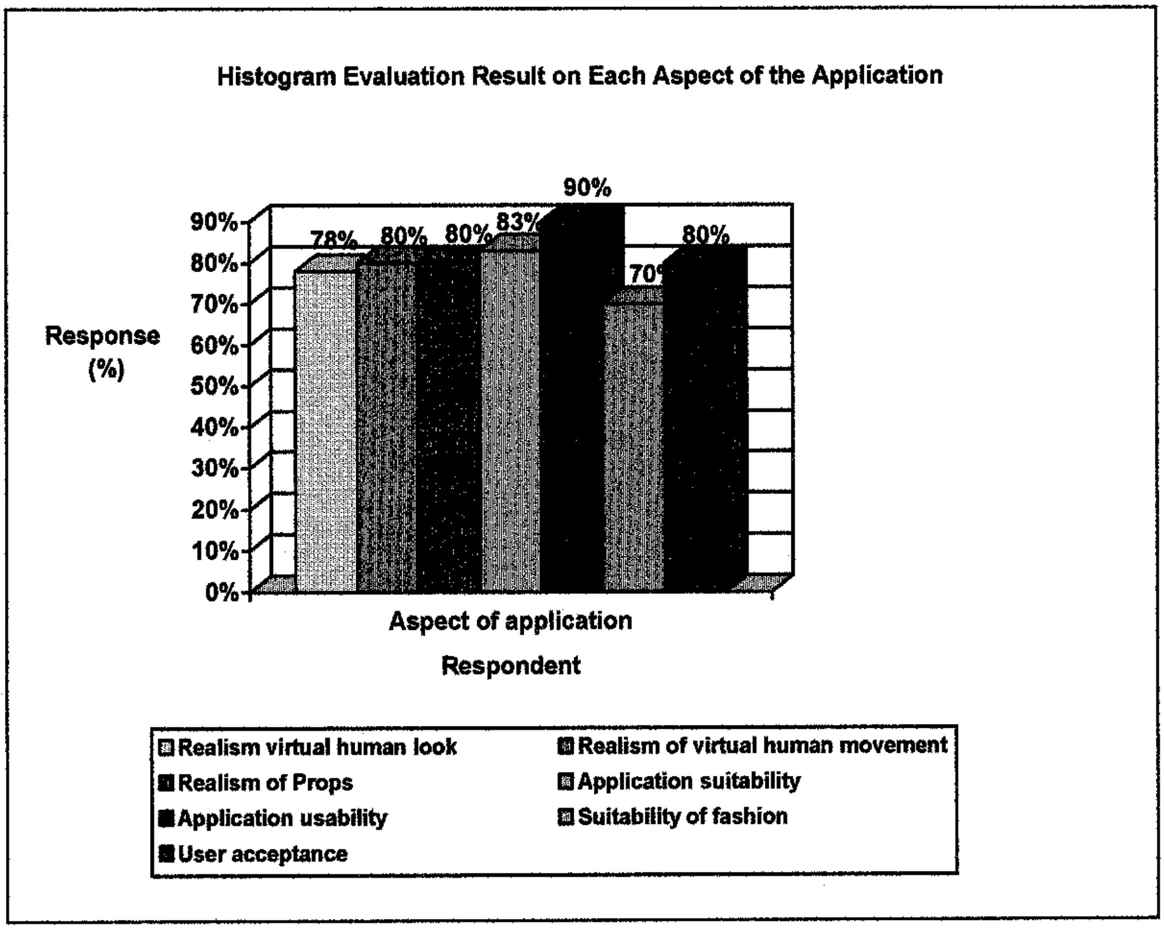


Figure 4.8: The overall percentage

The histogram shows the evaluation result for all the aspects tested on user (see Figure 4.8). This goal of the survey is to analyze each aspect of the application. From there, the improvement can be made based on the responds. From the histogram as shown in figure above, it shows percentage the realism of virtual human look is 78%. Virtual human model realism is an important aspect. The percentage a users agreed that the movement of virtual human is real, 80%. The realism of virtual human movement is the most important aspect to in this application. The percentage realism of props is 80%. The highest percentage is application suitability that is 90% gave a highest scale on it. The application usability aspect is to analyze the usefulness of application. It is useful because there is no such a batik modeling application. Meanwhile, the lowest percentage is suitability of fashion that is 70%. User acceptance towards this application is 80%. This indicated the user can accept this kind of application.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the Project

An animating virtual human for virtual batik modeling is developed as a new application which applying with a virtual reality technology, since there is no application of batik modeling. With this kind of application, can be as new alternative in easier present a batik cloth to the people.

In virtual batik modeling, the focused just on the female models. The focused of this project is creating a walking animation for the virtual human, which the models able walk to show a batik cloth. Walking design is based on the real model walking movement, in term of hands motion, legs motion, hip swing, and chest. This important in ensure the walking animation looks real. In the application consists of several models in show a different fashion of batik cloth.

In increase the animation realism, one of the important be considered is collision detection. This is to ensure the realism of the body movement and cloth. Body movement and cloth is related. This because, the cloth must moves based on the body movement.

To develop a good application, there is a limitation, which in term of computer performance. In developed this project the computer I used did not fulfill the requirement for Random Access Memory (RAM), so this suffered in time taken to simulate and drape the models. To simulate and drape one models time taken is about two hours, and every modification made, this need to simulate again the models. So, the time taken in just to simulate and drape the models is very longer. The lower RAM also effect time in make a movie of the application. To make one movie the time is about 14 hours. I also face problem, in combination of models in one scene, this also because memory. So, I can't combine it in one scene. In developing a project that related with virtual reality technology, it required a higher computer performance.

5.2 Limitation of Project

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5.3 Future Enhancement

Upon the completion of this project, limitations, and constraints had arisen, whether in terms of time, resources, knowledge, or technology. For example, limitations of computer requirement and performance limit the project from having other great features. There are a few suggestion and recommendation for next enhancement of this project.

First is the interactivity of application. When, the virtual human walking user can indicate it direction, whether right, left, back, and front. This feature can be accepted by user because they can interact with the application.

Besides that, the animation of the hair can be considered to increase the movement realism. Hair animation is based on the body movement. The enhancement of this part will give a good result in term of movement.

In addition to that, provide a traditional cloth to the model. The traditional cloths are such as 'baju kurung', 'kebaya', 'kebarung', and 'kurung kedah'. All cloth will be textured with 'batik' pattern.

Furthermore, an enhancement can be made is user able to change a virtual human cloth, with several different cloth. The user, just click on the button then cloth will change to another cloth.

In terms of technology, there is also a restriction in the navigation technique, in which mouse and keyboard is used as the navigation device. Other devices can be used, for example is tracker which used for body motion. The tracker is the special purpose hardware used in virtual reality to measure the real-time change in a 3D object position and orientation. Using a tracker, the user can move the virtual human body based on their body movement.

The other enhancement is props. In the props have a stage, which the virtual human walk on the stage to present batik cloth. This enhancement is to increase the suitability of the props.

The future enhancement is needed to improve the quality of this project. This project is useful as an alternative to present 'batik'. So, it is appropriate to upload this project in the website.

5.4 Conclusion

As a conclusion, this project has met the objective of the project which to animating a virtual human for virtual batik modeling. This virtual batik modeling project is significant as a new alternative to present a' batik'. The application of virtual technology in the batik modeling, is for attract user attention toward 'batik'. The suitable techniques is applied in develop the models and animation. In modeling the techniques used are direct interpolation techniques, this for get the higher realism of movement. Meanwhile in animate the models the techniques have been applied are direct kinematics and inverse kinematics. For the cloth, collision detection is applied, this for cloth animate like a real cloth when the body moved. Higher realism of virtual human movement is important in ensure an excellent batik modeling. This is because; virtual batik modeling is relied on the virtual human animation. From the evaluation, the realism of virtual human movement is achieved, and this fulfills the project objectives.

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APPENDICES

APPENDIX A

The questions below ask about your views toward virtual batik fashion show application. In terms of realism, suitability and usability the application.

1. In terms of model looks, do you think the parts of body listed below look real?

   Please rate your answer between the given ranges:

1	2	3	4	5
Not Realistic	Less Realistic	Moderate	Realistic	Very Realistic

   i. Hair 1 2 3 4 5

   ii. Face 1 2 3 4 5

   iii. Body shape 1 2 3 4 5

   iv. Hands 1 2 3 4 5

   v. Legs 1 2 3 4 5

2. In terms of movement, do you think the parts of body listed below move like as a real model?

   Please rate your answer between the given ranges:

1	2	3	4	5
Not Realistic	Less Realistic	Moderate	Realistic	Very Realistic

   i. Head 1 2 3 4 5

   ii. Body 1 2 3 4 5

   iii. Hands 1 2 3 4 5

   iv. Legs 1 2 3 4 5

3. Do you think the props looks real?

1	2	3	4	5
Not Realistic	Less Realistic	Moderate	Realistic	Very Realistic

4. Does this application suitable to promote 'batik' as an alternative instead of the real batik fashion show?

1	2	3	4	5
Not Suitable	Less Suitable	Moderate	Suitable	Very Suitable

5. If is suitable, then is it useful to use this application?

1	2	3	4	5
Not Useful	Less Useful	Moderate	Useful	Useful

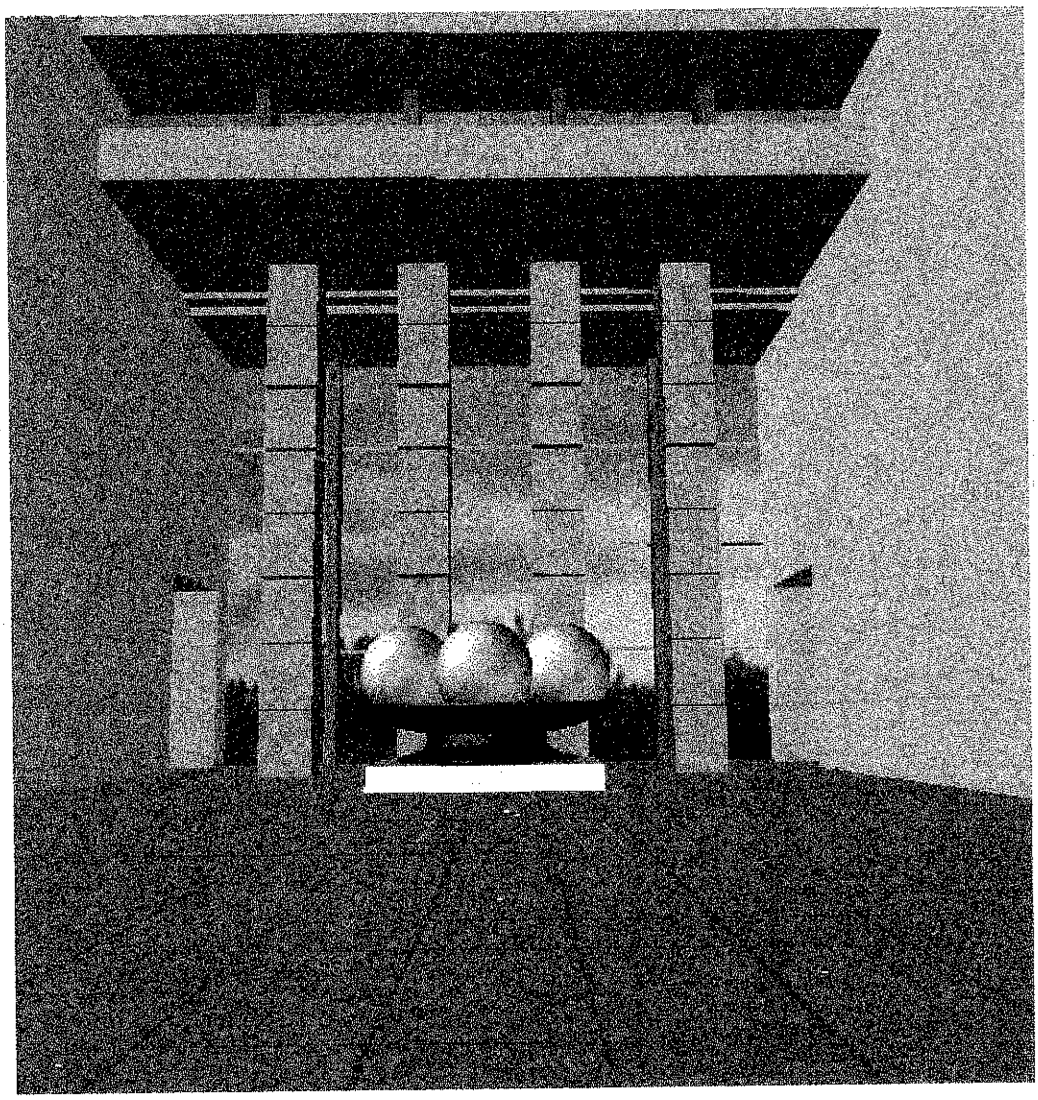
6. Do you think the fashion suitable with the model?

1	2	3	4	5
Not Suitable	Less Suitable	Moderate	Suitable	Very Suitable

7. Does this application acceptable to you?

1	2	3	4	5
Not Acceptable	Less Acceptable	Moderate	Acceptable	Very Acceptable

APPENDIX B



The Props

Model 1


Model 2