Design of Immersive Online Hotel Walkthrough System Using Image-Based (Concentric Mosaics) Rendering

by

Nor Farhana Binti Abdul Liyo Nedor

Dissertation submitted in partial fulfillment of
the requirement for the
Bachelor of Technology (Hons)
(Business Information System)

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CERTIFICATION OF APPROVAL

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Approved by,

(Mr. Yew Kwang Hooi)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
July 2007

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.

NOR FARHANA BT ABDUL LIYO NEDOR

ABSTRACT

Conventional hotel booking websites only represents their services in 2D photos to show their facilities. 2D photos are just static photos that cannot be move and rotate. Image-based virtual walkthrough for the hospitality industry is a potential technology to attract more customers. In this project, a research will be carried out to create an Image-based rendering (IBR) virtual walkthrough and panoramic-based walkthrough by using only Macromedia Flash Professional 8, Photovista Panorama 3.0 and Reality Studio for the interaction of the images. The web-based of the image-based are using the Macromedia Dreamweaver Professional 8. The images will be displayed in Adobe Flash Player 8 or higher. In making image-based walkthrough, a concentric mosaic technique is used while image mosaicing technique is applied in panoramic-based walkthrough. A comparison of the both walkthrough is compared. The study is also focus on the comparison between number of pictures and smoothness of the walkthrough. There are advantages of using different techniques such as image-based walkthrough is a real time walkthrough since the user can walk around right, left, forward and backward whereas the panoramic-based cannot experience real time walkthrough because the user can only view 360 degrees from a fixed spot.

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LIST OF ABBREVIATION

FYP	Final Year Project
UTP	Universiti Teknologi PETRONAS
IBR	Image Based Rendering
2D	2 Dimension
3D	3 Dimension
LDI	Layered Depth Images
JPEG	Joint Photographic Expert Group
MB	Megabyte
GB	Gigabyte
CG	Computer Graphics
KETM	Kyongju Electronic Tourism Market
AVI	Audio Video Interleave
GIF	Graphics Interchange Format
VRML	Virtual Reality Modeling Language
WRL	Web Rule Language
FLV	Flash Video
IVR	Interactive Voice Response

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The travel and tourism industry is the single largest e-commerce category with a potential for exceptional future growth. This sector boasts an established audience of Internet savvy consumers who demand online content that is informative, compelling and easy to navigate. In the highly-competitive hospitality industry, hotels are engaged in a variety of marketing activities to attract new guests and to keep them coming back. In the context of e-commerce, studies have shown that consumers satisfied with the content of a travel or hospitality-related website are more likely to revisit for additional information or to make future purchases.

1.2 Background of Study

An Image-Based Rendering (IBR) virtual walkthrough for hotel room booking is a hot research area where computer graphics, computer vision and signal processing meet together. There are many approaches have been used to create the virtual environment for virtual walkthrough and all them used images as the source material. Some of the representative approaches are lightfield, lumigraph, concentric mosaics, and unstructured lumigraph.

The design of immersive online hotel walkthrough system using concentric mosaics rendering creates a new interactive ways between user and images in virtual walkthrough to promote the hospitality industry.

1.3 Problem statement

1.3.1 Problem identification

Most hotel websites use text and 2D photos to describe the services. Unfortunately, these are not sufficient to give the clear and exact picture of the room that a potential customer is getting. The limitations of 2D photos are display of only one point of view and lack of user interactivity that allows user to explore the room from every angle.

1.3.2 Significant of the Project

There are not many attempts to use IBR in hotel booking websites. IBR provides interactivity to user to explore the room online. The walkthrough is photo realistic for complex real world scenes and yet no tedious 3D modeling is required. User can interact with the prototype visually and feel the surroundings of the room moving forward, backward and turning around in 360 $^{\circ}$ angle. This can give the user better satisfaction in decision making before booking the hotel room.

1.4 Objective and Scope of Study

Objectives

To implement image-based virtual walkthrough that provides immersive and interactive experience for visitors checking the room.

Scope of Study

Focus is on studying the construction of image-based virtual walkthrough applications. This includes:

1. The design of the image-based rendering virtual walkthrough using concentric mosaics.
2. Comparison of correlation of pictures with smoothness of walkthrough between image-based (Concentric mosaics and Image mosaicing) walkthrough.

CHAPTER 2

LITERATURE REVIEW AND/OR THEORY

2.1 Introduction

In the competitive hospitality industry, hotels are engaged in a variety of partnerships, opportunities and marketing activities to attract guests to their property and keep them coming back. Most of the hotel nowadays used 2D photos to represent their products and facilities which cannot impress the customer much. This problem can be overcome by implementing a virtual tour via the internet. Image-based rendering is a powerful new approach for generating real-time photorealistic computer graphics.

This new field of computer graphics generates an image for a new viewpoint from a set of prerecorded reference images. Two of the most prominent open questions in image based methods are how many reference images with depth information are needed to reconstruct a scene from other viewpoints and where to place these reference images. Research concentrates on methods to determine if a given set of reference images contains enough information to reproduce the scene without artifacts from visibility or inadequate sampling for a given set of viewpoints.

An important application of such a technique is to verify if a set of images of a real scene is 'complete', or if additional images are needed. Above techniques enable an image based rendering system to preprocess the environment by telling the user where to place the camera in a real scene. The goal is to create a real time image based rendering system that correctly re-renders a given scene from any viewpoint.

2.2 A Survey on Image-Based Rendering

Cha Zhang and Tsuhan Chen [2] observed that essentially all the image-based rendering (IBR) representations are derived from plenoptic function, which are seven dimensional and difficult to handle.

The traditional model-based rendering approach adopts such a description: shapes of the objects are represented by certain geometric models; properties of the object surfaces are described by texture maps and reflection models; lighting and shading are the results of interaction between the light sources and objects, etc. The source description is often compact and insightful, because it tells how the world is composed. However, it has the disadvantage that such a description is not always available. From what we can observe with our eyes or cameras, deriving the source description is not trivial, and has been the goal of computer vision for more than twenty years with limited success.

An alternative way to describe the world is through the appearance description. The appearance of the world can be thought of as the dense array of light rays filling the space, which can be observed by posing eyes or cameras in the space. These light rays can be represented through the plenoptic function, proposed by Adelson and Bergen [14].

As pointed out by Adelson and Bergen [14]:

"The world is made of three-dimensional objects, but these objects do not communicate their properties directly to an observer. Rather, the objects fill the space around them with the pattern of light rays that constitutes the plenoptic function, and the observer takes samples from this function. The plenoptic function serves as the sole communication link between the physical objects and their corresponding retinal images. It is the intermediary between the world and the eye."

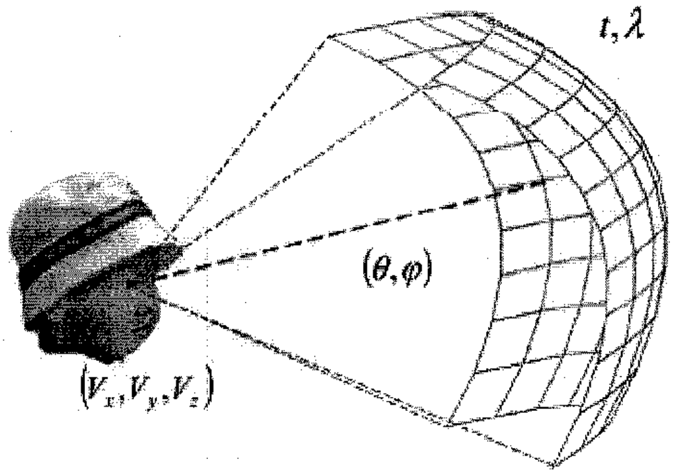


Figure 1 Plenoptic Function

Definition—IBR: Given a continuous plenoptic function that describes a scene, IBR is a process of two stages—sampling and rendering.2 In the sampling stage, samples are taken from the plenoptic function for representation and storage. In the rendering stage, the continuous plenoptic function is reconstructed with the captured samples.

2.2.1 Commonly used assumptions to restrain the viewing space

In the former category, they summarize six common assumptions that were often made in various approaches and discuss how the dimension of the plenoptic function can be reduced based on these assumptions. Some of them are preferable, as they do not impact much on the viewers' experiences. Some others are more restrictive and used only when the storage size is a critical concern. We list them below roughly based on their restrictiveness.

Assumption 1. As we are taking images of the scene for IBR, we may simplify the wavelength dimension into three channels, i.e., the red, green and blue channels. Each channel represents the integration of the plenoptic function over a certain wavelength range. This simplification can be carried out throughout the capturing and rendering of IBR without noticeable effects. Almost all the practical representations of IBR make this assumption.

Assumption 2. The air is transparent and the radiances along a light ray through empty space remain constant. Under this assumption, we do not need to record the radiances of a light ray on different positions along its path, as they are all the same. To see how we can make use of this assumption, let us limit our interest to the light rays leaving the convex hull of a bounded scene (if the viewer is constrained in a bounded free-space region, the discussion hereafter still applies). Under Assumption 2, the plenoptic function can be represented by its values along an arbitrary surface surrounding the scene. This reduces the dimension of the plenoptic function by one. The radiance of any light ray in the space can always be obtained by tracing it back to the selected surface. In other words, Assumption 2 allows us to capture a scene at some places and render it at somewhere else. This assumption is also widely used. However, a real camera has finite resolution. A pixel in an image is in fact an average of the light rays from a certain area on the scene surface. If we put two cameras on a line and capture the light ray along it, they may have different results, as their observing area size on the scene surface may be very different. Such resolution sensitivity was pointed out by Buehler et al [15].

Assumption 3. The scene is static, thus the time dimension can be dropped. Although a dynamic scene includes much more information than a static one, there are practical concerns that restrict the popularity of dynamic IBR. One concern is the sample data size. We all know that if we capture a video for a scene instead of a single image, the amount of data may increase for about 2 or 3 orders of magnitude. It can be expected that dynamic IBR will have the same order of size increase from static IBR. Moreover, IBR often requires a large amount of capturing cameras. If we want to record a dynamic scene, all these cameras must be present and capturing video together. Unfortunately, today's practical systems cannot afford to have that many cameras. The known IBR camera array that has the largest number of cameras may be the Stanford light field video camera, which consists of 128 cameras. This is yet not enough for rendering high quality images. Capturing static scenes does not have the above problem, because we can always use the time axis to compensate for the lack of cameras. That is, images captured at different time and positions can be used together to render novel views.

Assumption 4. Instead of moving in the 3D space, the viewer is constrained to be on a surface, e.g., the ground plane. The plenoptic function can then reduce one dimension, as the viewer's space location becomes 2D. Although restricting the viewer on a surface seems unpleasing, Assumption 4 is acceptable for two reasons. First, the eyes of human beings are usually at a certain height-level for walk-through applications. Second, human beings are less sensitive to vertical parallax and lighting changes because their two eyes are spaced horizontally. Example scenes using concentric mosaics showed that strong effects of 3D motion and lighting change could still be achieved under this assumption.

Assumption 5. The viewer moves along a certain path. That is, the viewer can move forward or backward along that path, but he/she cannot move off the path. Assumption 5 reduces two dimensions from the full plenoptic function. Branch movies is an example that takes this assumption. This assumption is also reasonable for applications such as virtual touring, where the viewer follows a predefined path to view a large scene.

Assumption 6. The viewer has a fixed position. This is the most restrictive assumption, which reduces the dimension of the plenoptic function by three. No 3D effects can possibly be perceived under this assumption. Nevertheless, under this assumption the representations of IBR can be very compact and bear much similarity to regular images and videos. Capturing such representations is also straightforward. Thanks to these benefits, the QuickTime VRTM technology based on Assumption 6 has become the most popular one among all the IBR approaches in practice.

There is one important thing to notice. That is, the dimension reduced by the above six assumptions may not be addable. In particular, Assumption 2 does not help further save dimension so long as one of the Assumption 4, 5 or 6 is made. This is because when the viewer's position has certain constraints, usually the sampled light ray space intersects each light ray only at a single point, which makes Assumption 2 not useful any more.

Table 1: IBR representations with various viewing space constraints

Dimension	**Example Representations**	**Assumptions**
7D	Plenoptic function	No
6D	Surface pleonoptc function	(2)
5D	Plenoptic modeling	(1, 3)
	Light field video	(1, 2)
4D	Light field / Lumigraph	(1, 2, 3)
3D	Concentric mosaics	(1, 2, 3, 4)
	Panoramic Video	(1, 6) or (1, 3, 5)
	Branch movies	(1, 3, 5)
	Video	(1, 6)
2D	Image mosaicing	(1, 3, 6)
	Image	(1, 3, 6)

Why Concentric Mosaic?

According to H.Y. Shum, the concentric mosaic [8] has proven itself to be a very useful tool for generating real-time photo realistic views of the synthetic and real world scenery. By rotating a single off-center camera and recording the captured images at regular intervals, concentric mosaic scenery is built up quickly, and novel views can be easily obtained by interpolating existing light rays. Under the paradigm of image-based rendering (IBR), concentric mosaic gives a 3D parameterization of the plenoptic function. The concentric mosaic greatly eases the task of 3D scene acquisition and navigation.

Why Image Mosaicing? (For comparison purpose)

In computer vision, image mosaics are part of a larger recent trend, namely the study of *visual scene representations* .The complete description of visual scenes and scene models often entails the recovery of depth or parallax information as well. In computer graphics, image mosaics play an important role in the field of *image- based rendering*, which aims to rapidly render photorealistic novel views from collections of real (or pre-rendered) images.

In concentric mosaic, the scene is captured by mounting a camera at the end of a level beam, and shooting images at regular intervals as the beam rotates, as is shown in Figure 2.

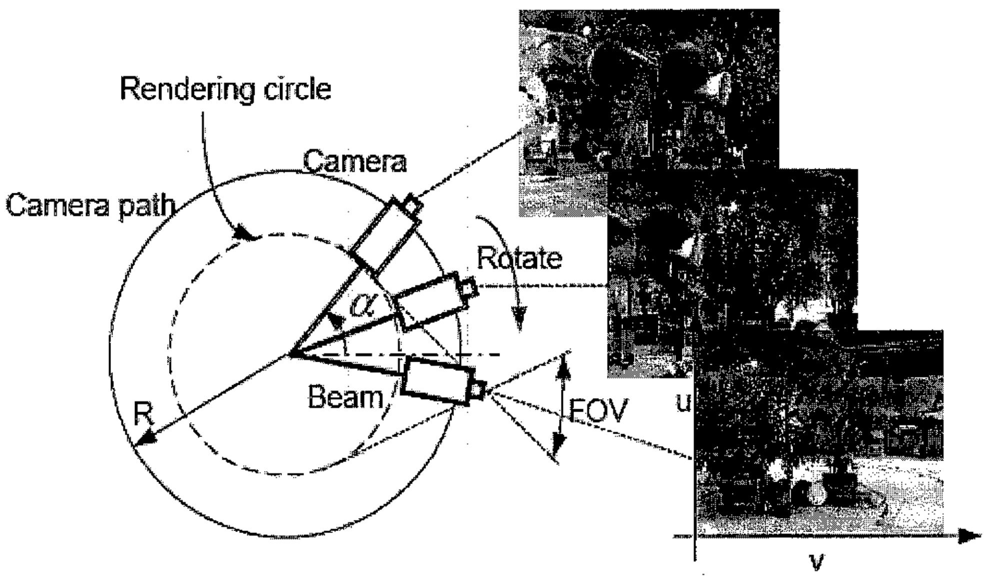


Figure 2 Concentric mosaic capturing

The light rays are then indexed by the camera position or the beam rotation angle α, and the pixel locations (μ,v):

$L^{(3)}(\alpha,\mu,v)$.

This parameterization is equivalent to having many slit cameras rotating around a common center and taking images along the tangent direction. Each slit camera captures a manifold mosaic, inside which the pixels can be indexed by (α,μ), thus the name concentric mosaics. During the rendering, the viewer may move freely inside a rendering circle (Fig 1) with radius R sin (FOV/2), where R is the camera path radius and FOV is the field of view of the cameras. The rendering of concentric mosaics is slit-based. The novel view is split into vertical slits. For each slit, the neighboring slits in the captured images are located and used for interpolation. The rendered view is then reassembled using these interpolated slits.

2.3 A Review of Image-based Rendering Techniques

Image-based modeling and rendering techniques have recently received much attention as a powerful alternative to traditional geometry-based techniques for image synthesis. There are various rendering techniques (and their associated representations) into three categories, namely rendering with no geometry, rendering with implicit geometry, and rendering with explicit geometry.

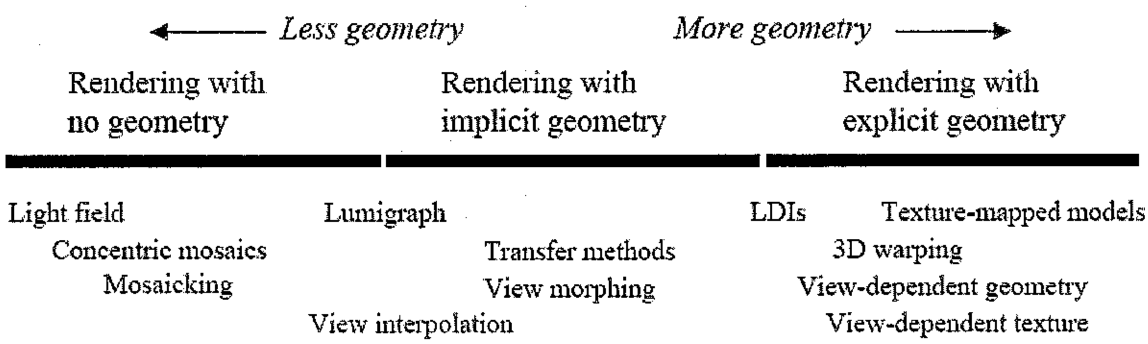


Figure 3 Categories of image-based rendering, with representative members

Some image-based rendering systems do not require explicit geometric models. Rather, they require feature (such as points) correspondence between images. For example, view interpolation generates novel views by interpolating optical flowbetween corresponding points. On the other hand, viewmorphing generates in-between camera matrices along the line of two original camera centers, based on point correspondences. Computer vision techniques are usually used to generate such correspondences.

At the other extreme, light field rendering uses many images but does not require any geometric information or correspondence. Light field rendering generates a new image of a scene by appropriately filtering and interpolating a pre-acquired set of samples. Lumigraph is similar to light field rendering but it applies approximated geometry to compensate for non-uniform sampling in order to improve rendering performance. Unlike light field and lumigraph where cameras are placed on a two-dimensional grid, the concentric mosaics representation reduces the amount of data by capturing a sequence of images along a circle path. Light field rendering, however, has a tendency to rely on oversampling to counter undesirable aliasing effects in output display. Oversampling means more intensive data acquisition, more storage, and more redundancy.

2.3.1 Rendering with no geometry

Light field and lumigraph

It was observed in both light-field rendering and lumigraph systems that as long as we stay outside the convex hull (or simply a bounding box) of an object,1 we can simplify the 5D complete plenoptic function to a 4D lightfield plenoptic function,

$$P4 = P(u, v, s, t), \quad (4)$$

where (u, v) and (s, t) parameterize two parallel planes of the bounding box, as shown in Figure 2. To have a complete description of the plenoptic function for the bounding box, six sets of such two-planes are needed. The camera motion is restricted to a straight line.

In the light field system, a capturing rig is designed to obtain uniformly sampled images. To reduce aliasing effect, the light field is pre-filtered before rendering. A vector quantization scheme is used to reduce the amount of data used in light field rendering, yet achieving random access and selective decoding. On the other hand, the lumigraph can be constructed from a set of images taken from arbitrarily placed viewpoints. A re-binning process is therefore required. Geometric information is used to guide the choices of the basis functions. Because of the use of geometric information, sampling density can be reduced.

Concentric mosaics

An interesting 3D parameterization of the plenoptic function, called Concentric Mosaics, is proposed by Shum and He (1999) where the camera motion is constrained along concentric circles on a plane. By constraining camera motion to planar concentric circles, concentric mosaics can be created by compositing slit images taken at different locations of each circle.

Concentric mosaics index all input image rays naturally in 3 parameters: radius, rotation angle and vertical elevation. Novel views are rendered by combining the appropriate captured rays in an efficient manner at rendering time. Although vertical distortions exist in the rendered images, they can be alleviated by depth correction. Concentric mosaics have good space and computational efficiency. Compared with a lightfield or lumigraph, concentric mosaics have much smaller file size because only a 3D plenoptic function is constructed.

Most importantly, concentric mosaics are very easy to capture. Capturing concentric mosaics is as easy as capturing a traditional panorama except that concentric mosaics require more images. By simply spinning an off-centered camera on a rotary table, we can construct concentric mosaics for a real scene in 10 minutes. Like panoramas, concentric mosaics do not require the difficult modeling process of recovering geometric and photometric scene models. Yet concentric mosaics provide a much richer user experience by allowing the user to move freely in a circular region and observe significant parallax and lighting changes. The ease of capturing makes concentric mosaics very attractive and useful for many virtual reality applications.

Image mosaicing

Specifically, a panoramic mosaic is constructed by registering multiple regular images. For example, if the camera focal length is known and fixed, one can project each image to its cylindrical map and the relationship between the cylidrical images becomes a simple translation. For arbitrary camera rotation, one can first register the images by recovering the camera movement, before converting to a final cylindrical/spherical map.

Many systems have been built to construct cylindrical and spherical panoramas by stitching multiple images together. When the camera motion is very small, it is possible to put together only small stripes from registered images, i.e., slit images, to form a large panoramic mosaic. Capturing panoramas is even easier if omnidirectional cameras or fisheye lens are used.

Szeliski and Shum (1998) presented a complete system for constructing *panoramic image mosaics* from sequences of images. Their mosaic representation associates a transformation matrix with each input image, rather than explicitly projecting all of the images onto a common surface (e.g., a cylinder). In particular, to construct a full view panorama, a *rotational mosaic* representation associates a rotation matrix (and optionally a focal length) with each input image. A *patch-based alignment* algorithm is developed to quickly align two images given motion models. Techniques for estimating and refining camera focal lengths are also presented.

In order to reduce accumulated registration errors, global alignment (*block adjustment*) is applied to the whole sequence of images, which results in an optimally registered image mosaic. To compensate for small amounts of motion parallax introduced by translations of the camera and other unmodeled distortions, a local alignment (*deghosting*) technique warps each image based on the results of pairwise local image registrations. Combining both global and local alignment significantly improves the quality of our image mosaics, thereby enabling the creation of full view panoramic mosaics with hand-held cameras.

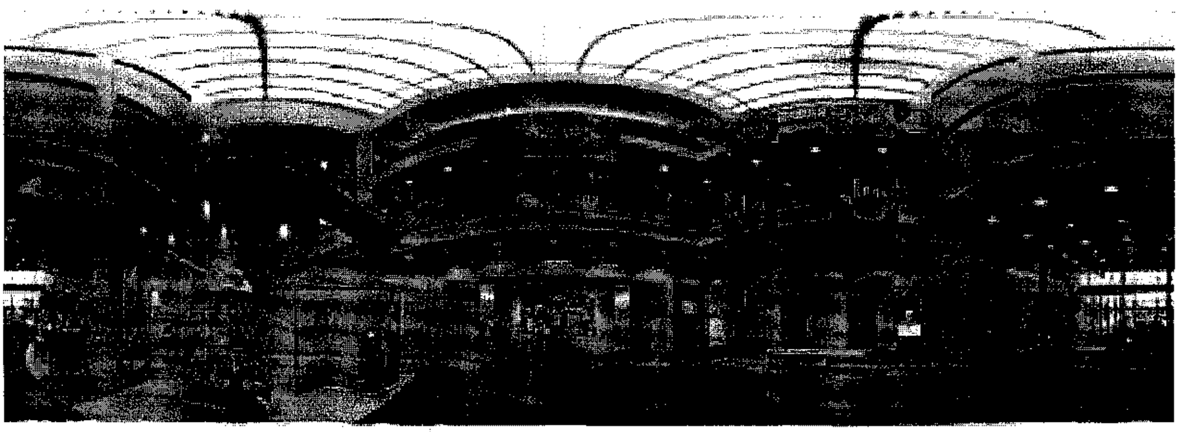


Figure 4 Tessellated spherical panorama covering the north pole (constructed from 54 images)

2.3.2 Rendering with implicit geometry

View interpolation

From two input images, given dense optical flow between them, Chen and Williams' view interpolation method (1993) can reconstruct arbitrary viewpoints. This method works well when two input views are close by, so that visibility ambiguity does not pose a serious problem. Otherwise, flow fields have to be constrained so as to prevent foldovers. In addition, when two views are far apart, the overlapping parts of two images become too small. Chen and Williams' approach works particularly well when all the input images share a common gaze direction and the output images are restricted to have a gaze angle less than 90 degrees.

Establishing flow fields for view interpolation can be difficult, in particular for real images. Computer vision techniques such as feature correspondence or stereo must be employed. For synthetic images, flow fields can be obtained from the known depth values.

View morphing

From two input images, Seitz and Dyer's view morphing technique (1996) reconstructs any viewpoint on the line linking two optical centers of the original cameras. Intermediate views are exactly linear combinations of two views only if the camera motions associated with the intermediate views are perpendicular to the camera viewing direction. If the two input images are not parallel, a pre-warp stage can be employed to rectify two input images so that corresponding scan lines are parallel. Accordingly, a post-warp stage can be used to un-rectify the intermediate images. Scharstein (1996) extends this framework to camera motion in a plane. He assumes, however, that the camera parameters are known.

Transfer methods

Transfer methods (a term used within the photogrammetric community) are characterized by the use of a relatively small number of images with the application of geometric constraints (either recovered at some stage or known *a priori*) to reproject image pixels appropriately at a given virtual camera viewpoint. The geometric constraints can be of the form of known depth values at each pixel, *epipolar constraints* between pairs of images, or *trifocal/trilinear tensors* that link correspondences between triplets of images. The view interpolation and view morphing methods above are actually specific instances of transfer methods.

Laveau and Faugeras (1994) use a collection of images called reference views and the principle of the fundamental matrix to produce virtual views. The new viewpoint, which is chosen by interactively choosing the positions of four control image points, is computed using a reverse mapping or raytracing process. For every pixel in the new target image, a search is performed to locate the pair of image correspondences in two reference views. The search is facilitated by using the epipolar constraints and the computed dense correspondences (also known as image disparities) between the two reference views.

Note that if the camera is only weakly calibrated, the recovered viewpoint will be that of a projective structure. This is because there is a class of 3-D projections and structures that will result in exactly the same reference images. Since angles and areas are not preserved, the resulting viewpoint may appear warped. Knowing the internal parameters of the camera removes this problem.

If a trifocal tensor, which is a $3 \times 3 \times 3$ matrix, is known for a set of three images, then given a pair of point correspondences in two of these images, a third corresponding point can be directly computed in the third image without resorting to any projection computation. This idea has been used to generate novel views from either two or three reference images.

The idea of generating novel views from two or three reference images is rather straightforward. First, the "reference" trilinear tensor is computed from the point correspondences between the reference images. In the case of only two reference images, one of the images is replicated and regarded as the "third" image. If the camera intrinsic parameters are known, then a new trilinear tensor can be computed from the known pose change with respect to the third camera location. The new view can subsequently be generated using the point correspondences from the first two images and the new trilinear tensor.

2.3.3 Rendering with explicit geometry

3D warping

When the depth information is available for every point in one or more images, 3D warping techniques can be used to render nearly viewpoints. An image can be rendered from any nearby point of view by projecting the pixels of the original image to their proper 3D locations and re-projecting them onto the new picture. The most significant problem in 3D warping is how to deal with holes generated in the warped image. Holes are due to the difference of sampling resolution between the input and output images, and the disocclusion where part of the scene is seen by the output image but not by the input images. To fill in holes, the most commonly used method is to splat a pixel in the input image to several pixels size in the output image.

To improve the rendering speed of 3D warping, the warping process can be factored into a relatively simple pre-warping step and a traditional texture mapping step. The texture mapping step can be performed by standard graphics hardware. This is the idea behind relief texture, a technique proposed by Oliveira and Bishop (1999). Similar factoring approach has been proposed by Szeliski in a two-step algorithm (1998) where the depth is first forward warped before the pixel is backward mapped onto the output image.

The 3D warping techniques can be applied not only to the traditional perspective images, but also multi-perspective images as well. For example, Rademacher and Bishop (1998) proposed to render novel views by warping multiple-center-of- projection images, or MCOP images.

Layered depth images (LDI)

To deal with the disocclusion artifacts in 3D warping, Shade et al. proposed Layered Depth Image, or LDI (1998), to store not only what is visible in the input image, but also what is behind the visible surface. In LDI, each pixel in the input image contains a list of depth and color values where the ray from the pixel intersects with the environment.

Though LDI has the simplicity of warping a single image, it does not consider the issue of sampling rate or how densely should the LDI be. Chang *et al.* (1999) proposed LDI trees so that the sampling rates of the reference images are preserved by adaptively selecting an LDI in the LDI tree for each pixel. While rendering with the LDI tree, only the level of LDI tree that is the comparable to the sampling rate of the output image need to be traversed.

View-dependent texture maps

Texture maps are widely used in computer graphics for generating photo-realistic environments. Texture-mapped models can be created using a CAD modeler for a synthetic environment. For real environments, these models can be generated using a 3D scanner or applying computer vision techniques to captured images. Unfortunately, vision techniques are not robust enough to recover accurate 3D models. In addition, it is difficult to capture visual effects such as highlights, reflections, and transpency using a single texture-mapped model.

To obtain these visual effects of a reconstructed architectural environment, Debevec *et al.* (1996) used view-dependent texture mapping to render new views, by warping and compositing several input images of an environment. A three-step view-dependent texture mapping method was also proposed later by Debevec *et al.* (1998) to further reduce the computational cost and to have smoother blending. This method employs visibility preprocessing, polygon-view maps, and projective texture mapping.

2.4 A Business Model and its Development Strategies for Electronic Tourism Markets

The tourist industry is one of the most successful areas of the electronic market because it is a consumer-oriented industry where services and information play a large part in transaction processes [3]. To increase transaction effectiveness and efficiency within the tourism market, and provide onestop services to customers, the electronic tourism market needs a new business model different from that of the industrial economy.

This article proposes a business model for electronic tourism markets, the strategies for its development, and a case study of the electronic tourism market. The strategies largely refer to the case of Kyongju Electronic Tourism Market (hereafter called KETM), the electronic tourism market that integrates tourist information systems, reservation systems, real-time broadcasting systems, Web-based geographical information systems, and the shopping mall including electronic payment systems based on the Internet.

The KETM is an electronic tourism market developed by collaborative efforts of both the public and the private sectors of the tourism destinations located in Kyongsanbuk-do, Korea, with emphasis on the city of Kyongju. The provincial government of yongsanbuk-do and the Ministry of Information and Communication of Korea provided funding for the KETM project (http://www.clicktour.kyongbuk.kr) to accomplish collaborative goals, namely improvements of competitiveness for the regional tourism industry.

The ultimate goal of the KETM is not only to promote the tourism destinations, but also to attain one-stop travel services with sources of revenues (Figure 9).

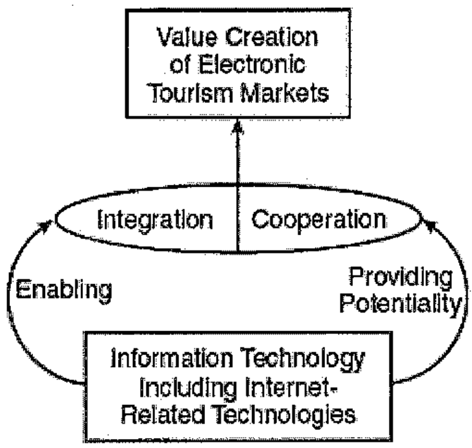


Figure 5 Relationship between Information Technology and Integration or Cooperation

Information technology is not a direct criterion for classifying business models of electronic tourism markets, but the driver of integration and cooperation because information technology has fueled their evolution.

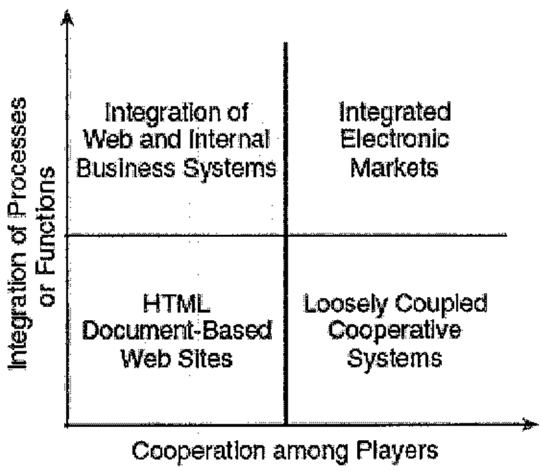


Figure 6 A classification of Electronic Tourism Markets

Phase	Characteristics	Case	Remarks
HTML document-based Web site	Travel information Promotion of products or services Electronic catalog of tour packages	Most individuals' Web sites for providing travel information	Only partial information, fitted with objectives of the Web site, is provided to travelers
Integration of Web and internal business systems	Integration of database systems and Web Efficient information retrieval Efficient and convenient information management for changes of source data	Web-based tourism information systems of the Korea National Tourism Organization, which integrated Web into existing tour database systems	The critical factors are efficient and convenient information search, and easy maintenance
Loosely coupled cooperative systems	Cooperation among players of the travel industry Electronic payment service through an alliance with credit card companies	Travelocity of SABRE Interactive and cyber travel agents	The critical factors are cooperation among players as well as those of the previous phase
Integrated electronic market	One-stop travel service Integration of internal and external systems, and extensive cooperation with various players Personalized travel services	Many portal sites specializing in the tour service want to reach this phase	Contents, community, commerce, as well as those of the previous phase are critical factors

Figure 7 Characteristics and the Case by Each Evolutionary Phase of Electronic Tourism Markets

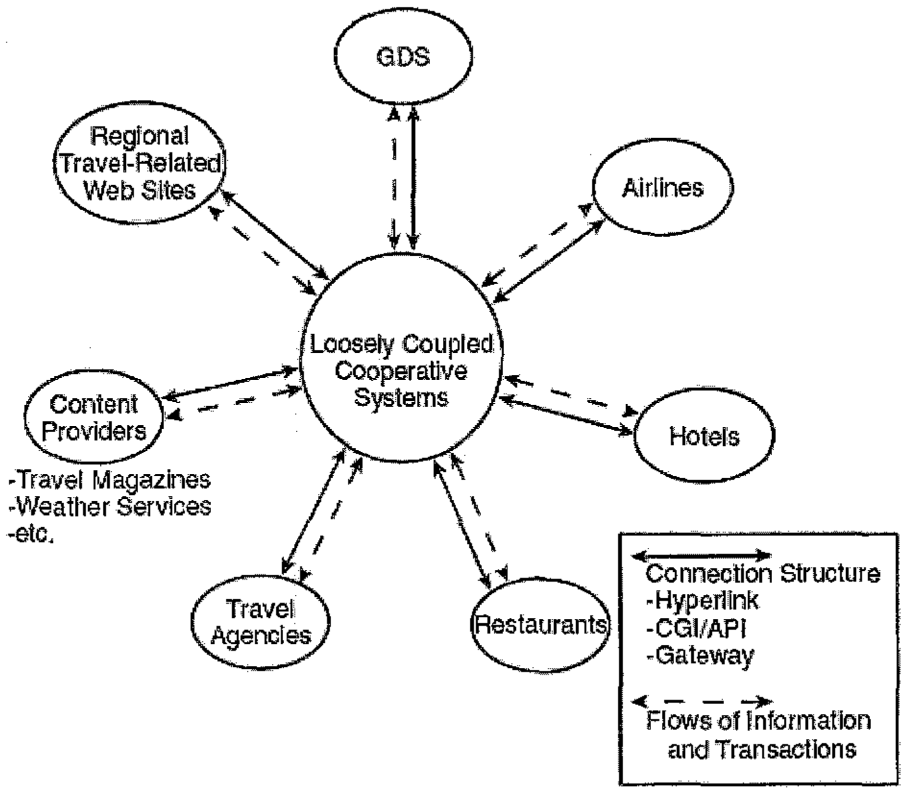


Figure 8 Cooperative Relationship between Businesses of the Tourism Industry

The virtual community could have significant effects on electronic markets. Virtual communities of the electronic tourism market can be organized according to the following alternatives:

- Providing exciting dynamic services enabling potential travelers to get virtual experiences for destinations, events, and so forth
- Providing exciting contents such as quizzes and entertainment
- Providing various services such as message boards including opinions and responses, chat rooms, free e-mail, and a free Web page
- Matching regional tourism experts and potential travelers who want to get some advice for a specific destination or culture

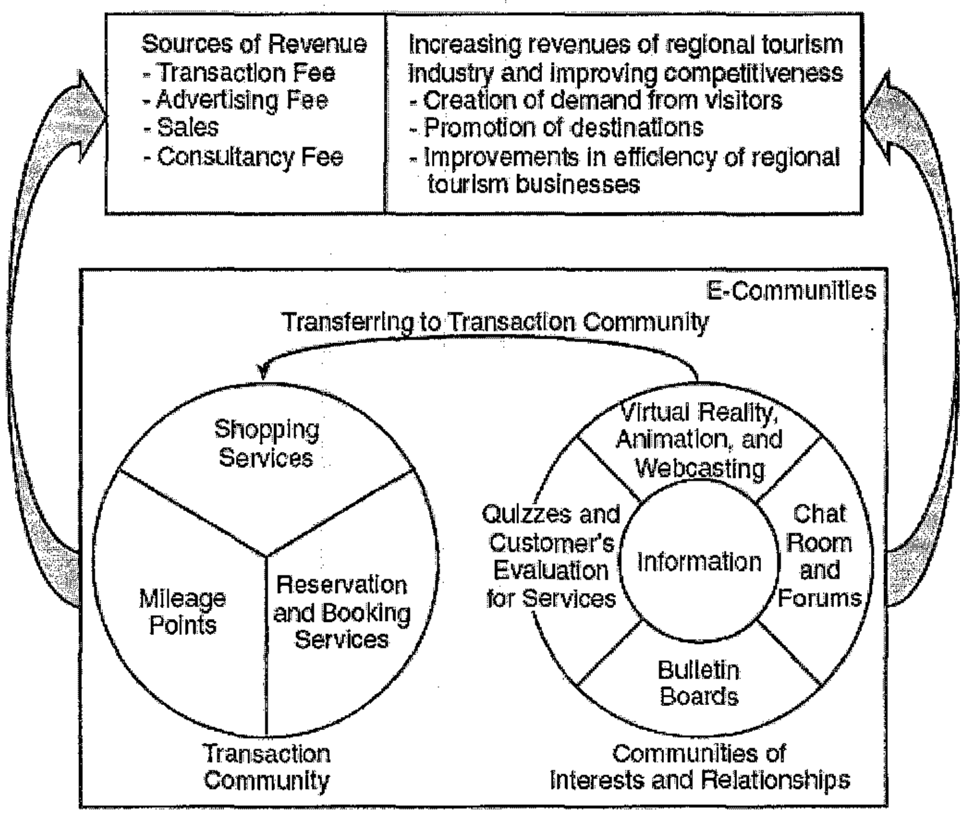


Figure 9 Sources of Revenue and Benefits in Kyongju Electronic Tourism Market (KETM)

Services	Overview
Tour information	Tour attractions Accommodations Restaurant Transportation Specialty products Full-text search Recommended tour: recommendation of tour packages that meet customers' requirements for their budget and interests as well as providing information on them Culture and leisure Events and festivals Virtual tour: virtual experiences of tour attractions and cultural assets with immersive panoramas, virtual tour, 3D objects, and flash animation Electronic map: searching services on electronic maps exploiting Web-based geographical information systems Bulletin board, chat room and forum: forum corner for matching customers and experts on travel-related domains Quiz: quizzes for culture, cultural properties, attractions, foods, specialty products, etc. (The goal of this program is to promote regional destinations and to convert the community of interests into the transaction community by providing incentives to buy some specialty products for visitors getting high points.)
Web broadcasting	Kyongju World Culture Expo: online and real-time broadcasting of performances at the World Culture Expo as well as video-on-demand services for major tour attractions and regional events
Reservations and payment services	Online reservations and payment: reservation and payment services for more than two airlines, 27 hotels, 200 motels, and 320 restaurants
Shopping mall and payment services	Search (by categories and product), order, payment, and delivery services for local specialty products

Figure 10 Services of the Kyongju Electronic Tourism Market (KETM)

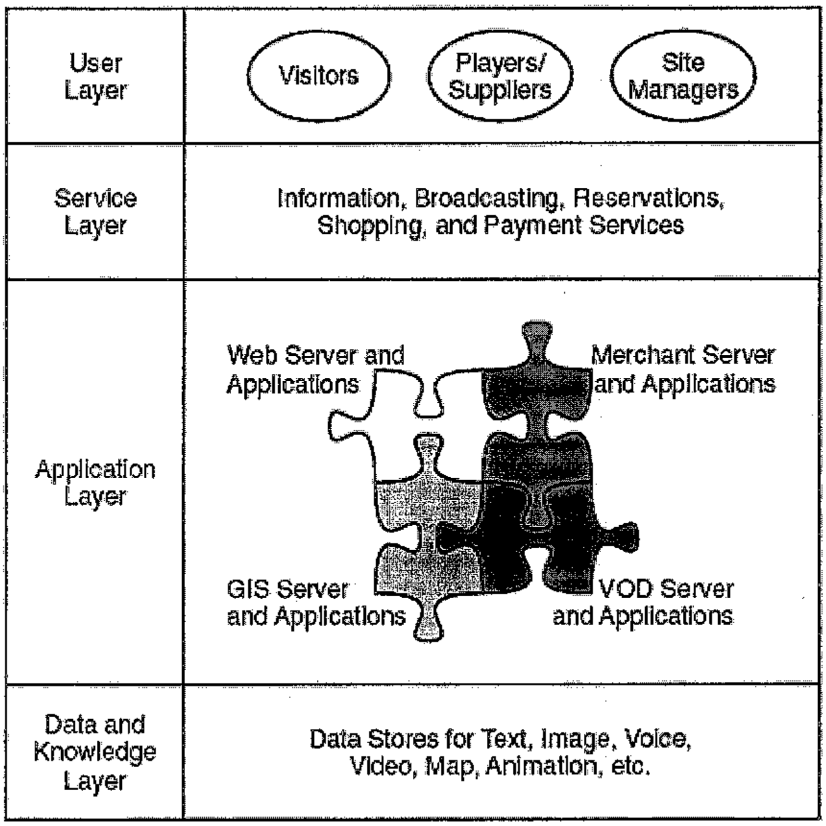


Figure 11 The Architecture of the Kyongju Electronic Tourism Market (KETM)

CHAPTER 3
METHODOLOGY/PROJECT WORK

3.1 Methodology

The methodology that is used to conduct the project is like two way development model. It can repeat the tasks if it is not appropriate. I chose this methodology because it is more able to cope with the (nearly inevitable) changes that software development generally entails. Figure 12 below shows the development model:

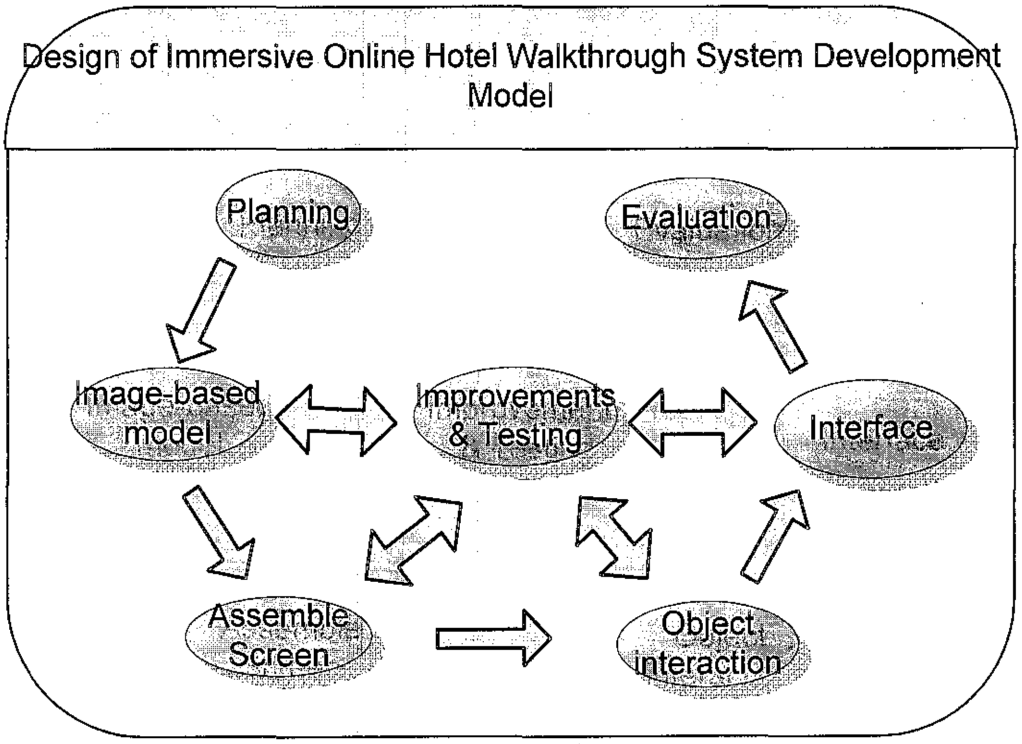


Figure 12 Design of Immersive Online Hotel Walkthrough System Development Model

The advantage of this development process is that the growth is built upon successful existing programs so the new growth is well-supported. It shorten turn around time for emergent user needs, focus on the most critical user needs at the current time, address threat changes, technology improvements, parts obsolescence, new missions, congressional influence and continuous feedback between testers, users and developers.

3.1.1 Planning

Planning for the images to assemble in the workplace requires a research on how to index the images. Articles and journals related to the images based rendering, techniques for compression, and indexes of a large image database has been read to grab a basic idea on each of the steps involved in creating an image-based rendering virtual walkthrough. Discussion and consultation on the related topics with Mr. Yew Kwang Hooi need actions on how to produce the result and outcome.

3.1.2 Image-based model

Images from the hotel are captured using the required tools on many angles and the number of pictures in 360 °. The output gives a different result on the smoothness the images can be. At first, the idea of capturing the images is using the octagon basis. Means the pictures are captured on each angles of octagon and then assemble the images according to the indexes. Lighting changes during capturing process is another outcome that needs to research more on the light ray. For final result, this idea is more suitable for image mosaicing technique.

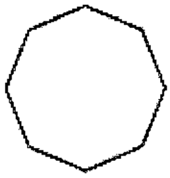


Figure 13 Octagon

3.1.3 Assemble screen

Discussion with the supervisor focused more on the how to assemble all the images that have been taken. Propose the channels are divided into several navigation and environment. Indexing number of images for a large number of databases needs a proper arrangement. One of the idea is using the equation of $f = 4x + y + 1$.

	0	1	2	3
0	1	2	3	4
1	5	6	7	8
2	9	10	11	12
3	13	14	15	16

Figure 14 Indexing method

For the image mosaicing, the assemble screen need to be stitching in order to gather the view.

3.1.4 Object interaction

For the image-based walkthrough, object interaction in Macromedia Flash needs an actionScript to execute the interaction well. These include how to turn on and off the layer. Layer properties such as layer.visible and set a Boolean value that specifies whether the layer's objects on the stage are shown or hidden. Dictionaries on the actionScript are required to refer for the commands. For the image mosaicing walkthrough, object interactions in Reality Studio are using the hotspot.

3.1.5 Interface

A prototype of the interface is developed in order to place the flash and displays the navigation such as turn right, left, forward and backward. A web-based of the hotel room is build in order to place the walkthrough.

3.1.6 Improvements & Testing

In between of each process of the development, there are improvements and testing to test the output whether it is working or not. Exercises on the Macromedia Flash tutorials are essential before implementing on the real stage of series of images.

3.1.7 Evaluation

After the virtual walkthrough prototype has been constructed, evaluations are conducted on various aspects to measure the quality of the virtual walkthrough created. Evaluations are carried out on the memory storage consumed by the virtual walkthrough prototype, smoothness of the virtual walkthrough as well as the quality of the virtual scene display.

3.2 Project Task Breakdown

The project is divided into 3 main parts. The first part which is done during the current semester FYP Part A is to conduct the requirement study and analysis on the proposed topic such as the research methodology, literature reviews and tools required. The study is also focus on the use of the appropriate development tools for the project such as Photovista Panorama, Reality studio, Macromedia Dreamweaver Professional 8 and Macromedia Flash Professional 8. During this stage, the image-based rendering virtual walkthrough is captured in the room hotel.

The second part is during the semester break. This part will be focusing on the development and implementation of the project. The design of image-based walkthrough was implemented.

The third part which is the last part of the project will be doing during the new semester FYP Part B. The part will be focusing on the improvements and testing. The design of the web-based prototype was implemented. The prototype will be tested and some modification will be made if it is required. Gantt chart of activities is provided on methodology section to get clearer of the project. (Refer to the appendices A4)

3.3 Data Gathering Process and implementation

Data gathering starts with capturing the 360° in the Hotel Seri Malaysia, Ipoh room. The room type for this experiment is twin sharing room. Below is the layout in the room:

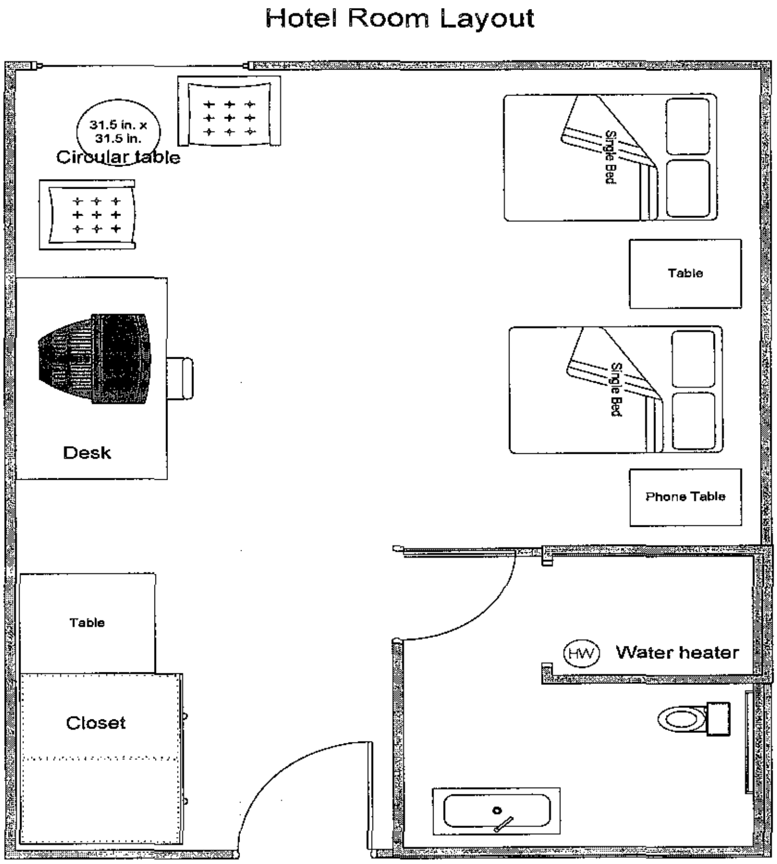
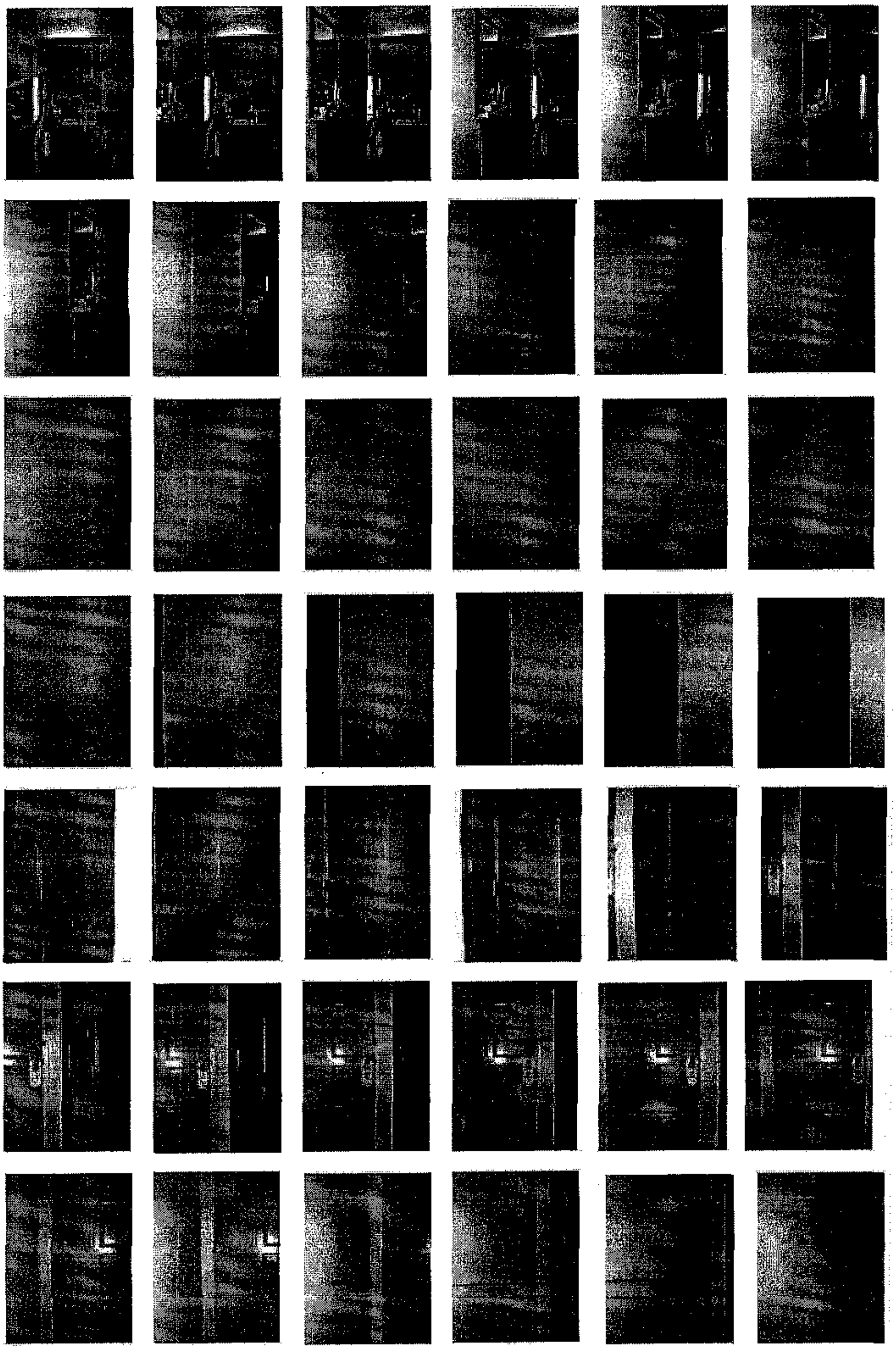


Figure 15 Hotel room layout



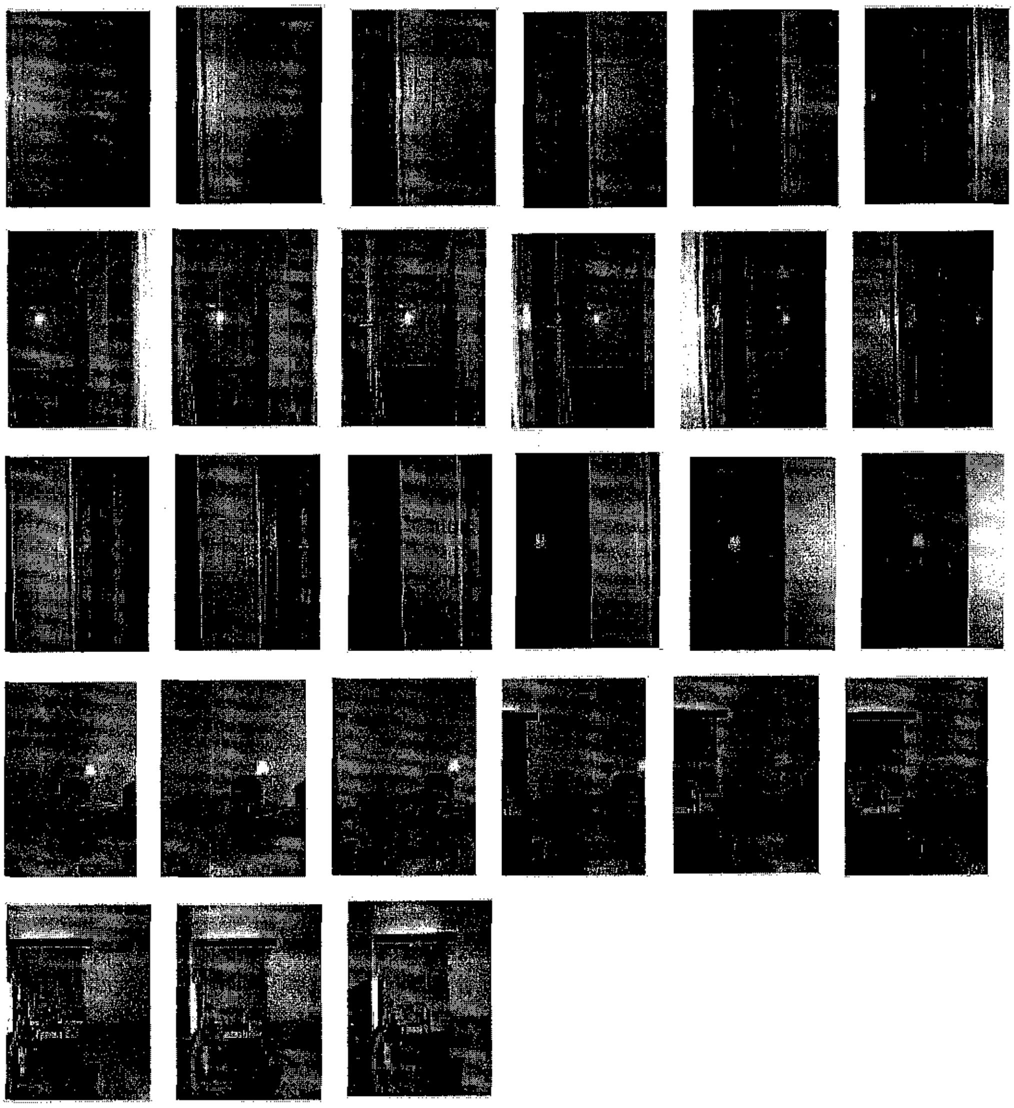
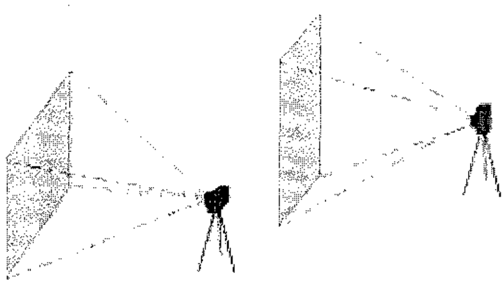


Figure 16 Images taken 360° in single rotation vertically

The camera settings used to take the single direction images are as below:

- Image quality: High Quality (2816x2112)
- Flash: With flash

Other settings remain unchanged (image stabilization setting). No zooming is applied and the camera is hold vertically in portrait orientation so that the captured photographs will have the maximize viewpoint below and above using tripod. After resizing the image, the size of the image is 450x600.



Landscape orientation. *Portrait Orientation*

Figure 17 Camera orientation

Hotel Room Layout

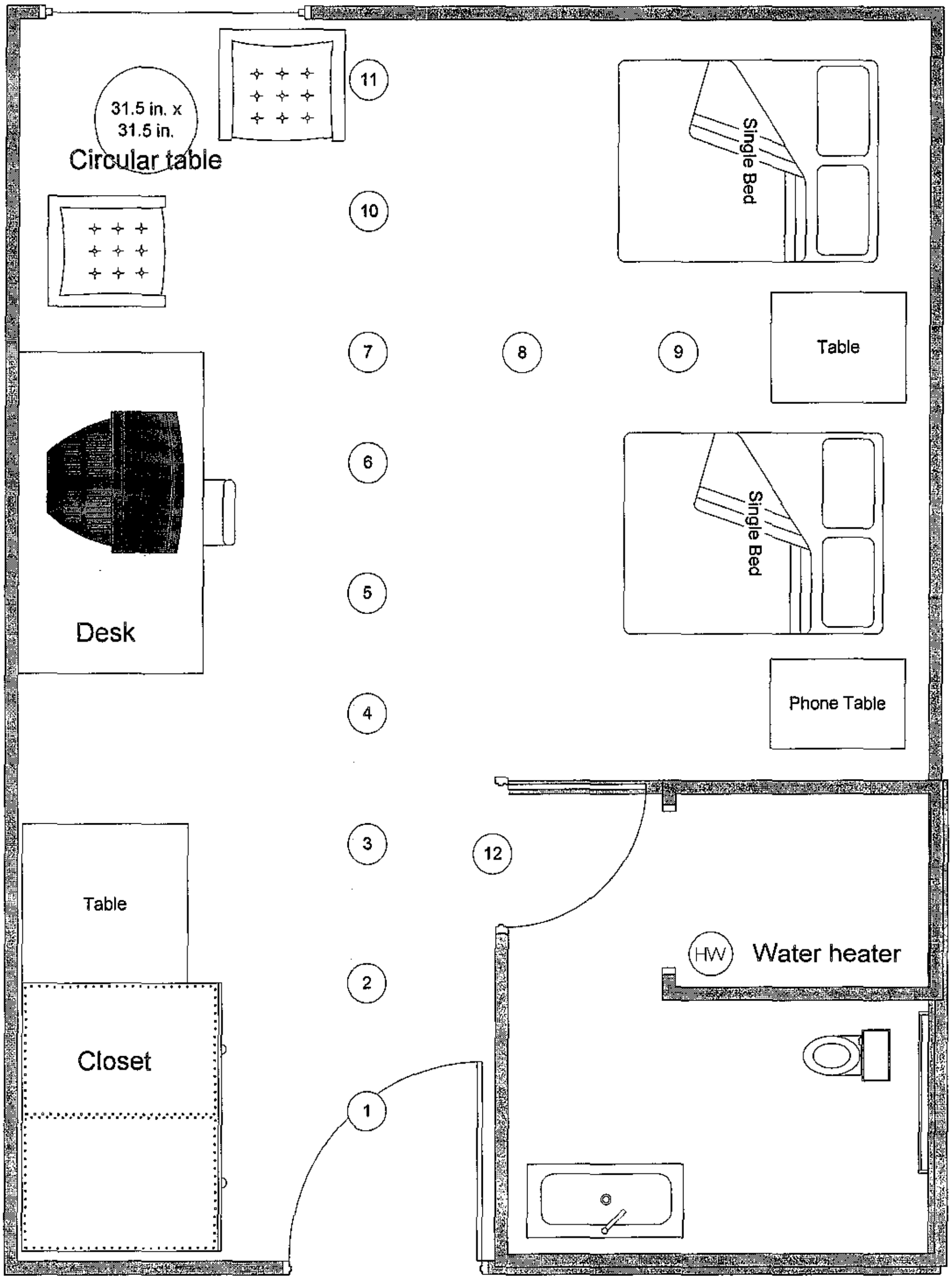


Figure 18 Step points in taking the 360° images

3.4 Screen design

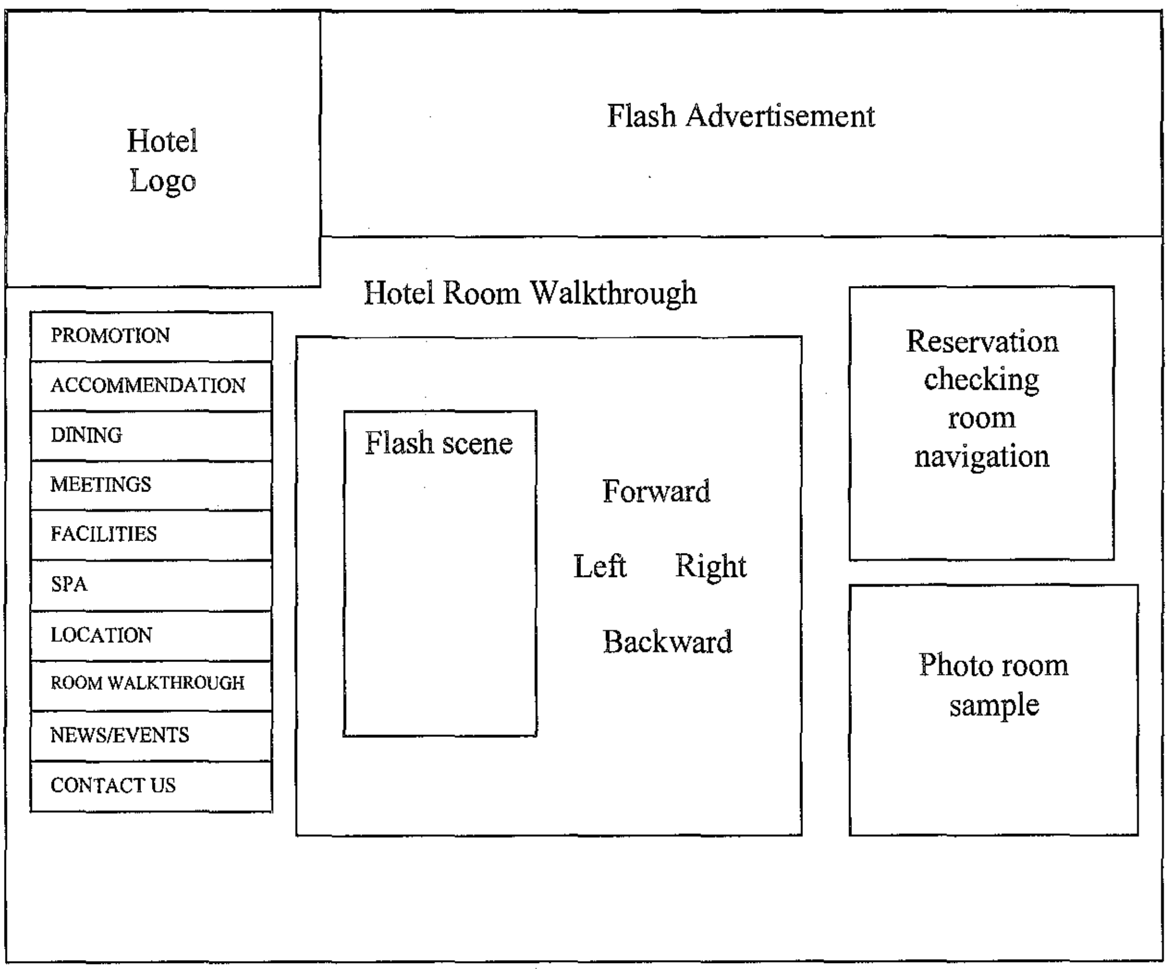
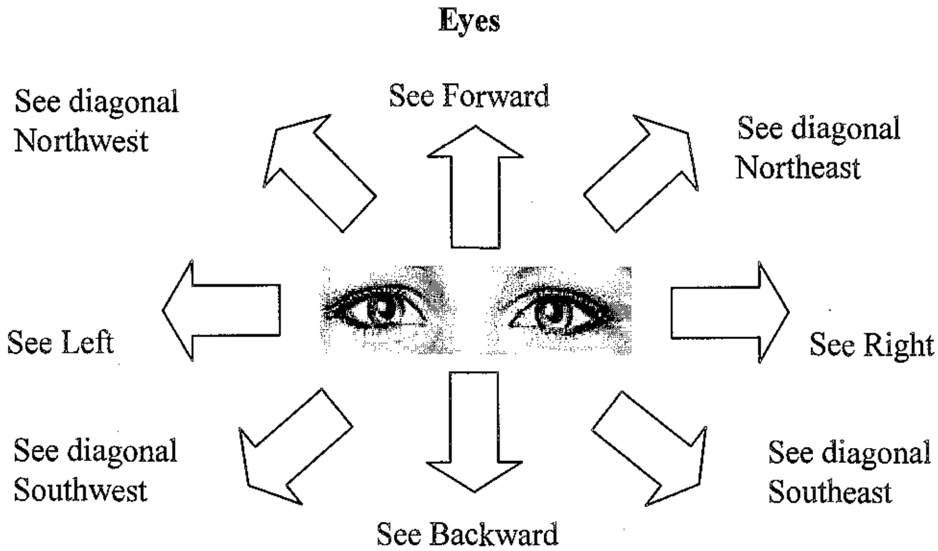
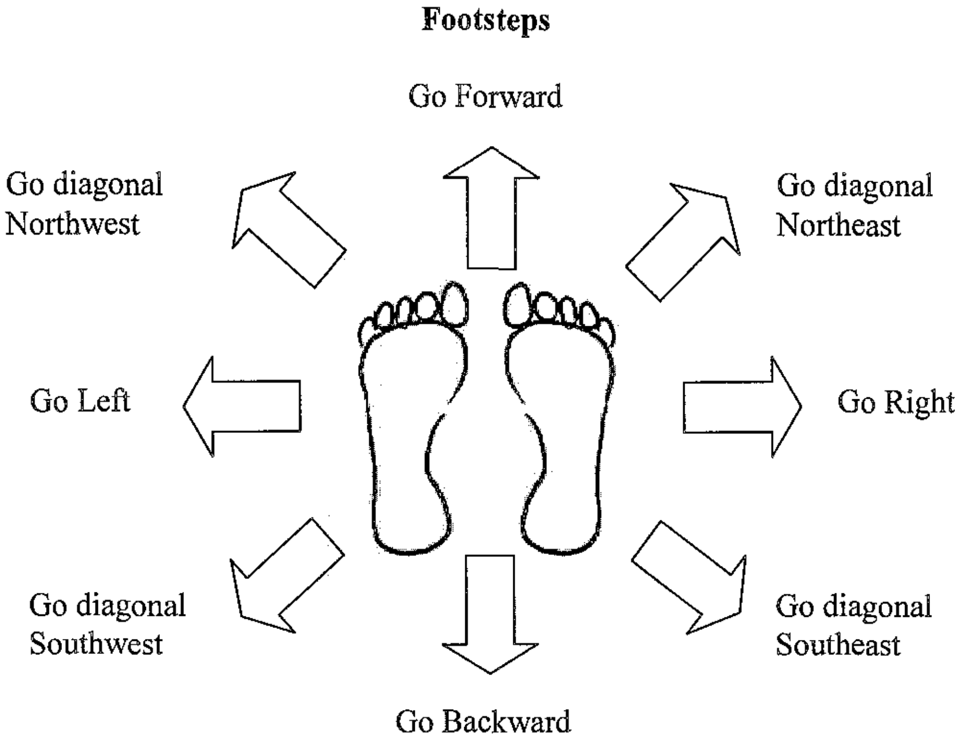


Figure 19 Screen design

3.4.1 Walkthrough Orientation





The user can see right and left of the walkthrough together with the footsteps. Forward and backward orientation can be tested in image mosaicing walkthrough.

3.5 Tools Required

3.5.1 Digital Camera

The main source material in implementing the virtual walkthrough is photographs, thus it is crucial in selecting the type of digital camera which can produce the sets of photographs with the desired quality. This is very important to ensure that the virtual walkthrough constructed has good display quality. The selected digital camera is Olympus FE-190, which has 3x optical zoom and has the capability of capturing digital photographs with 6.0 Megapixels resolution. Professional tripod is used when capturing the photographs. The quality of the photographs captured is good enough to be used in the virtual walkthrough prototype. The professional tripod that I used is borrowed from UTP Civil Engineering Department.

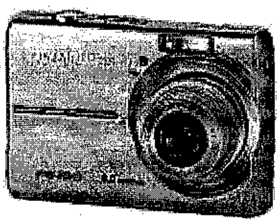


Figure 20 Camera Digital

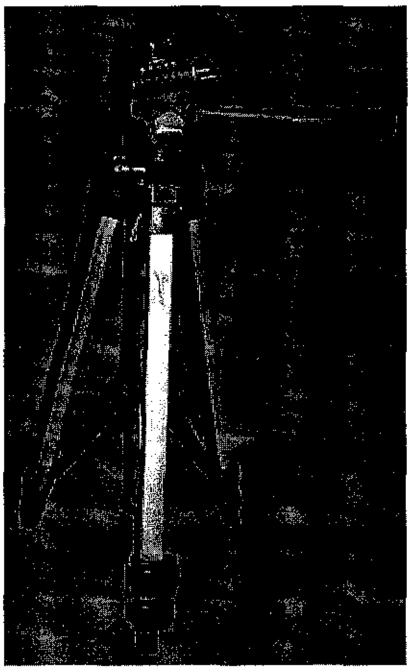


Figure 21 Professional Tripod

3.5.2 Hardware

The whole implementation work of the image-based virtual walkthrough prototype is implemented on a personal computer installed with only:

- Operating system - Microsoft Windows XP Professionals Version 2002 Service Pack 2
- Intel Pentium M 760 processor (2MB L2 cache,2.0 GHz,533MHz FSB)
- Ram of 512MB
- hard disk space of 60 GB

3.5.3 Software

Image-based Virtual Walkthrough for hotel booking is created and displayed in:

- **Photovista Panorama 3.0**

Photovista Panorama 3.0 puts 180- and 360-degree panorama features sophisticated users appreciate, such as the ability to adjust stitching manually and match the software's settings to a specific type of lens.

- **Reality Studio**

Reality Studio is a complete set of tools to create, edit, serve, and view photorealistic, fully immersive Web content, such as walk-throughs, detailed zoom-ins, virtual browsing, and photo panoramas. Site visitors will be able to examine images and objects in detail by zooming, rotating, or picking up objects without any plug-ins, extra software, or high-bandwidth connections.

This application is designed for ease of use, and requires no special programming or expertise. Reality Studio uses small files that load progressively. Even visitors with low-bandwidth connections can begin interacting immediately and experience the full impact of your site. Reality Studio's Java applet loads automatically to view 3-D scenes, objects, panoramas, and other single-media images, and plug-in viewers give full impact of mixed-media images. The Flashpix Photoshop plug-in makes it easy to acquire, edit, and save Flashpix images using Adobe Photoshop.

Reality Studio includes MGI PhotoVista software, letting you use photos from just about any source and stitch them into multiresolution, 360-degree Flashpix panoramas for viewing or printing. The Object Modeler lets you create 3-D image objects that visitors can rotate and examine closely from any angle. You can create hotspots that link to HTML pages, and add sound effects, animation, or movies to your Web site. Reality Studio supports AVI, JPEG, WAV, animated GIFs, and QuickTime files.

The Image Server enables to distribute images, panoramas, and 3-D objects over the Web, and allows a single user to post and view Reality Studio content on the Web site. Use the Project Manager tool to keep track of all the panoramas and their elements. The World Map tracks links between scenes from a bird's-eye view. The intuitive interface also has integrated view ports and libraries for organizing image-based objects, 3-D objects (including IVR, VRML, and WRL files), Flashpix images, and other multimedia files.

- **Macromedia Flash Professional 8**

It is used to create content for the Adobe Engagement Platform (such as web applications, games and movies, and content for mobile phones and other embedded devices). It features support for vector and raster graphics, a scripting language called ActionScript and bi-directional streaming of audio and video. There are also versions of the Flash Player for mobile phones and other non-PC devices.

Flash Professional 8 added features focused on expressiveness, quality, video, and mobile authoring. New features included Filters and blend modes, easing control for animation, enhanced stroke properties (caps and joins), object-based drawing mode, run-time bitmap caching, FlashType advanced anti-aliasing for text, On2 VP6 advanced video codec, support for alpha transparency in video, a stand-alone encoder and advanced video importer, cue point support in FLV files, an advanced video playback component, and an interactive mobile device emulator.

- **Macromedia Dreamweaver 8.0**

It is a web development tool of the application served as simple WYSIWYG HTML editors but more recent versions have incorporated notable support for many other web technologies such as CSS, JavaScript, and various server-side scripting frameworks.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Project Prototype

A prototype of image-based using concentric mosaic technique walkthrough has been implemented with Macromedia Flash Professional 8 whereas image-based using image mosaic technique walkthrough has been implemented in Reality Studio and Photovista Panorama. Both walkthrough are using the images that are taken from the hotel room. uring the walkthrough, the user will be able to move left and right, forward and backward to discover the walkthrough. Below are some of the screen shots taken from the virtual walkthrough, for more images please refer to the appendices.

4.1.1 Image-based walkthrough using concentric mosaics move left and right

In order for the user to be able to move left and right, Macromedia Flash has coding to move the images left and right by pressing the mouse. The images will move 360 degrees like a series of images.

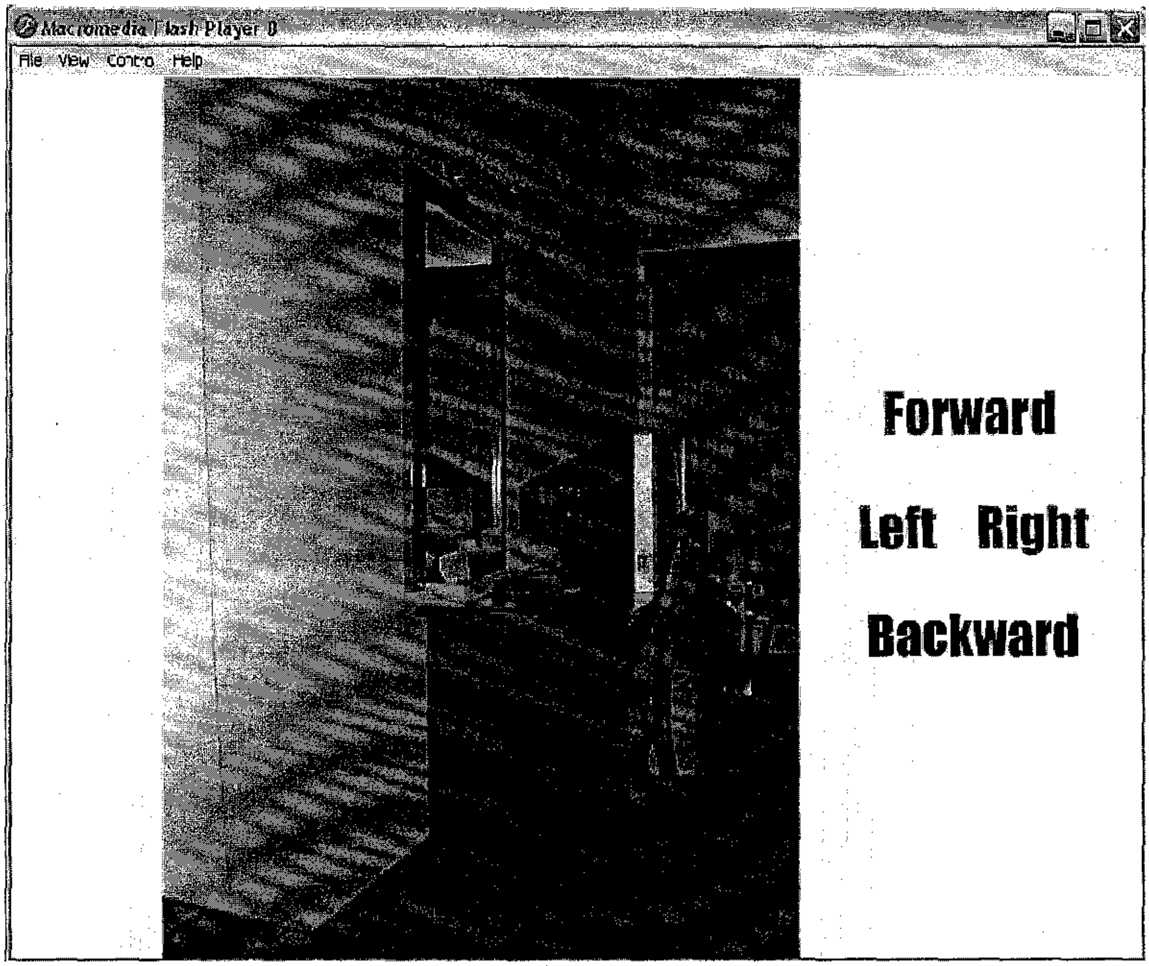


Figure 22 Move left and right (1)

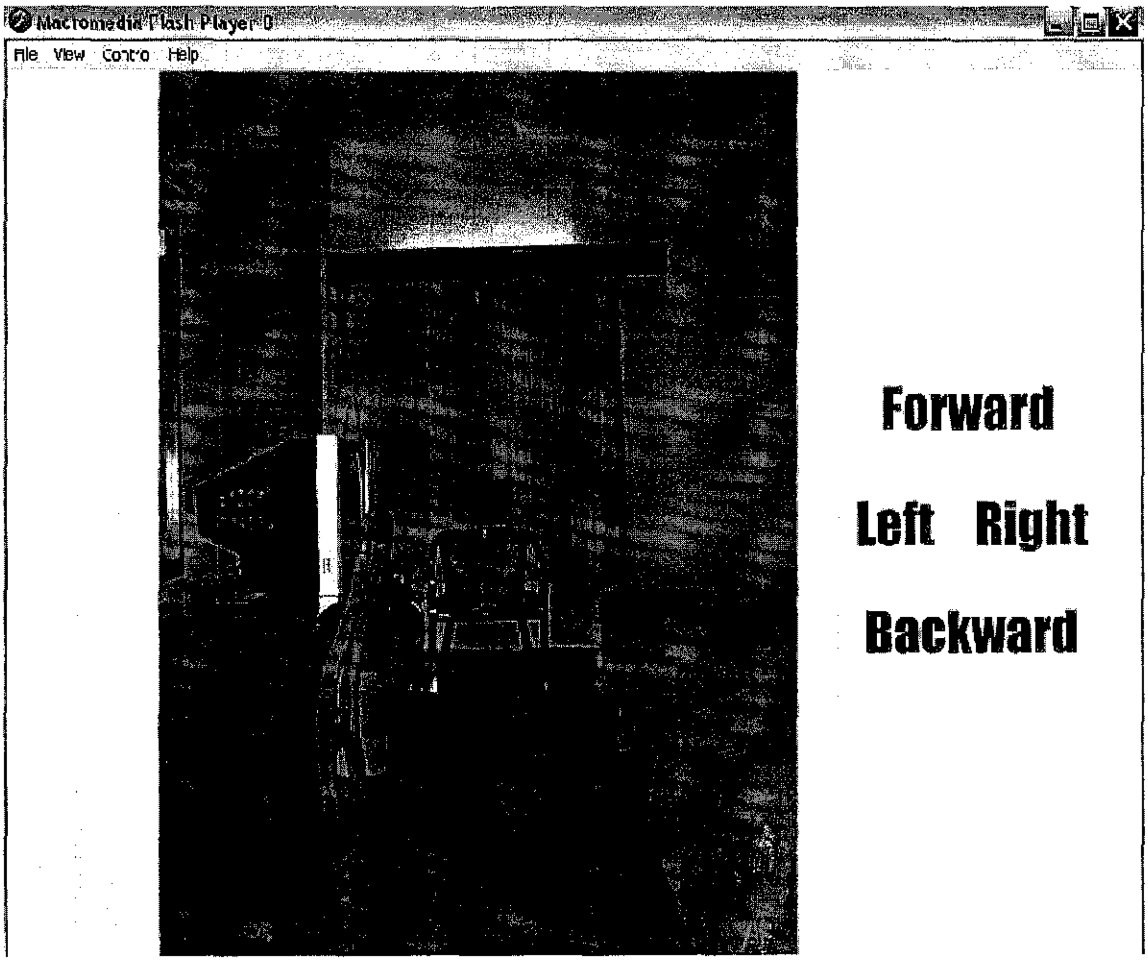


Figure 23 Move left and right (2)

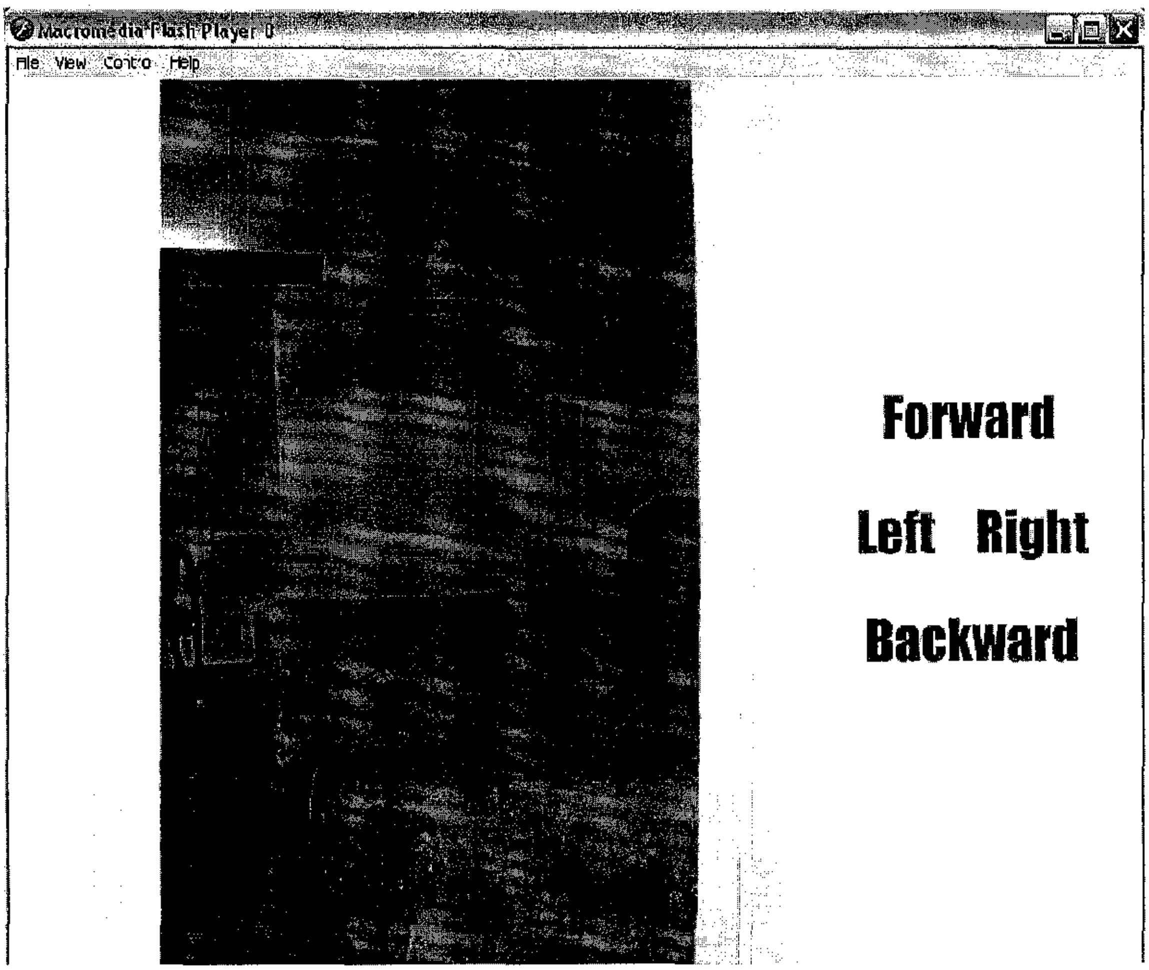


Figure 24 Move left and right (3)

4.1.2 Image mosaicing technique walkthrough

Reality studio has a function to link for the next step by clicking the hotspot. When the user clicks the hotspot, the images will jump to the next step. It also has function to zoom in and zoom out the walkthrough (Refer to the appendices A1 and A2 for more images).

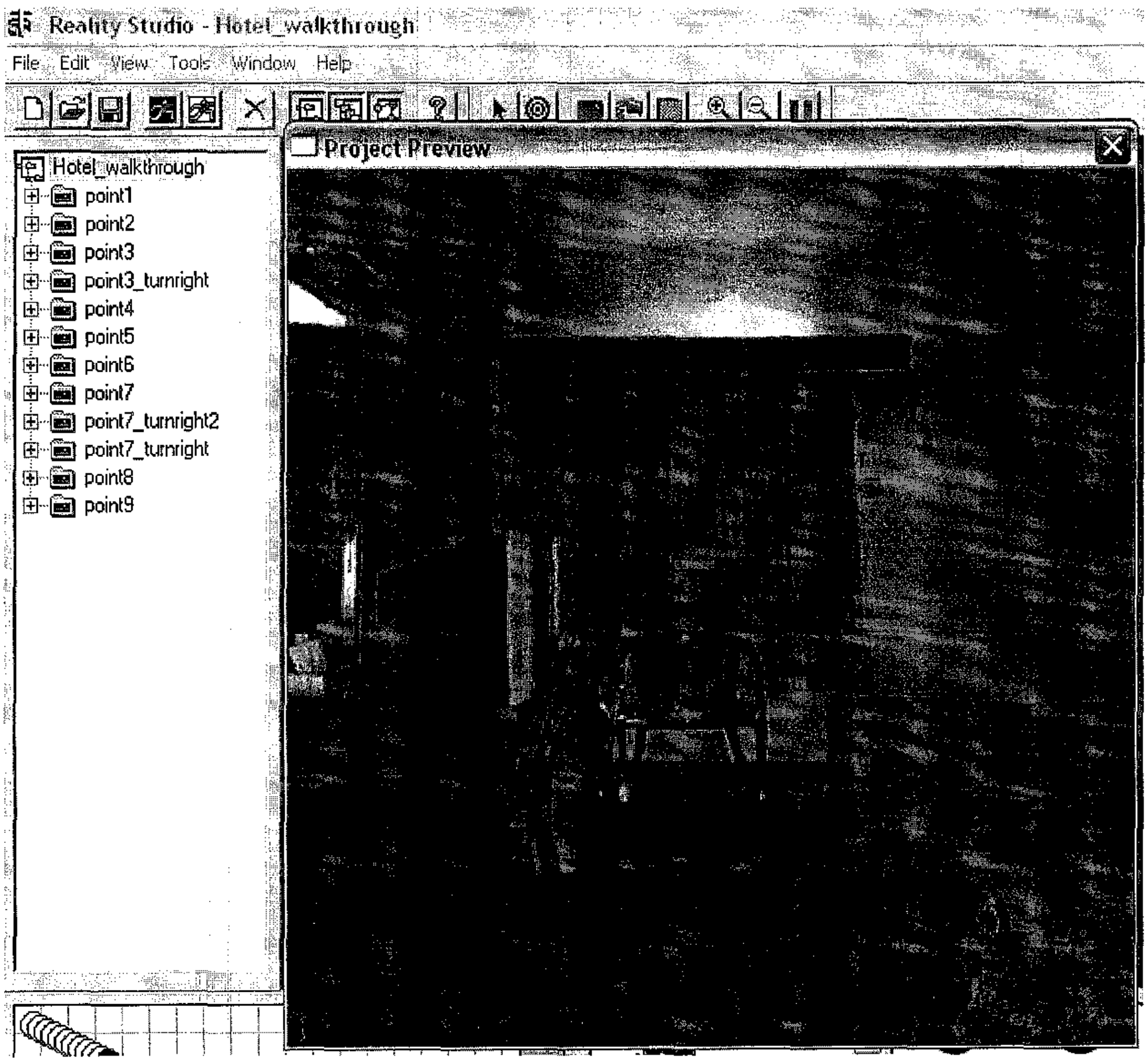


Figure 25 Walkthrough in reality studio

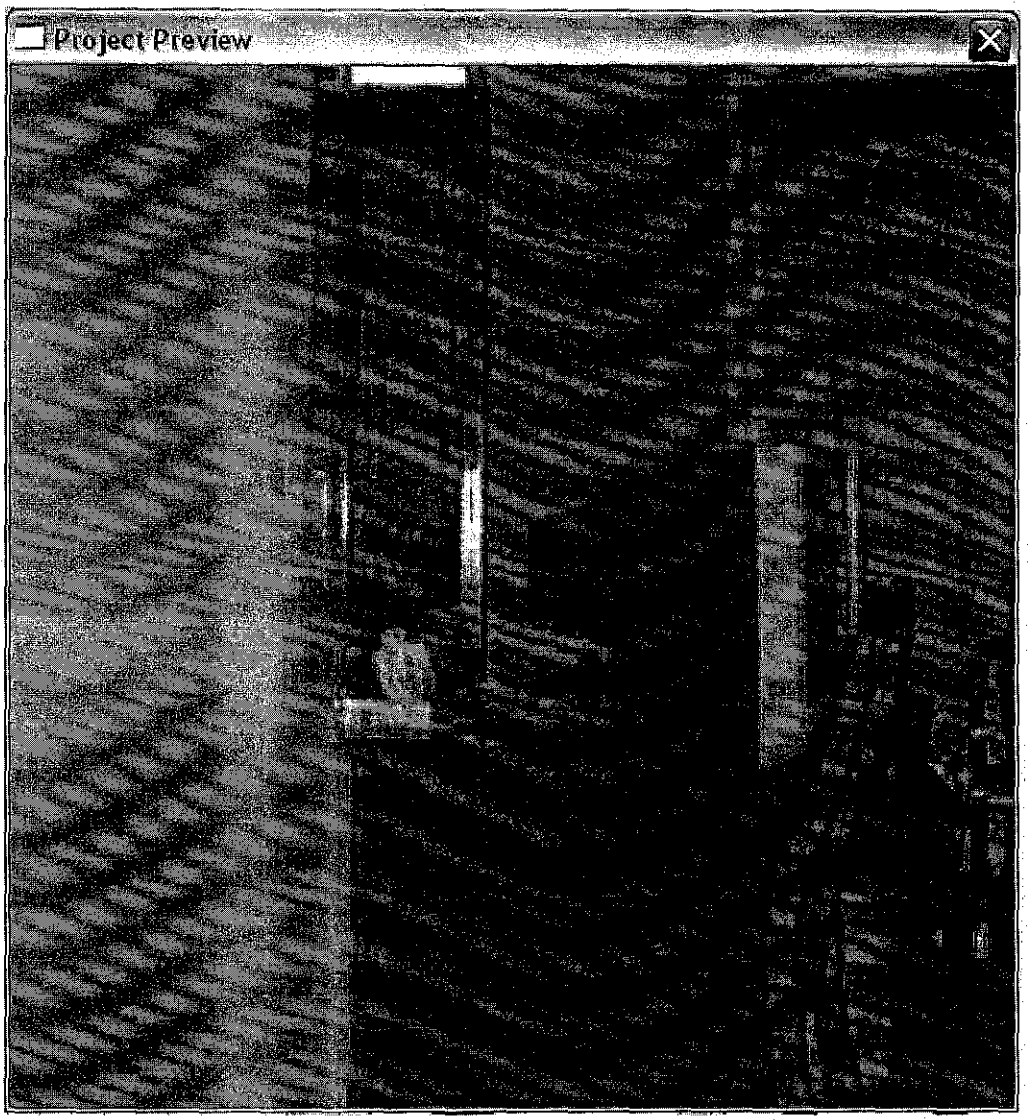


Figure 26 Zoom In

Figure above show the user zoom in the walkthrough by pressing the 'Shift'.

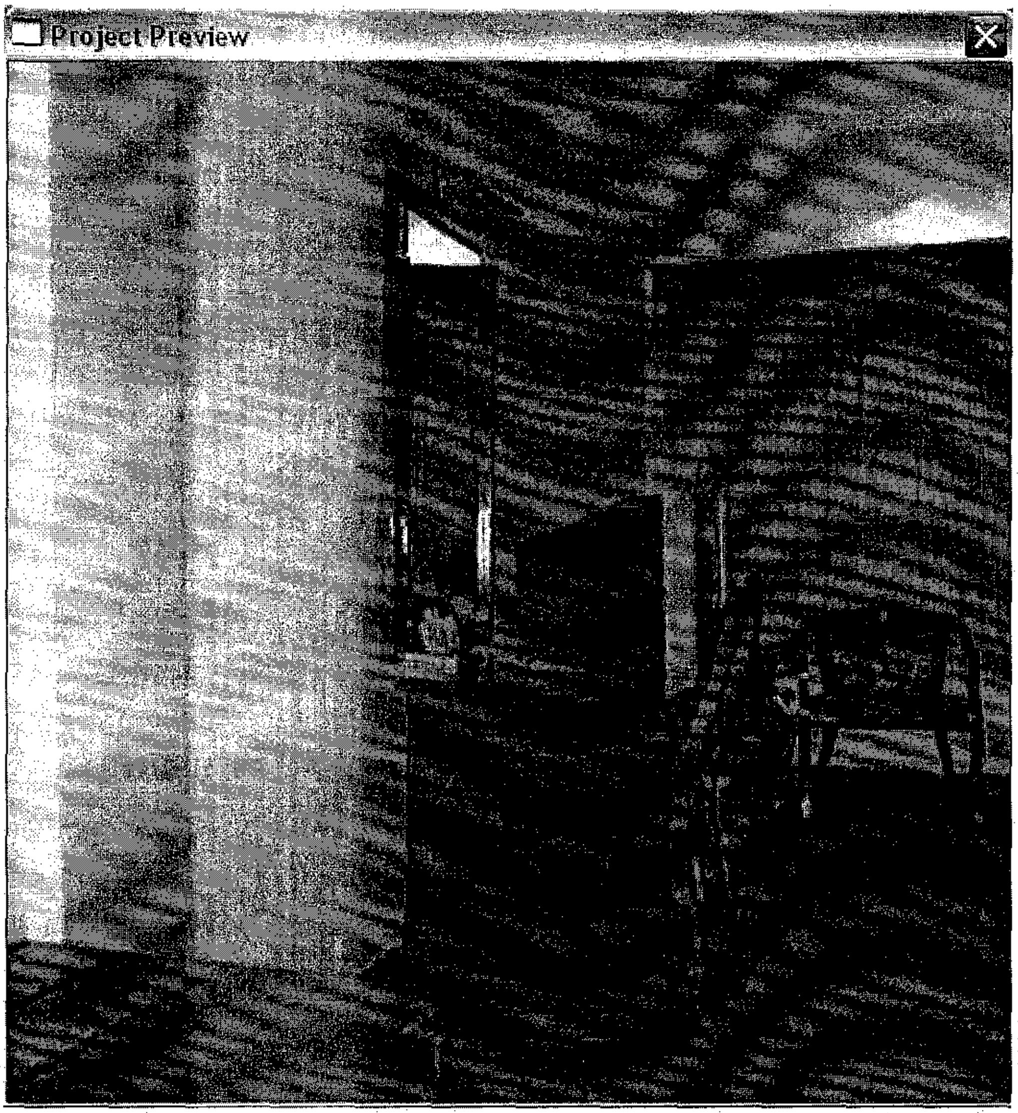


Figure 27 Zoom Out

Figure above shows the user zoom out the walkthrough by pressing the 'Ctrl'.

4.1.3 Image mosaicing technique walkthrough move left and right

In order for the user to move left and right, follow the mouse direction to the left and right. No need to press any arrow on the keyboard.

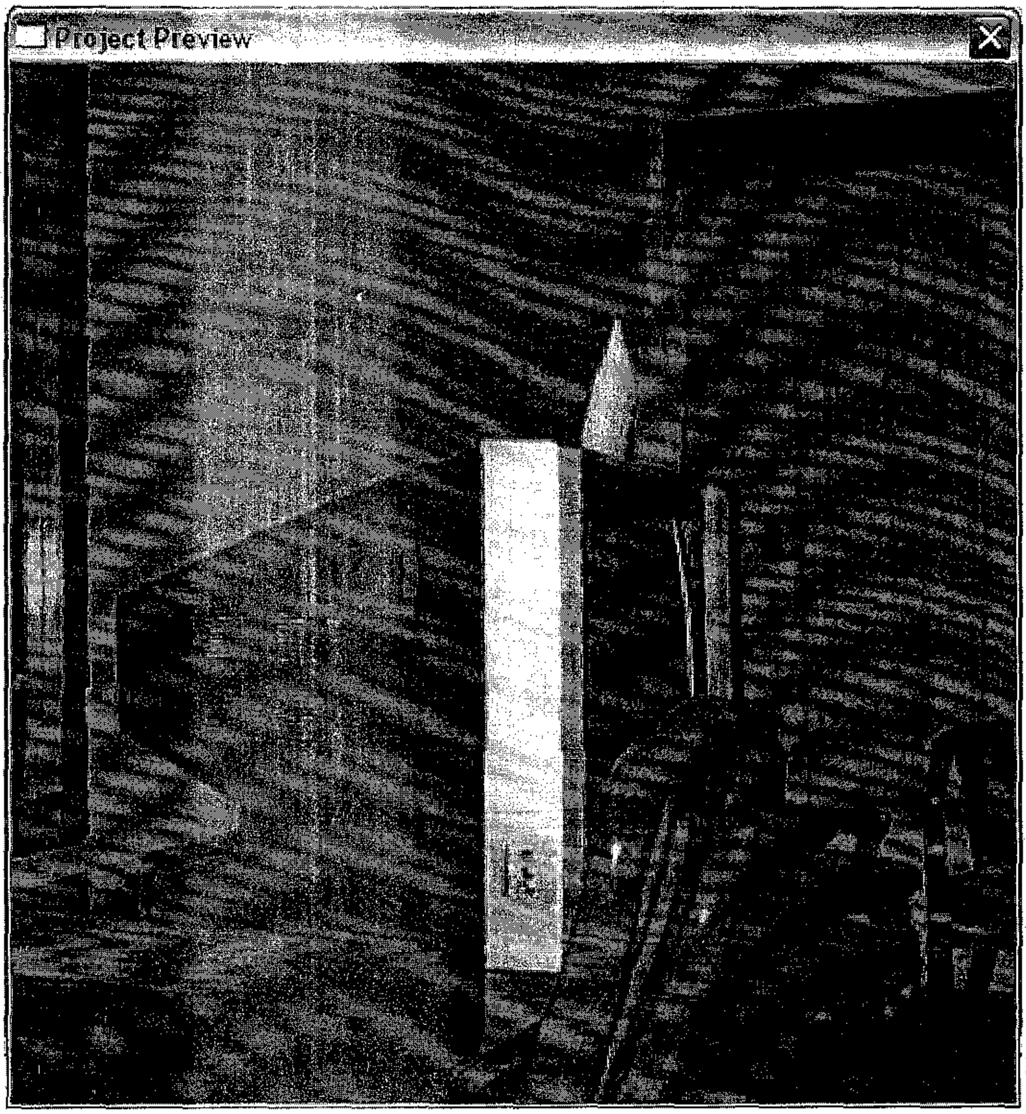


Figure 28: move left and right (1)

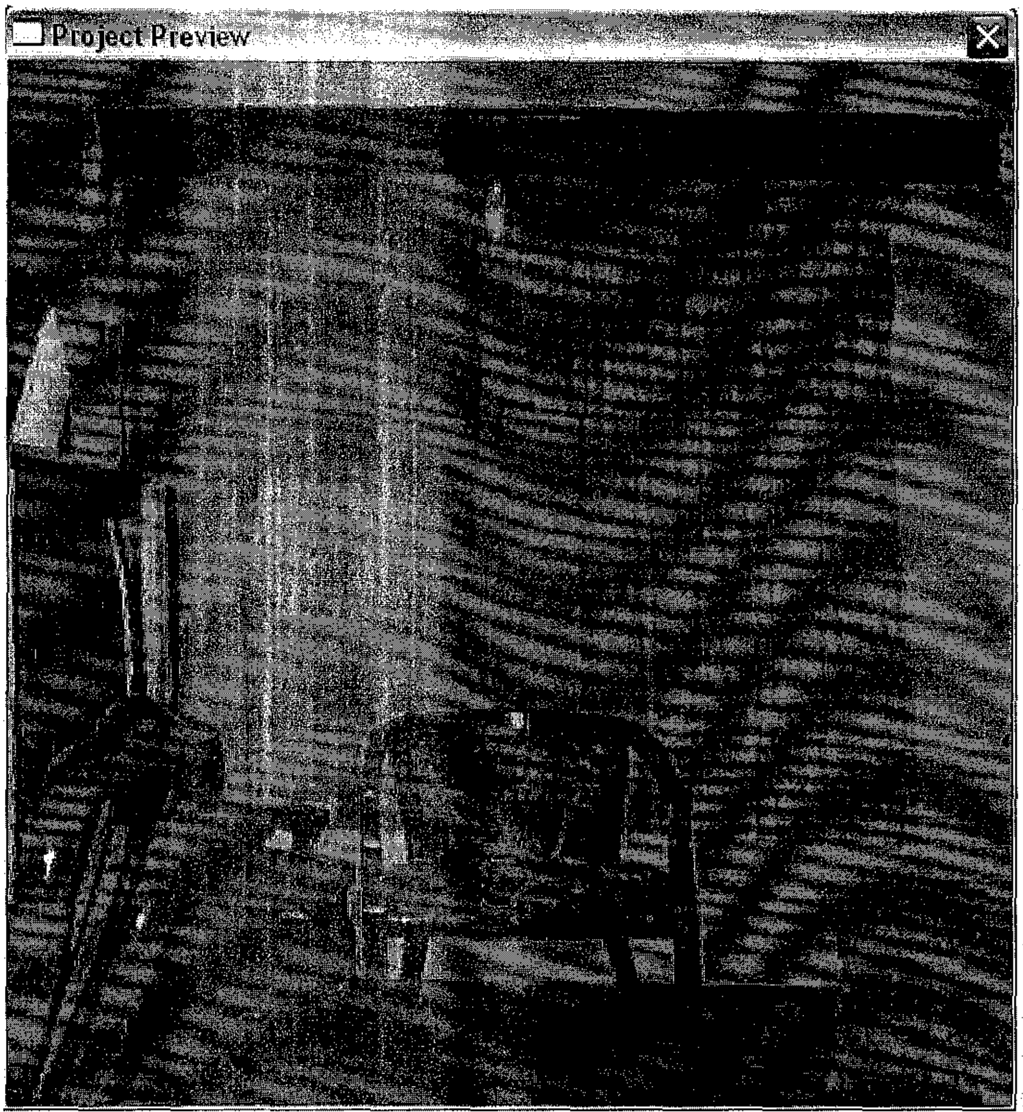


Figure 29 Move left and right (2)

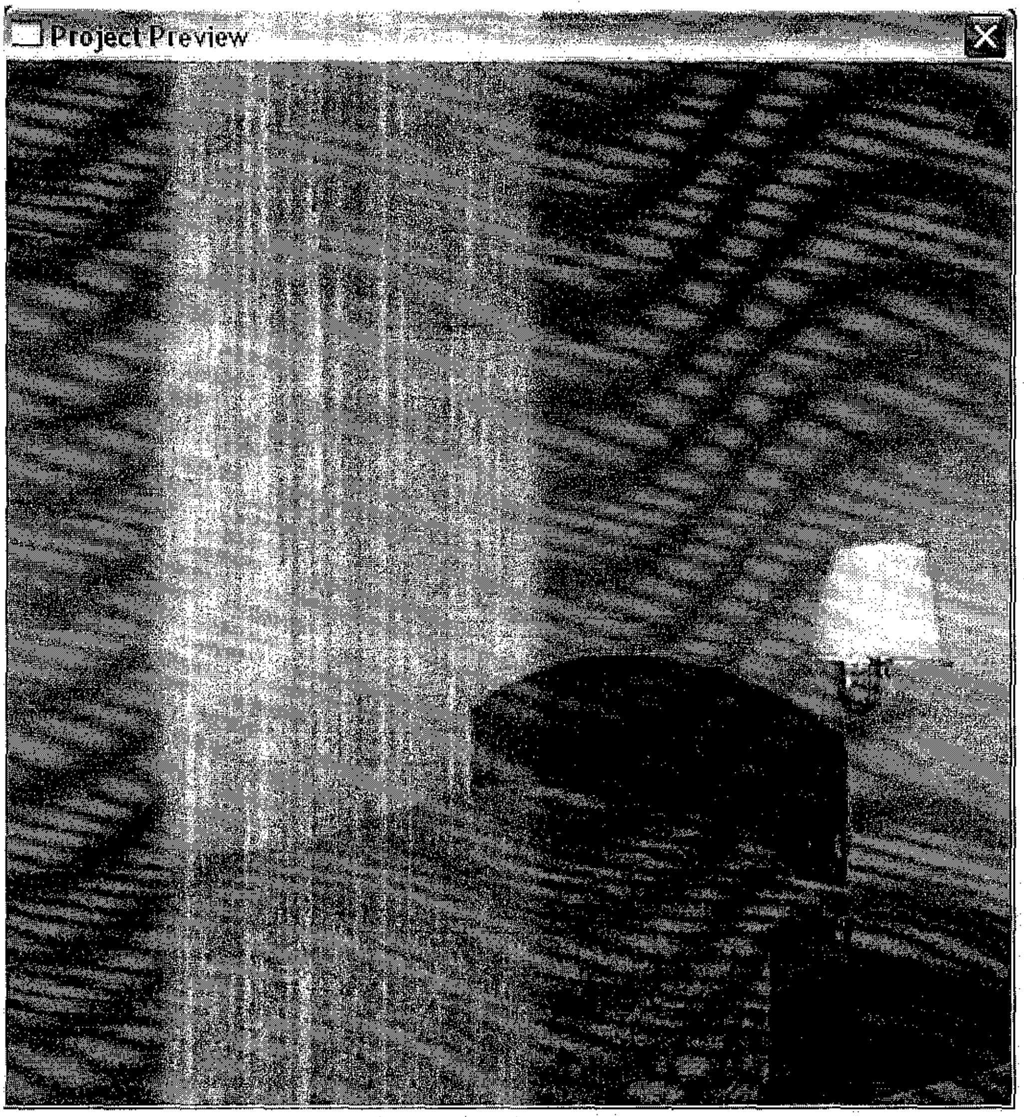


Figure 30 Move left and right (3)

4.1.4 Web-based prototype

Figure 31 Web-based prototype homepage

The web-based prototype is created in Macromedia Dreamweaver professional 8 in html files. The design of web-based prototype purposely builds for Seri Malaysia Hotel since the walkthrough images are captured in their room.

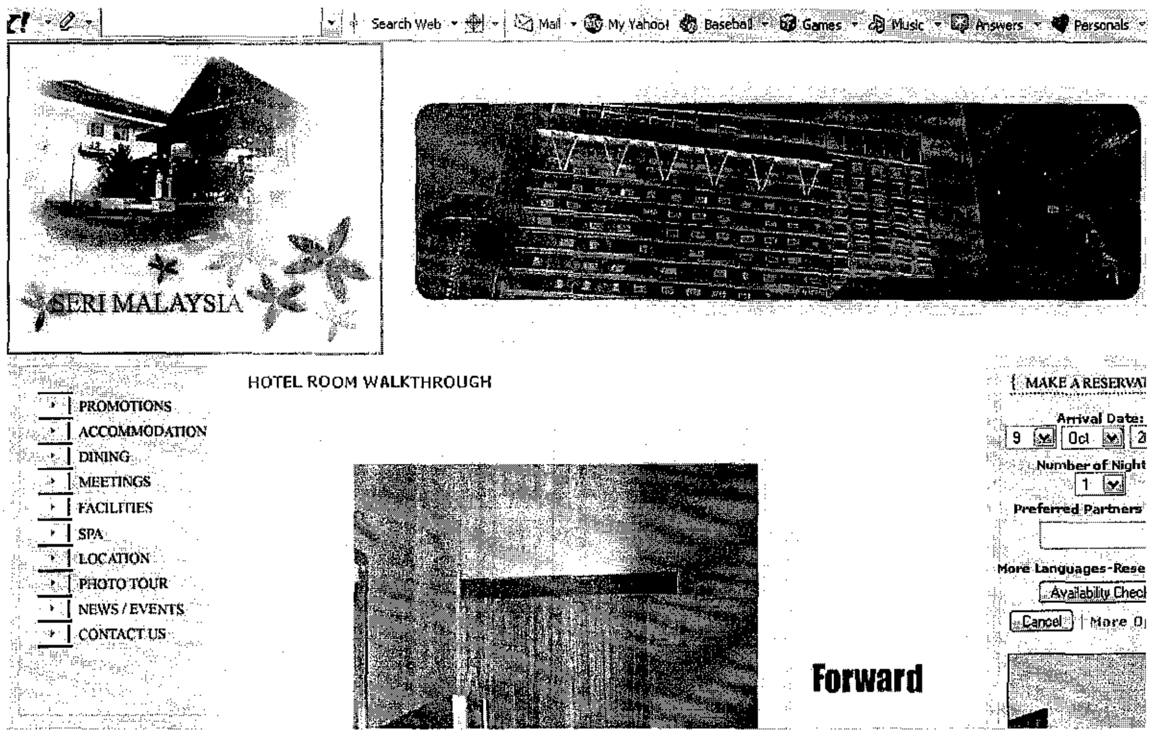


Figure 32 Hotel room walkthrough webpage

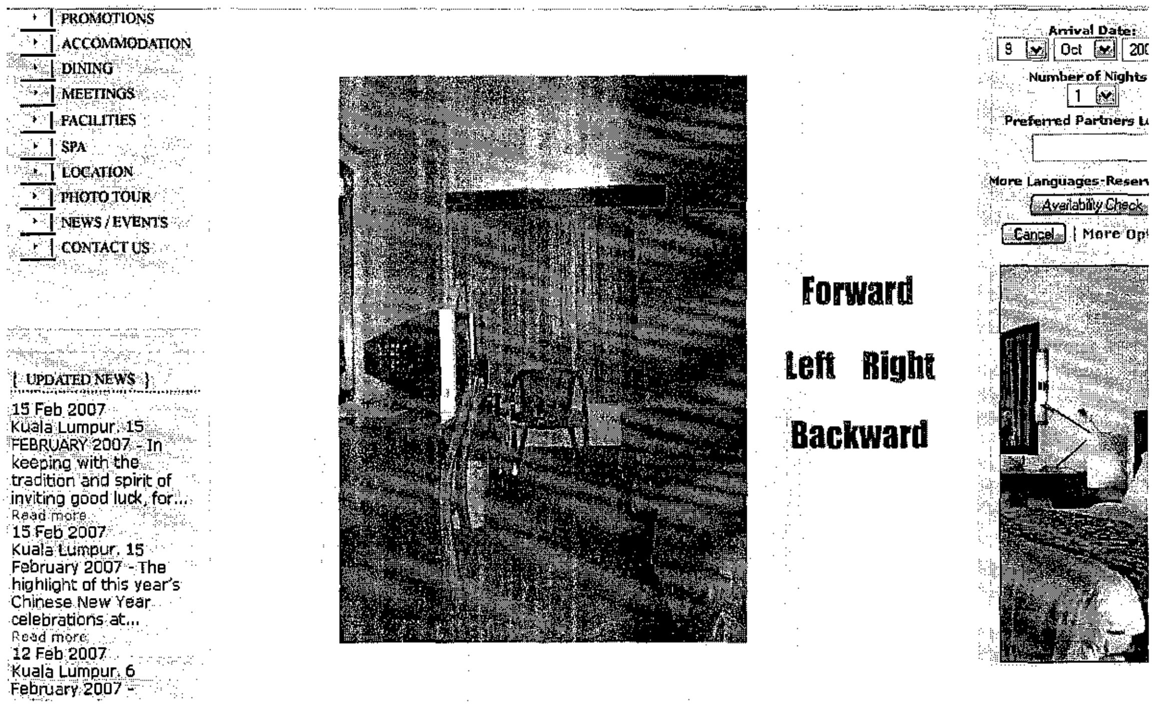


Figure 33 Flash navigation in the webpage

4.2 Experimentation / Modeling

4.2.1 Comparison number of pictures and smoothness of the walkthrough

To create a seamless panorama with a regular film or digital camera, it is begin by capturing a series of images around a single point of rotation, the optical center of the lens.

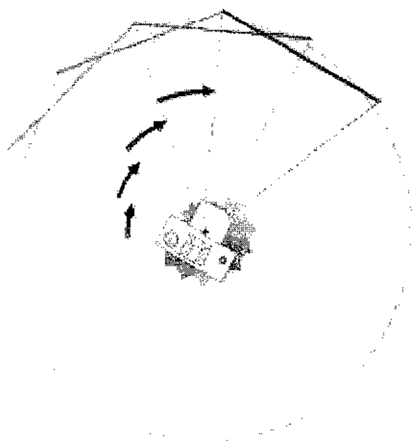


Figure 34 Individual, but overlapping pictures are captured around a point of rotation.

There are differences in smooth movement between the numbers of pictures that have been taken. At first, I have taken about 20 pictures per 360 ^{o}, then 40, and 70 pictures in 360 ^{o}. I observe that 70 pictures per 360 ^{o} are very smooth in movement and look realistic compared to 20 and 40 pictures per 360 ^{o}. Therefore, one step of movement requires a lot of pictures.

Table 2: Comparison number of pictures and smoothness of the walkthrough

Number of pictures	**Smoothness of walkthrough**
20	- Less smooth movements of the images - The gap between the images are noticeable
40	- Quite smooth movement of the images - The gap between the images are less noticeable
70	- More smooth in movement of the images – The gap between the images are not really obvious

4.2.2 Comparison between image-based using Concentric Mosaics and Image Mosaicing techniques walkthrough

Many techniques can be used in order to construct Image-Based Rendering such as image mosaicing, concentric mosaics, lumigraph, plenoptic modeling and more. Each technique has differences in the way they are display and assemble. The differences of image-based using concentric mosaics image mosaicing are as follow:

Table 3: Differences of Image-based using concentric mosaics and image mosaicing

Image-based (Concentric Mosaics)	**Image-based (Image mosaicing)**
1. Number of images - Approximately 70 images per 360 degree are required because the scene is captured by mounting a camera at the end of a level beam, and shooting images at regular intervals as the beam rotate by certain degrees. The smaller degrees the images taken, the more realistic the image can be.	- The image mosaic used approximately 15 images to stitch together for constructing panoramic image mosaics.
2. Stitch - Concentric mosaics do not need to use stitch because it uses a sequence of images to render the view.	- Image mosaic needs stitching multiple images together to generate a cylindrical panoramic image. Walking in a space is

	currently accomplished by "hopping" to different panoramic points. One panorama is generated for one location (panoramic node). All panoramic nodes are linked in a graph structure.
3. Measurement - No need measurement	- Need measurement (patch-based alignment technique)
4. Real-time walkthrough - Image-based walkthrough using concentric mosaics is a real time walkthrough. - Concentric mosaic can move in virtual environment like a person can walk around right, left, forward and backward.	- Image-based using image mosaicing is not a real walkthrough because the images are stitch to construct a panoramic view. - Image mosaic can only view 360 degrees from a fixed spot. The user can navigate the walkthrough by clicking the hotspot to move to the next point of view.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The project has implemented an image-based virtual walkthrough that provides immersive and interactive experience for visitors checking the room.

With the recent developments in the area of image-based rendering, various techniques of producing Image-based Rendering has been explored as a better alternative to the conventional model-based virtual walkthrough application.

All the image-based rendering representations are derived from plenoptic function. The plenoptic approach to modeling and display provides robust and high-fidelity models of environments based entirely on a set of reference projections. The difficulty of producing realistic models of real environments will be greatly reduced by replacing geometry with images.

For this project, an image based rendering techniques called concentric mosaics and image mosaicing is presented. The techniques are compared in term of the real time walkthrough, number of pictures, and the process of implementation of both techniques.

However, the viewer may experience significant horizontal parallax and lighting changes and high storage requirements.

5.2 Recommendation

The future recommendation for the current walkthrough prototype can be enhanced by implementing the server system to interactively display the image-based virtual walkthrough. In order to retrieve the images, a server is needed to store all the photographs. A web site based on CGI (Common Gateway Interface) is implemented. The system is based on Browser/Server model and is tested in www.

An image-based deployment system takes a snapshot of a source system and deploys the image to target systems without human intervention. The target servers (the servers to which software will be deployed) can be remote, located at any distance from the operation, as long as they can be reached through a LAN to which the administrator has Web access. The target servers do not need attention from an operator at any time after power up; furthermore, the servers do not need any console peripherals (keyboard, mouse, or monitor) attached to them.

OpenManage Remote Install resides on a networked server (the *image server* in Figure below), which should be near the target servers—"near" in the network sense, not necessarily in the physical sense. Because administrators access the image server through a Web-based application located on that server, they do not need to be physically near the server.

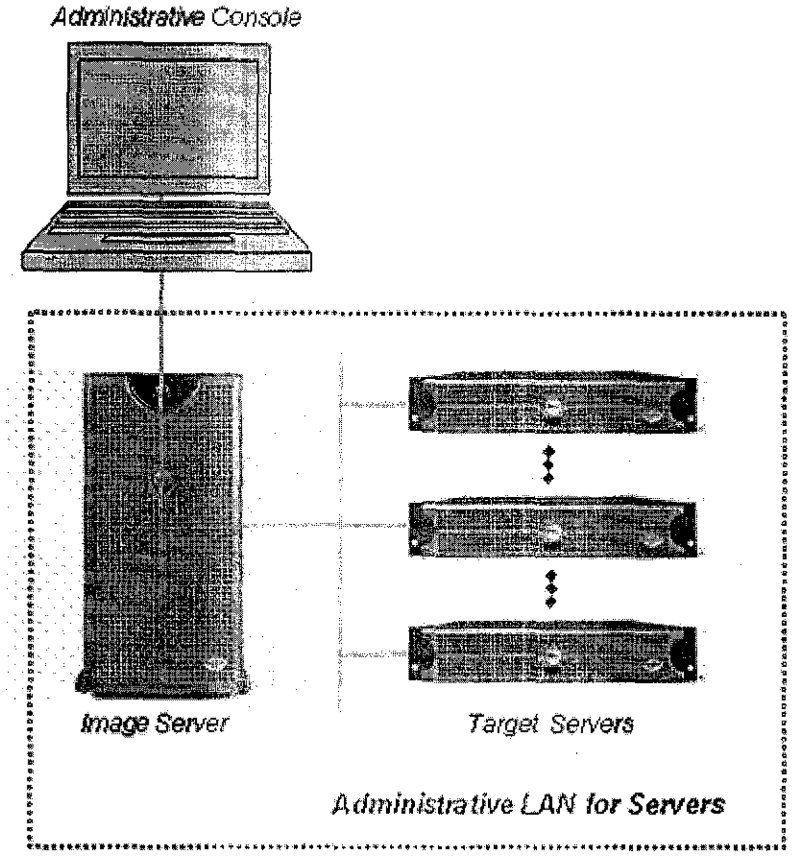


Figure 35 Administrators can Manage Deployments over the Web, Outside the Server LAN

The image server maintains a library of compressed OS images on storage assigned to it for that purpose. It also maintains a library of configuration files that define the network identities of the target servers.

Administrators can accomplish these tasks over the network without human intervention at the target server's site.

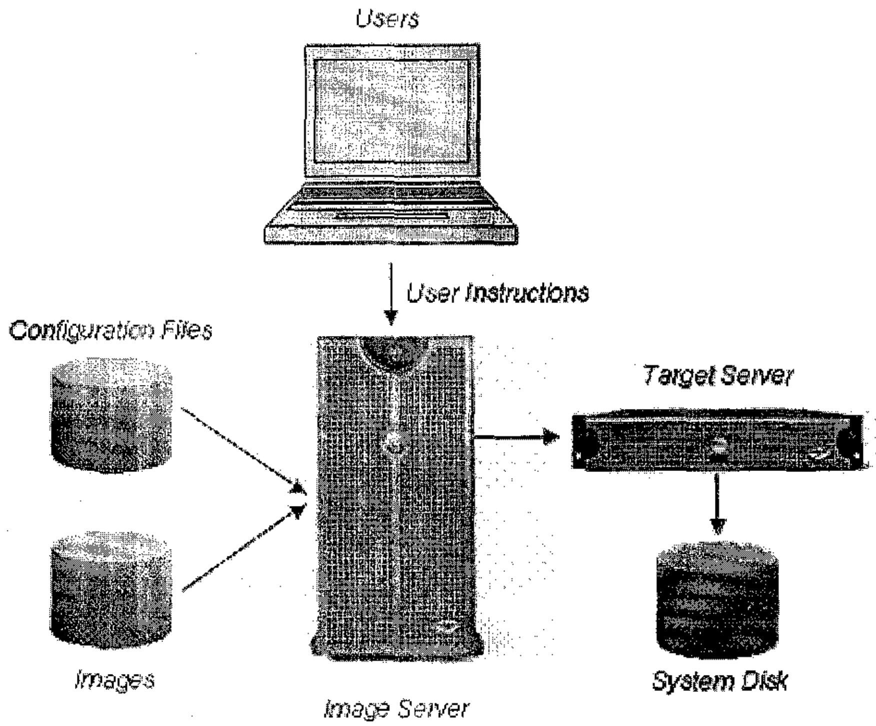


Figure 36 Deployment Consists of OS Images and Configuration Data

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APPENDICES

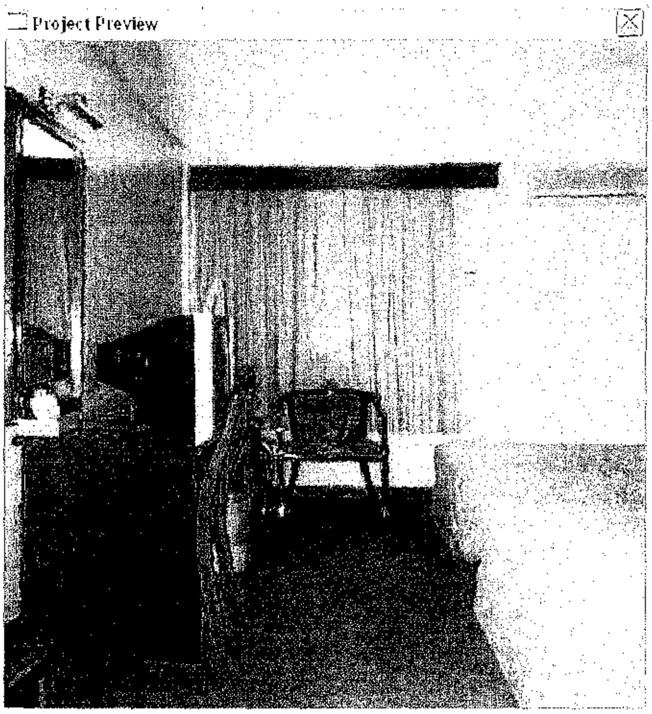
A1. Moving forward and backward in the virtual environment (Image mosaicing)

A2. Turn around at a fixed spot to view 360 degrees surrounding (Image mosaicing)

A3. Making a 360 degrees turn in the virtual environment (Concentric mosaic)

A4. FYP Gantt chart - In Microsoft Visio (General) and Microsoft Project (Detailed)

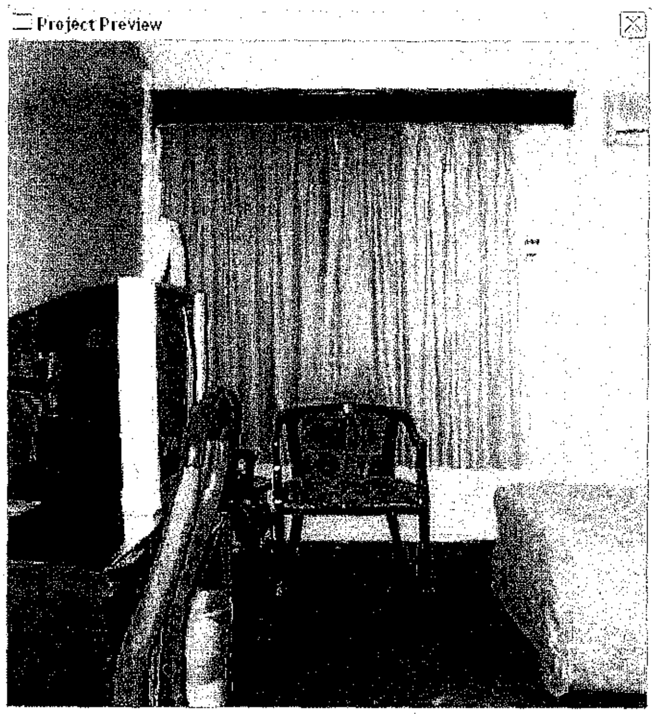
A1. Moving forward and backward in the virtual walkthrough (Image Mosaicing)



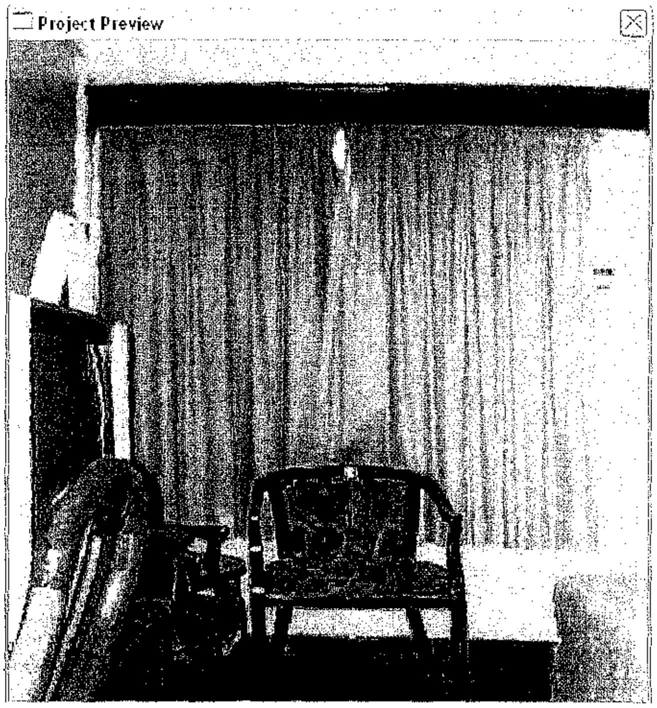
1st step

2nd step

3rd step



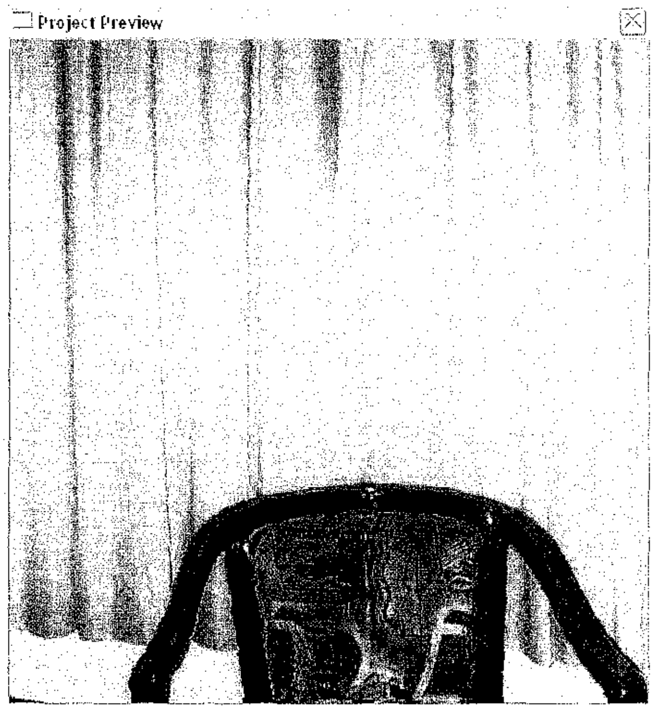
4^{th} step



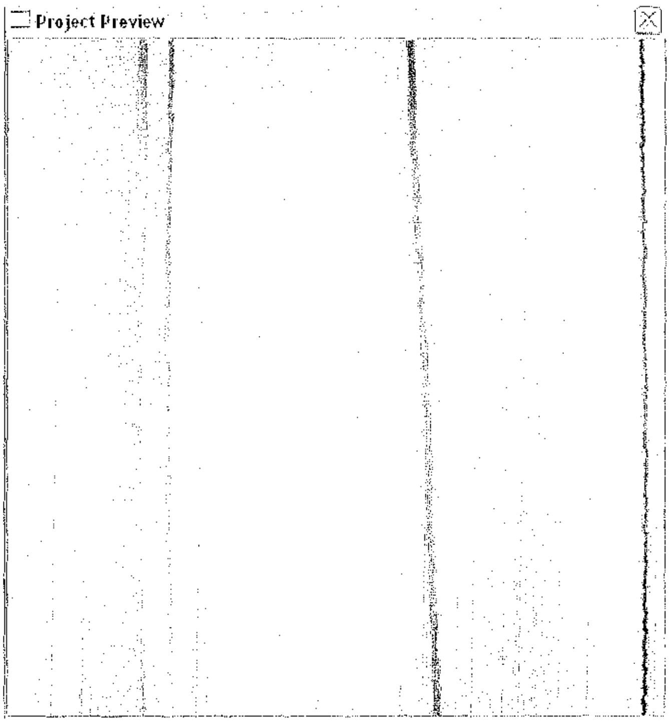
5^{th} step

6th step

7th step



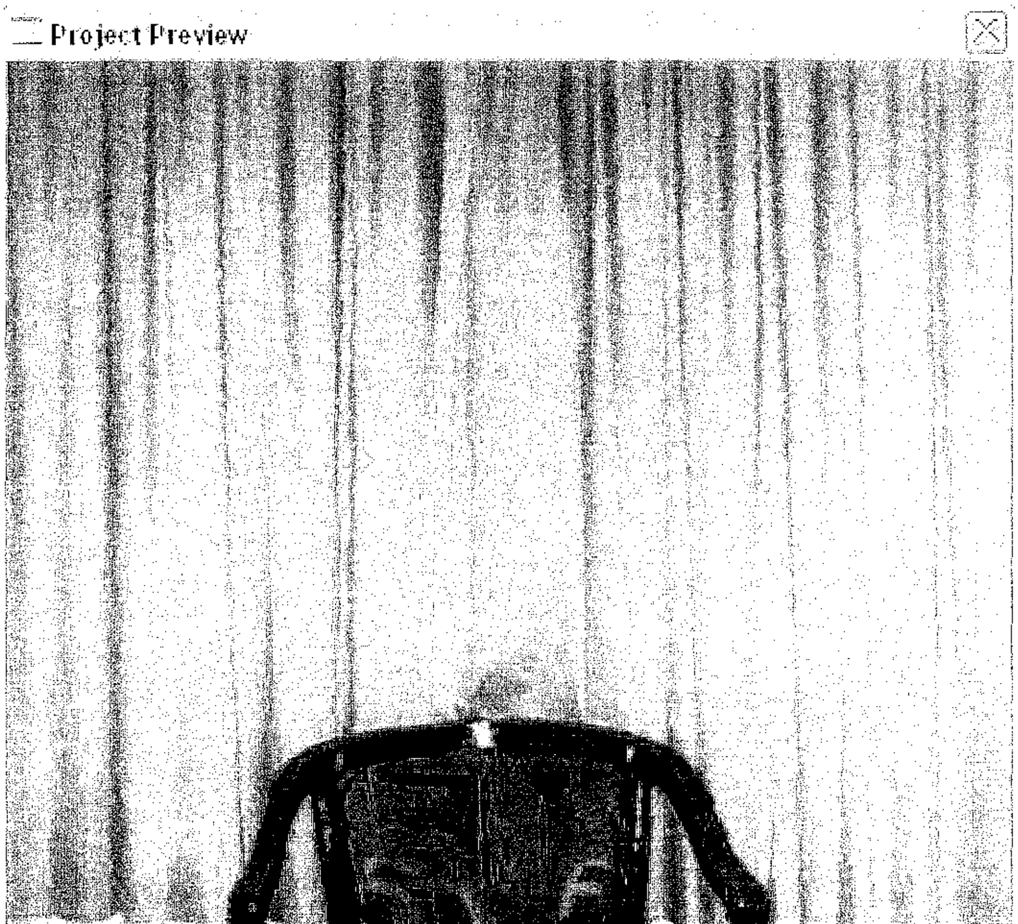
8th step



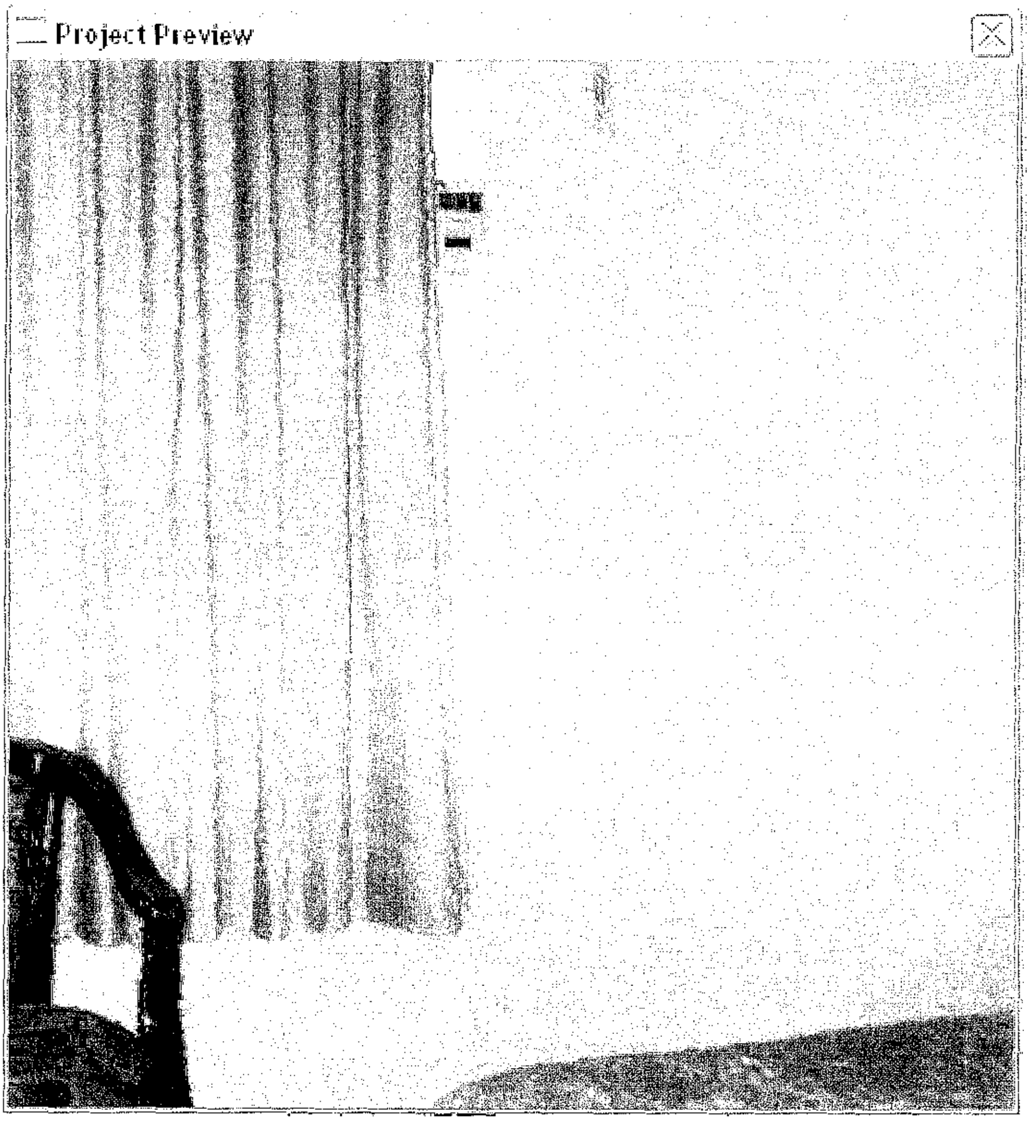
9th step

A2. Turn around at a fixed spot to view 360 degrees surrounding (Image Mosaicing)

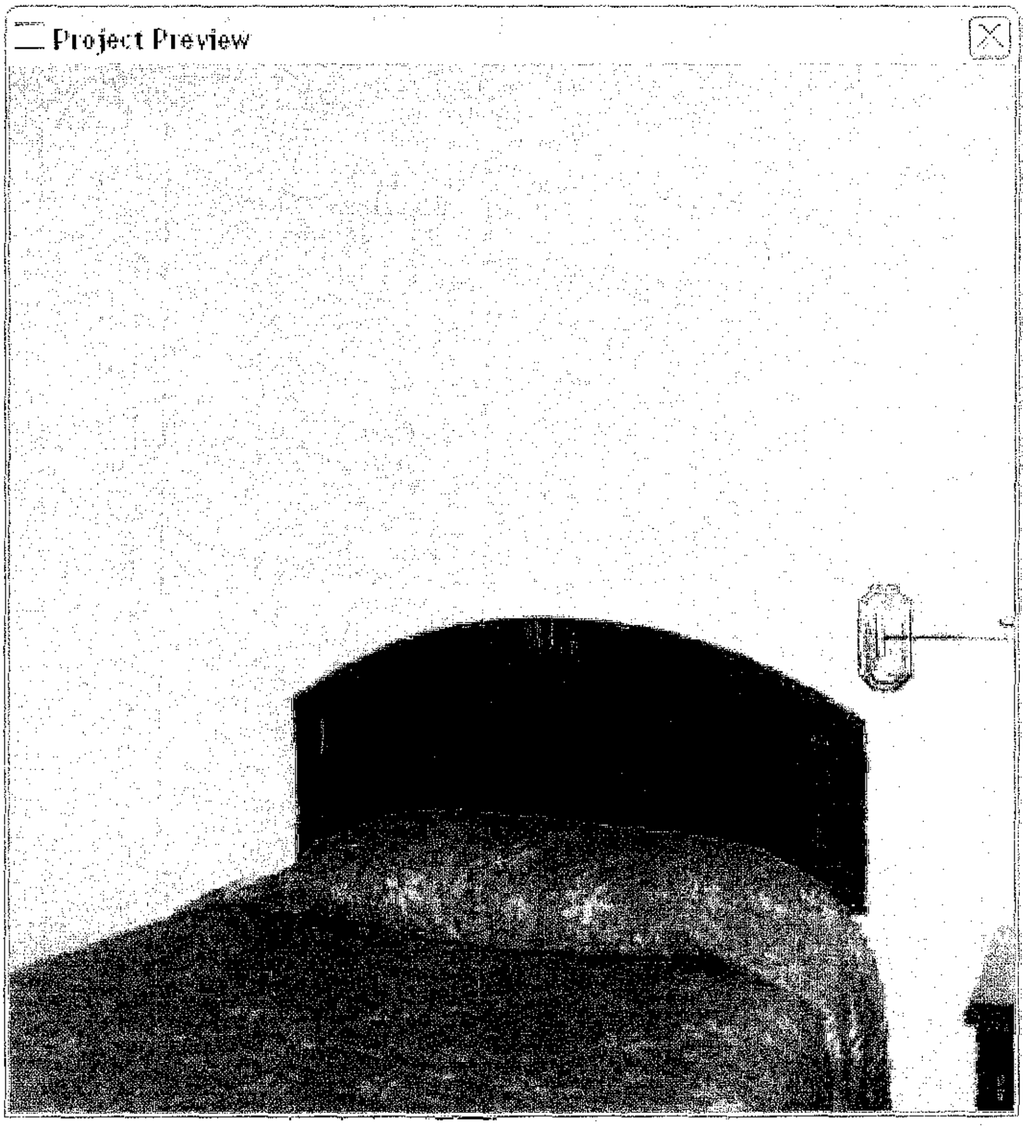
At every step points, the viewer is able to turn around 360 degrees on the spot to view the surrounding. The user can move the mouse left and right to view it. Figure below are part of screen captured to turn around in 360 degrees.



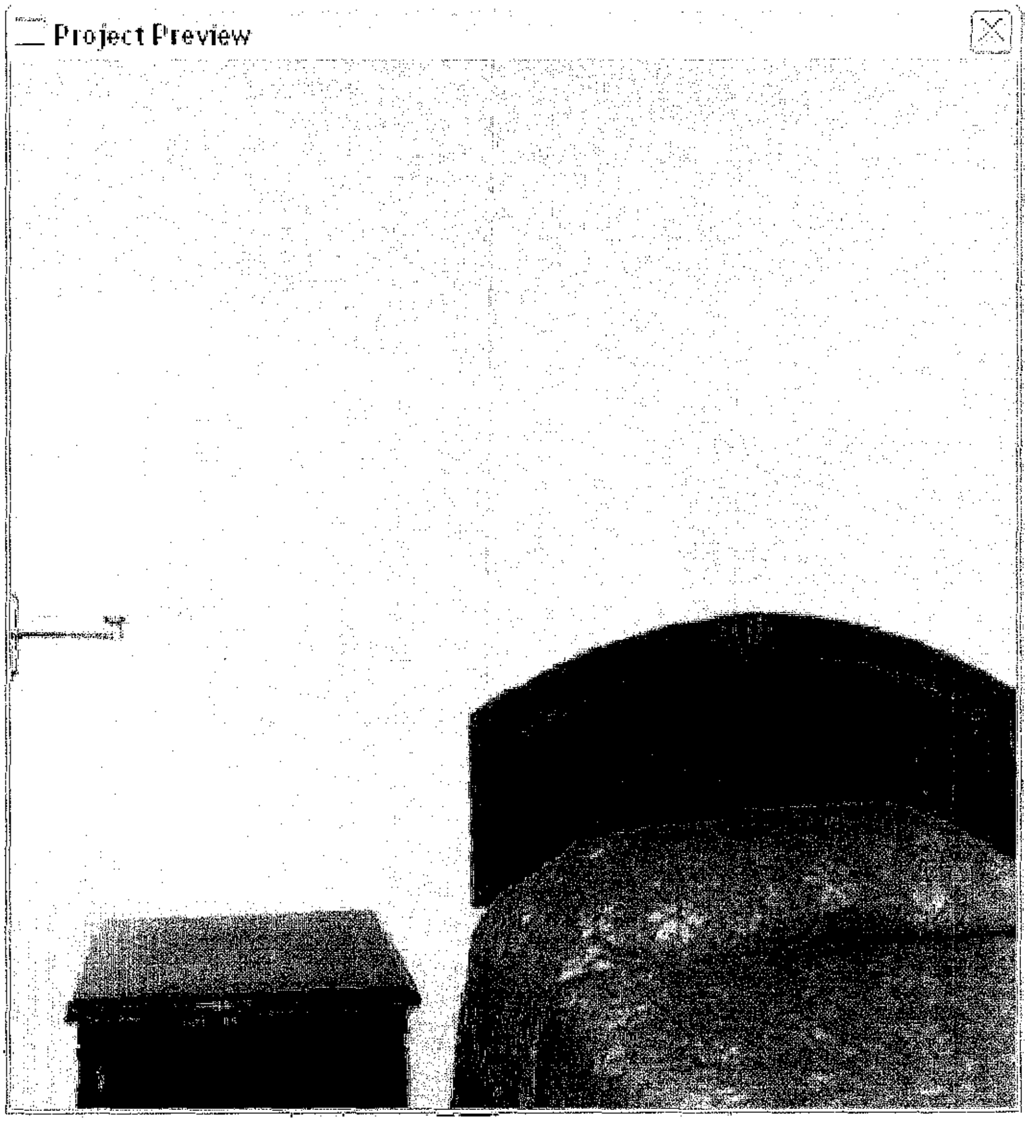
360 degrees view (1)



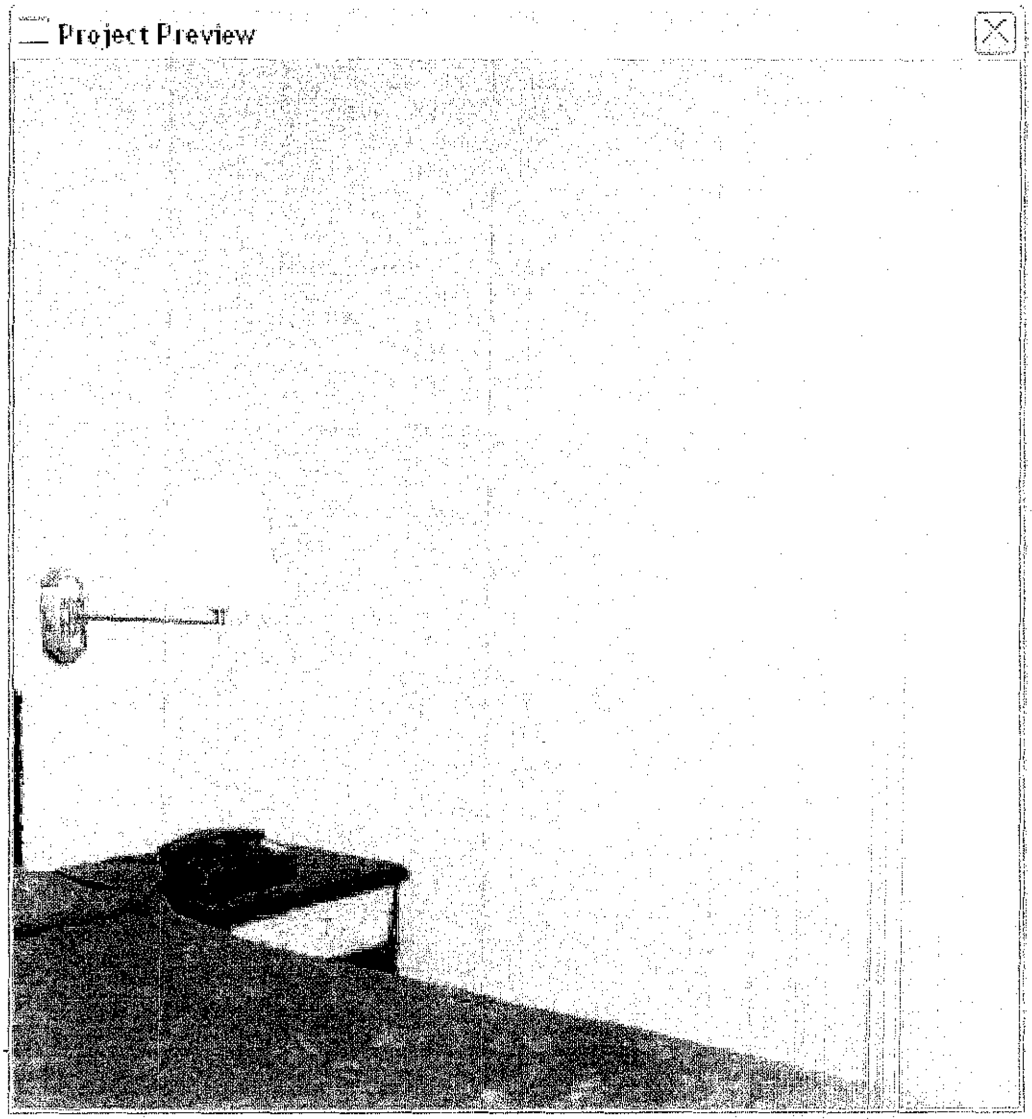
360 degrees view (2)



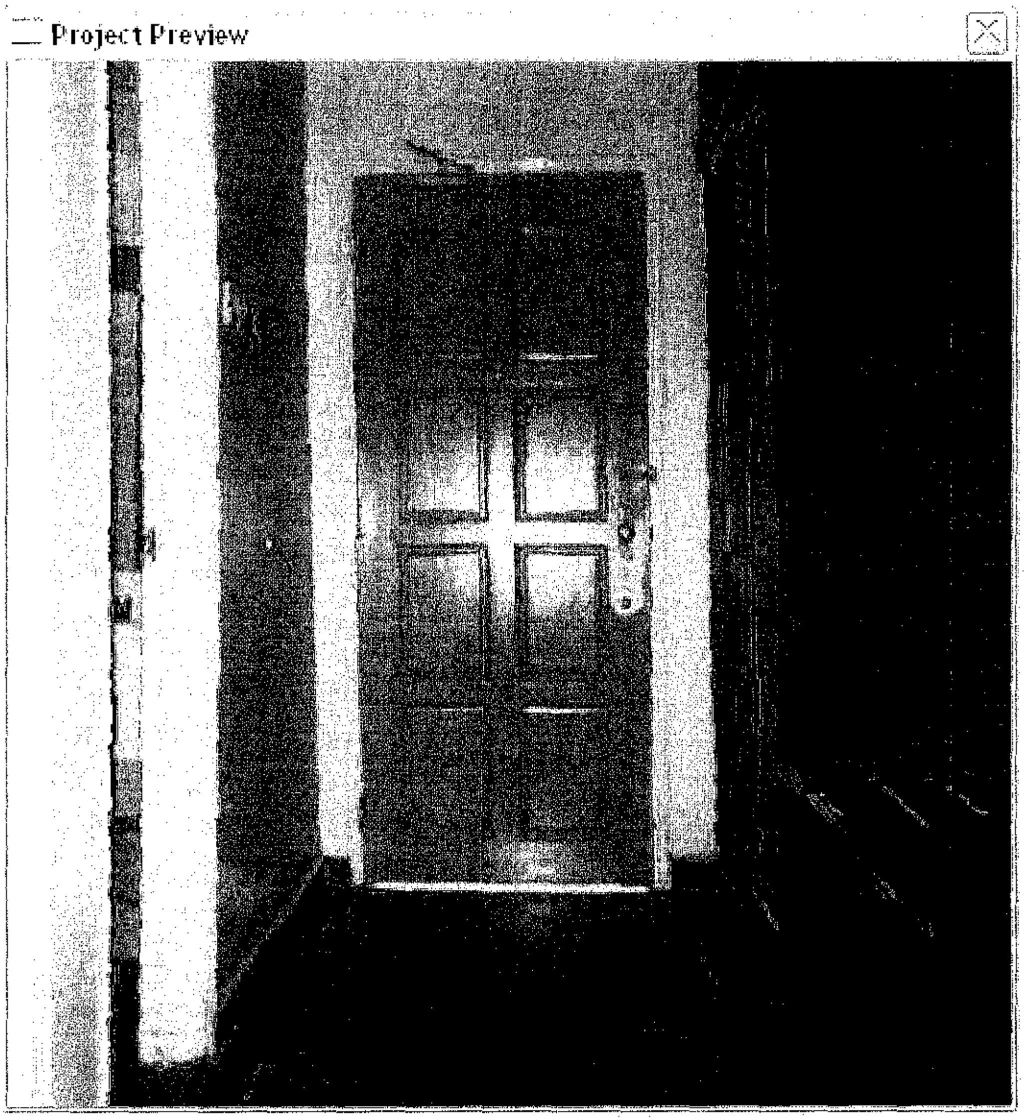
360 degrees view (3)



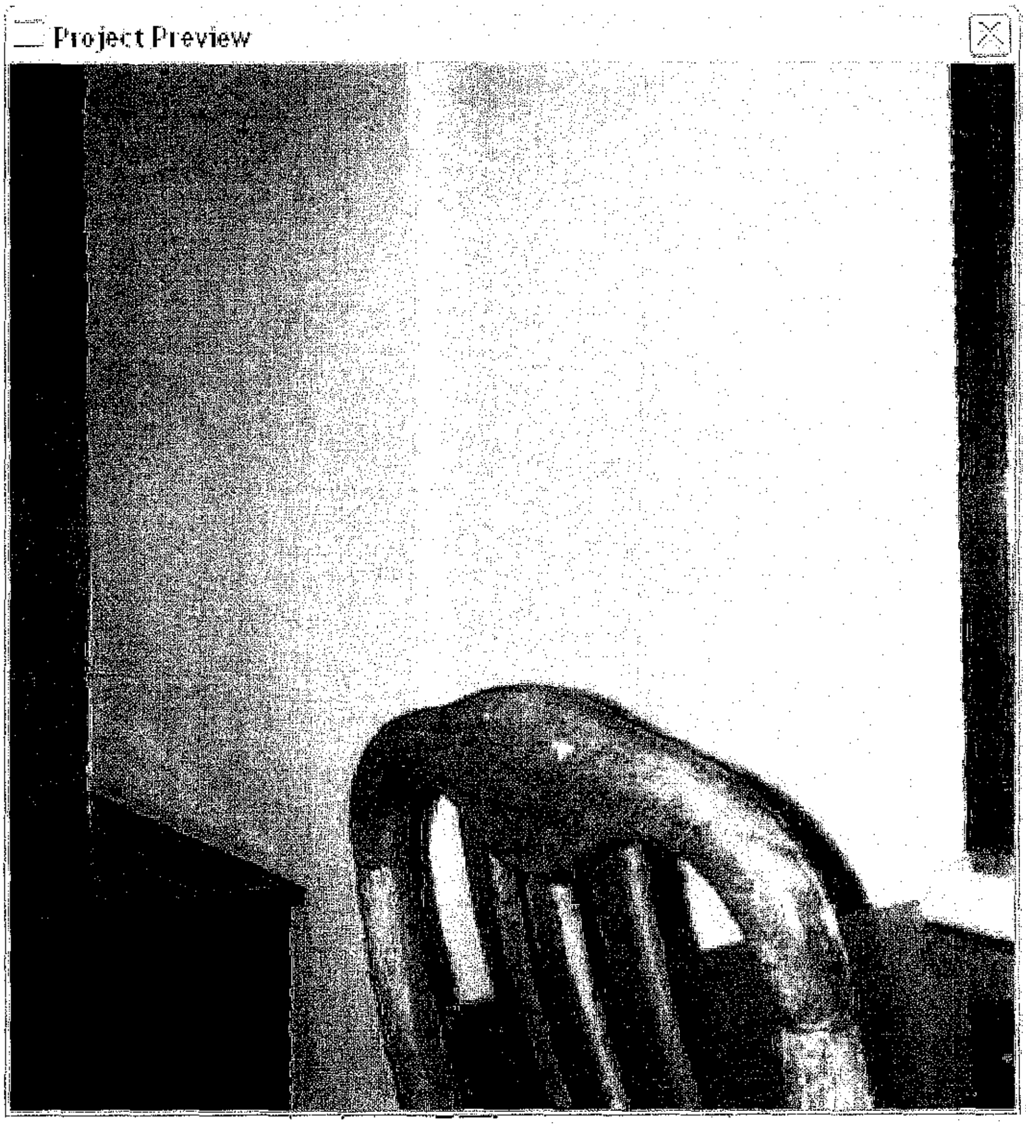
360 degrees view (4)



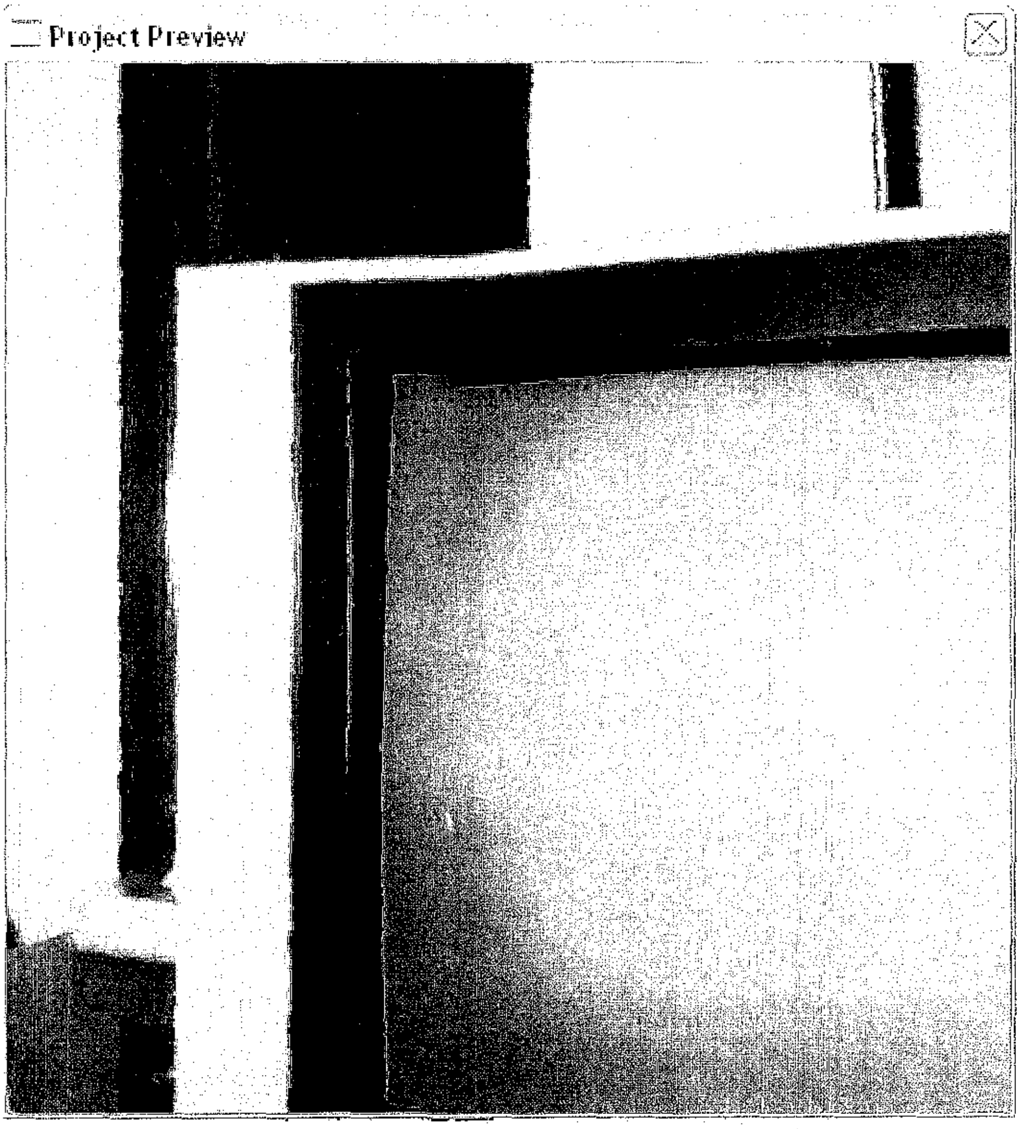
360 degrees view (5)



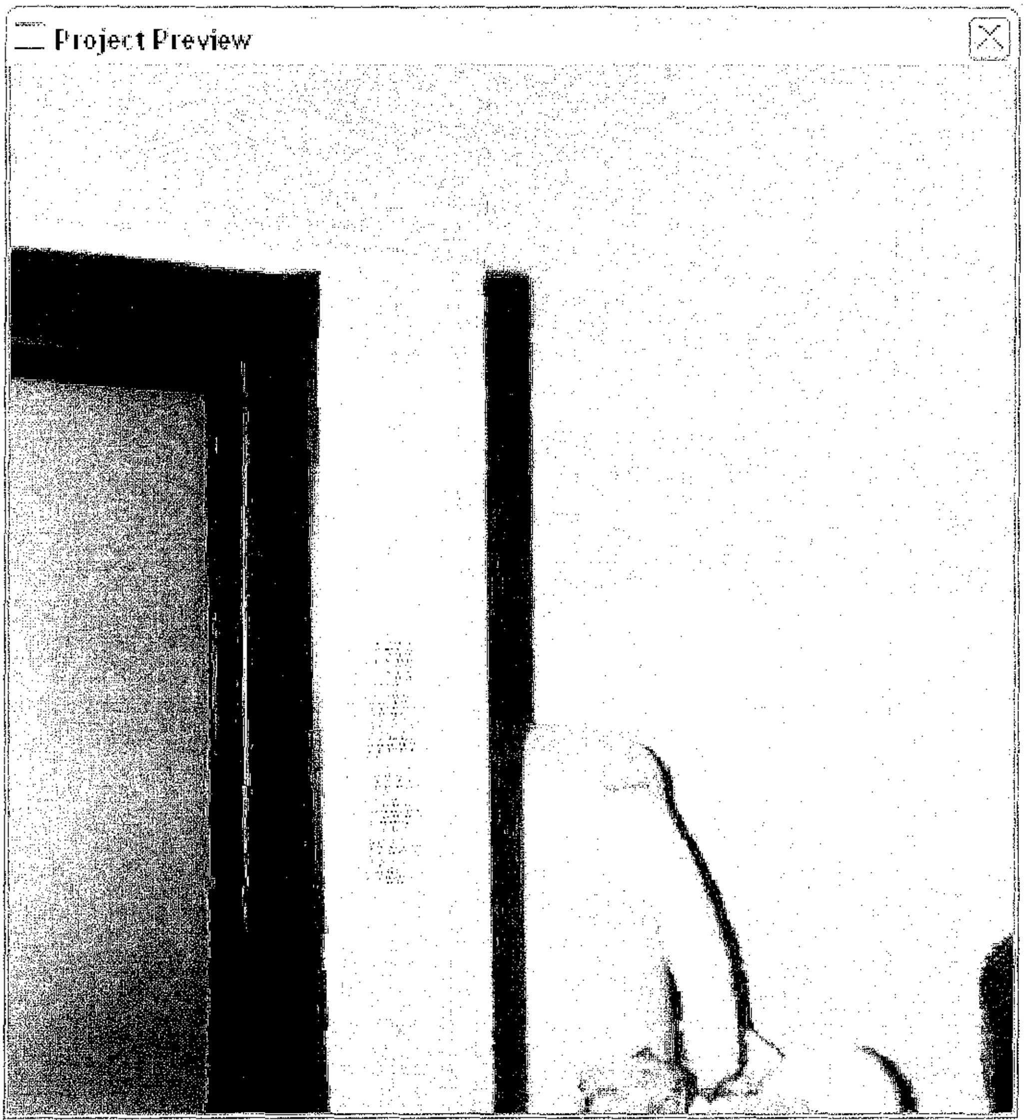
360 degrees view (6)



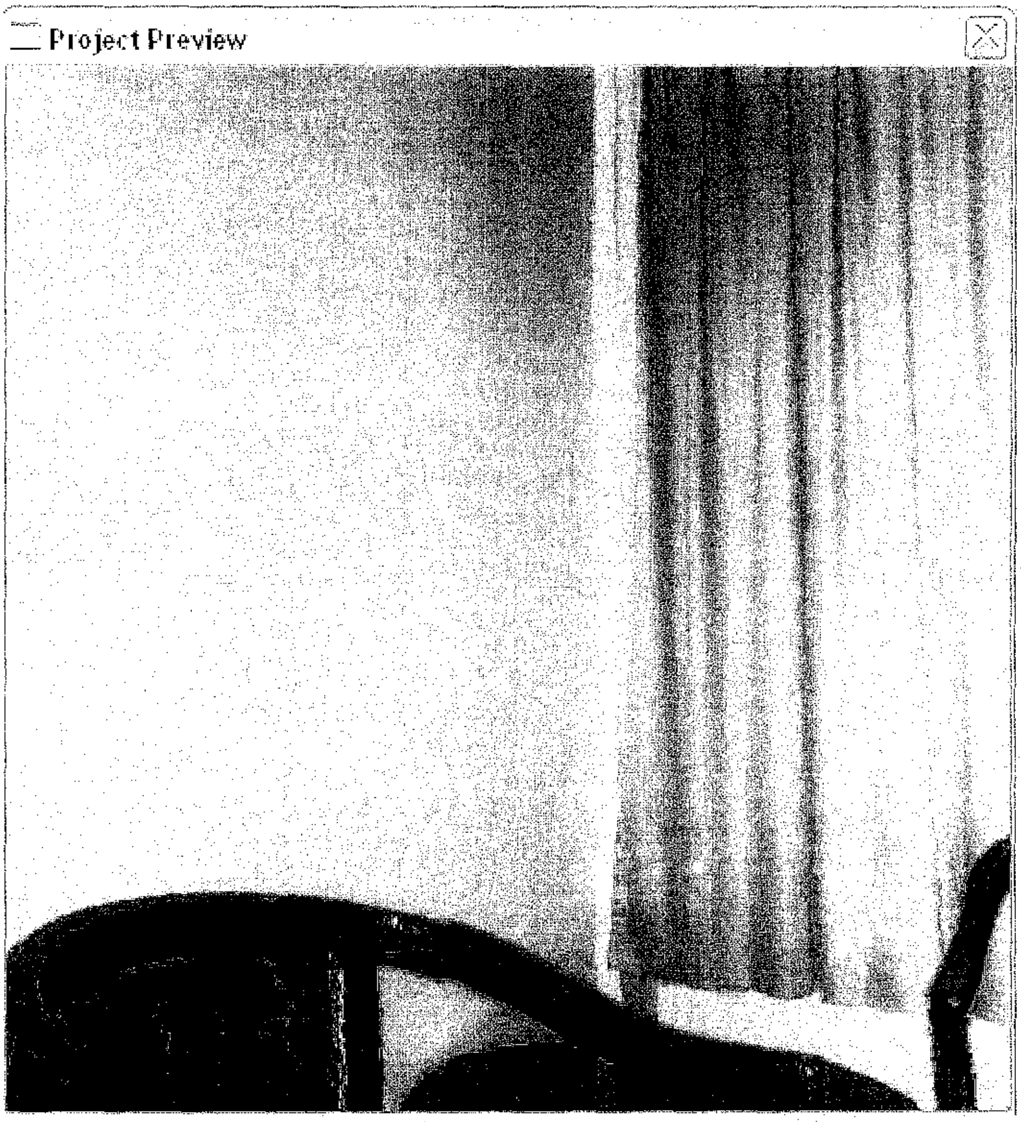
360 degrees view (7)



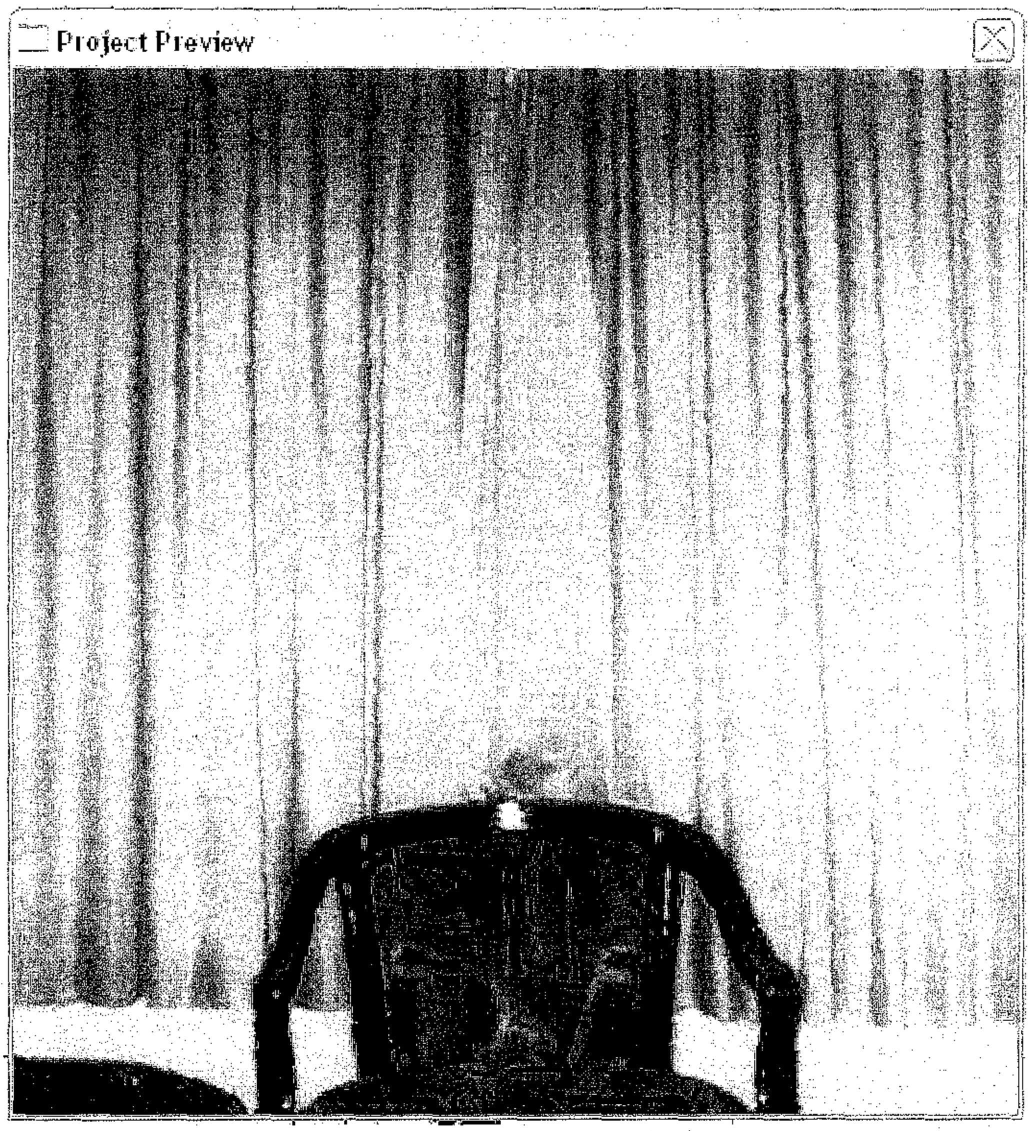
360 degrees view (8)



360 degrees view (9)

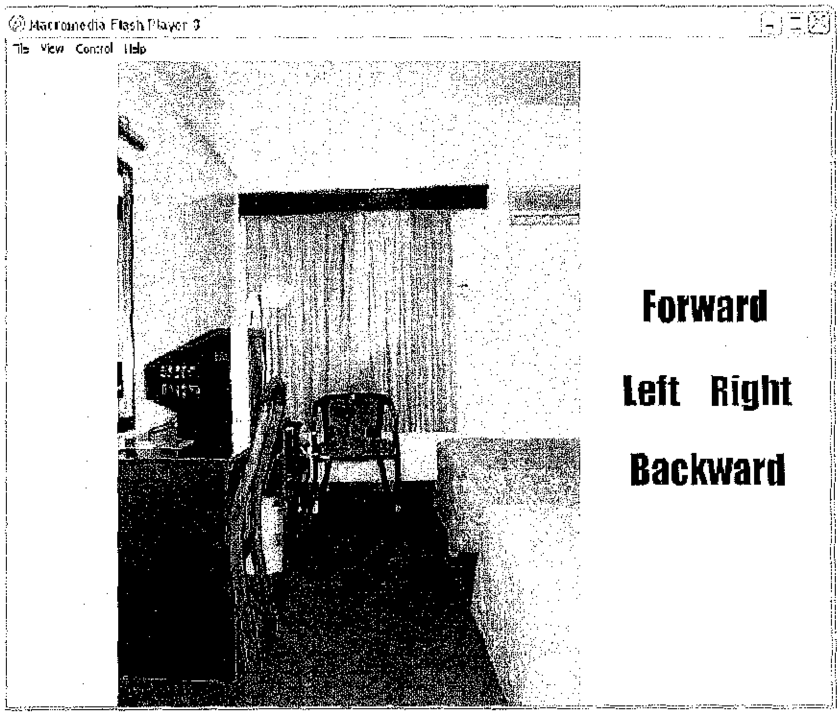


360 degrees view (10)



360 degrees view (11)

A3. Making a 360 degrees turn in the virtual walkthrough (Concentric Mosaics)



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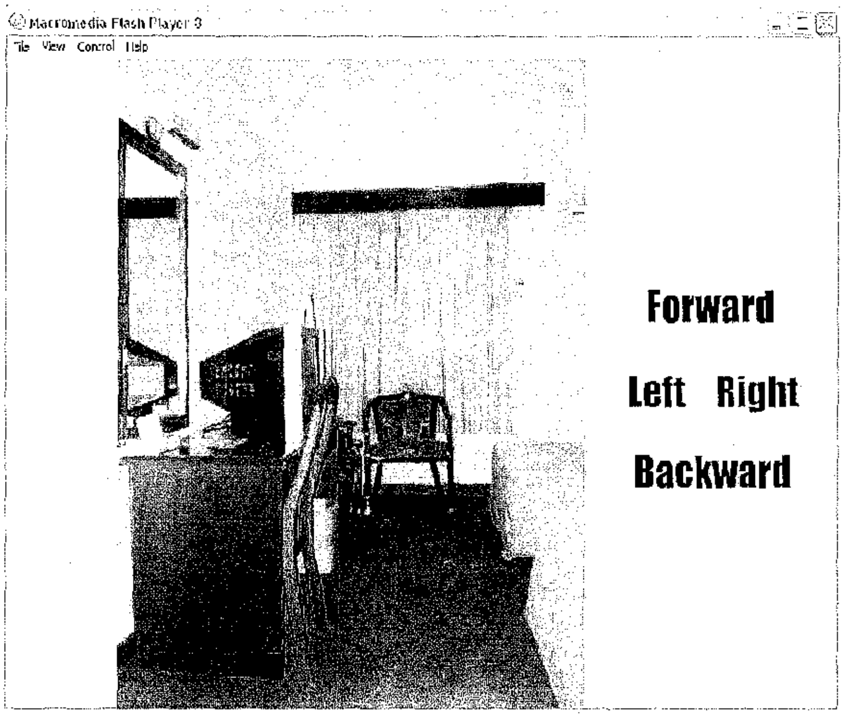
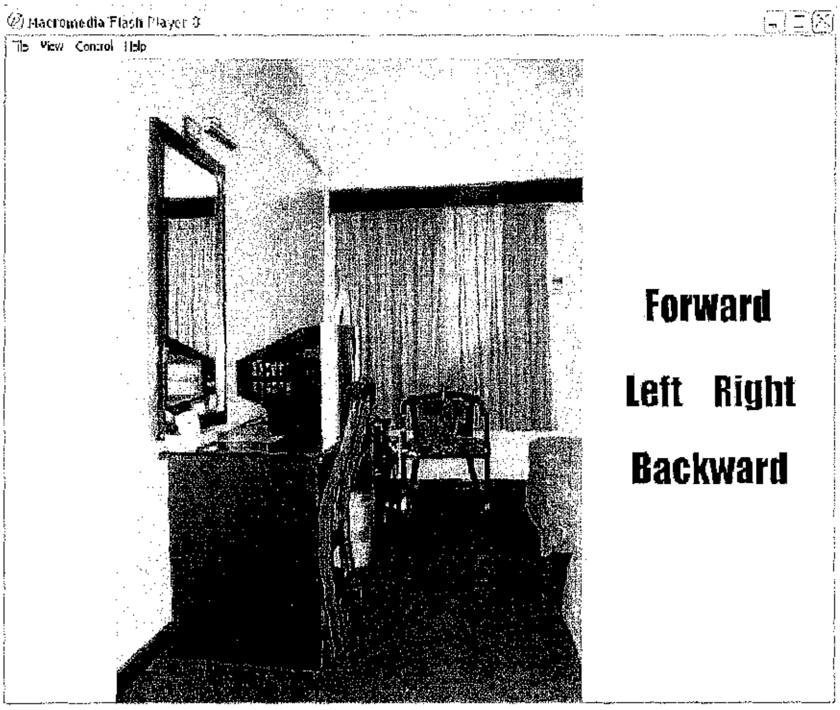
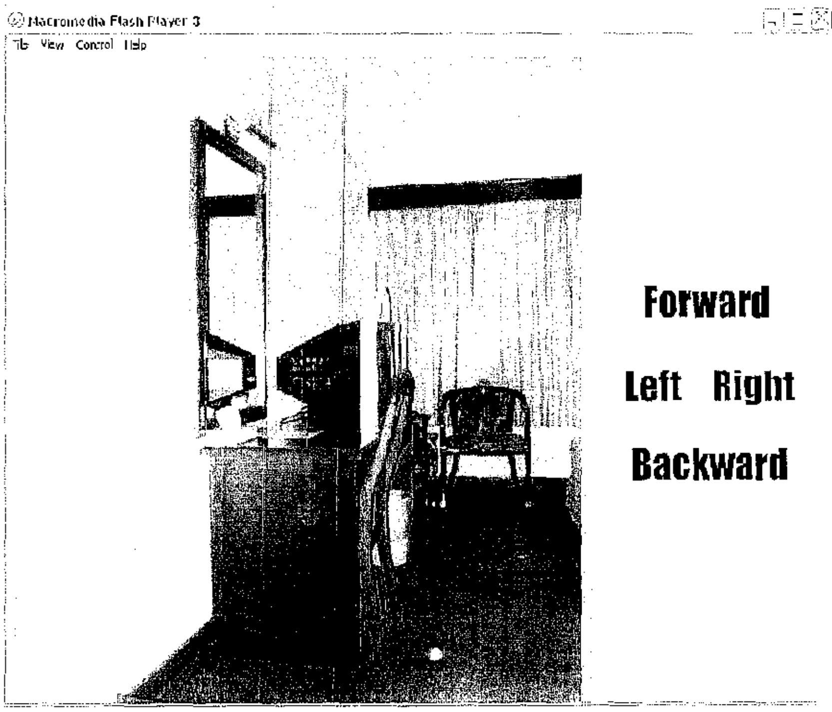


2^{nd} turn



3^{rd} turn



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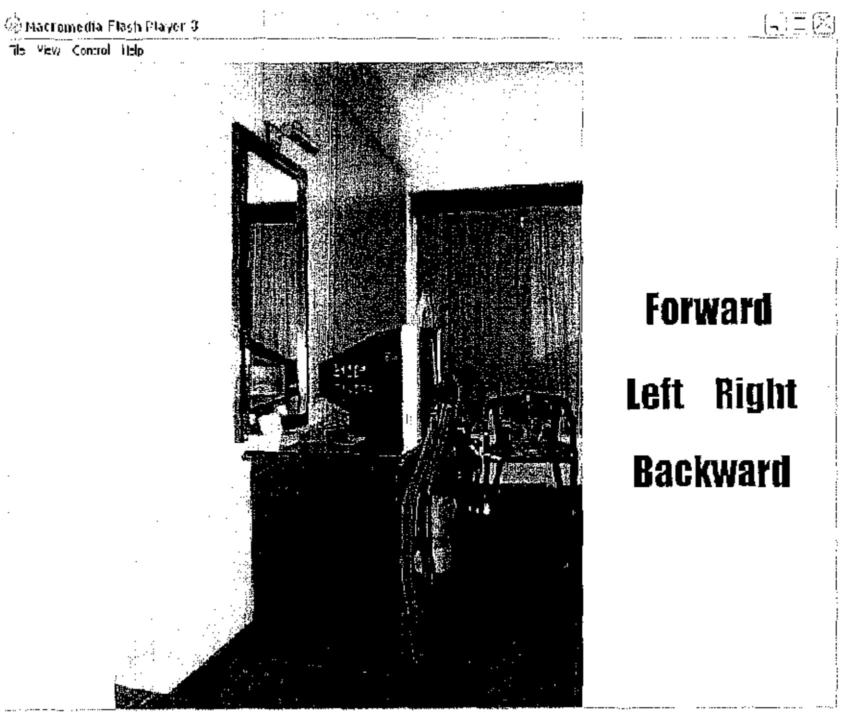

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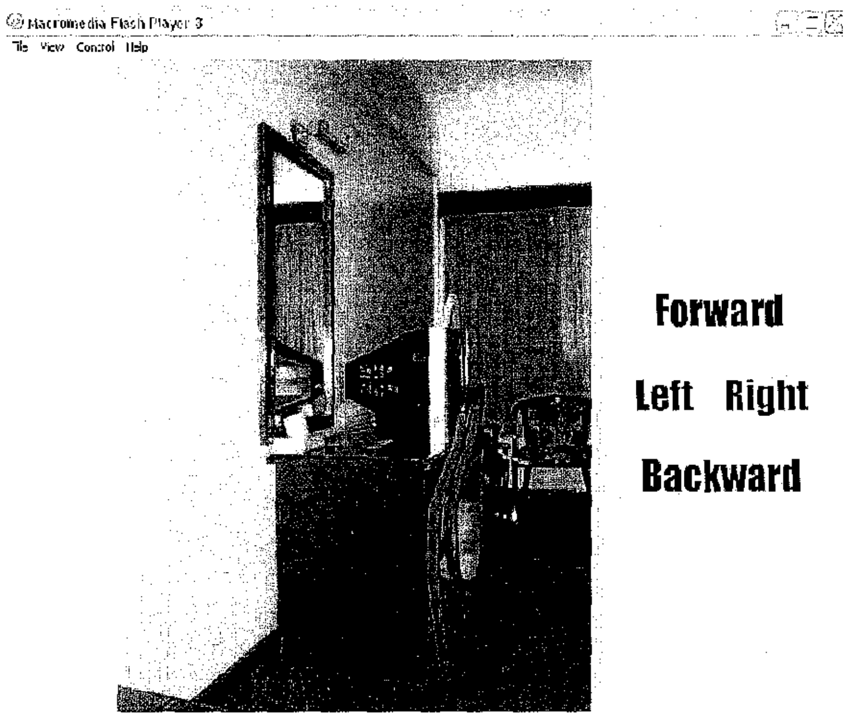

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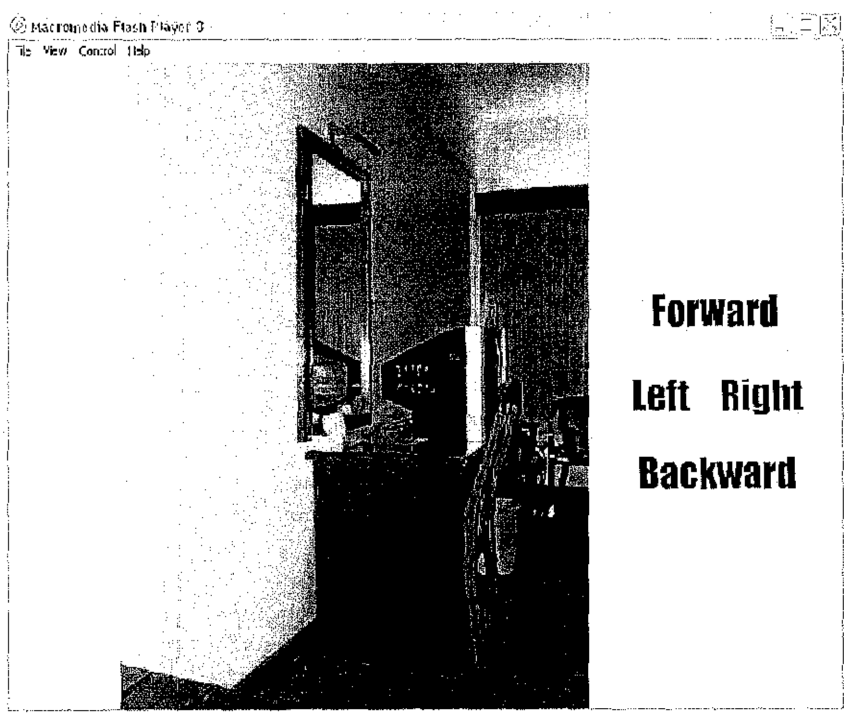

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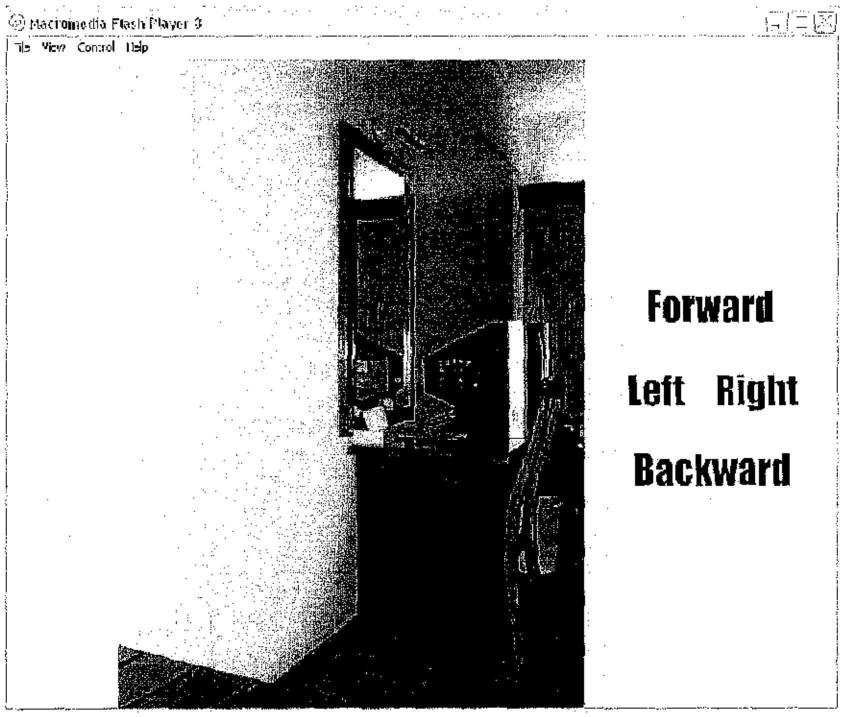

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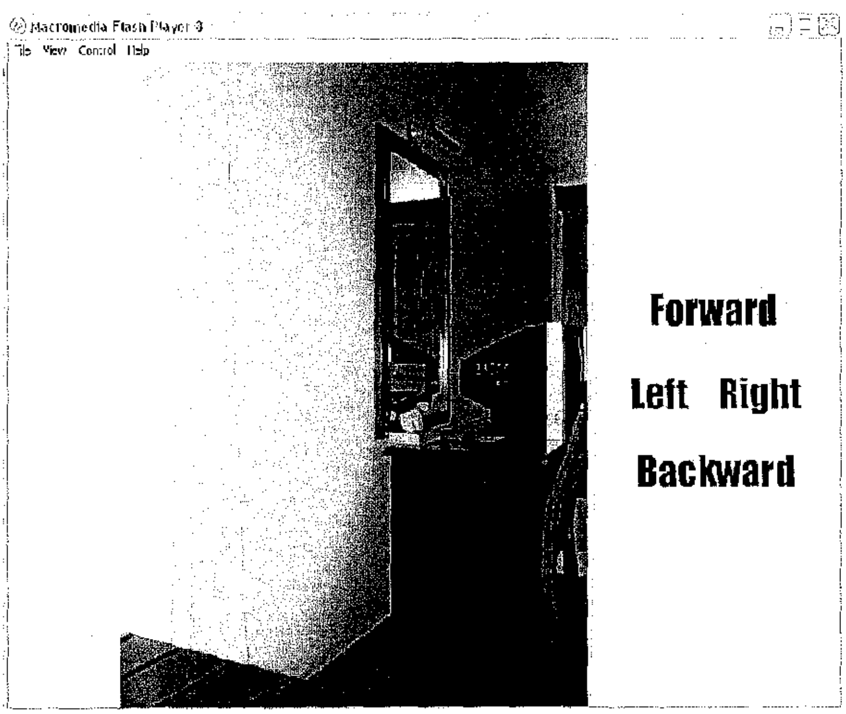

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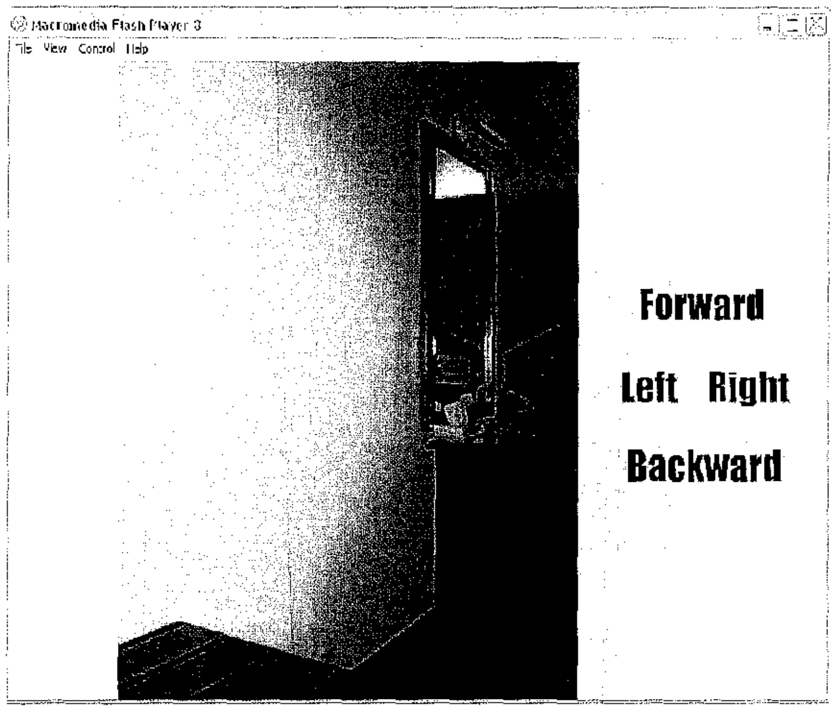

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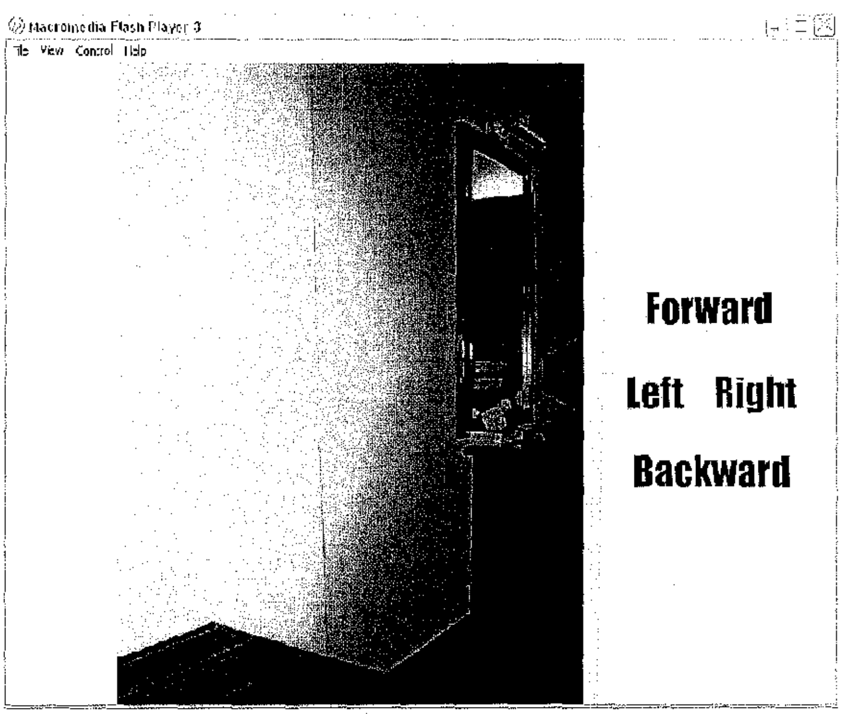

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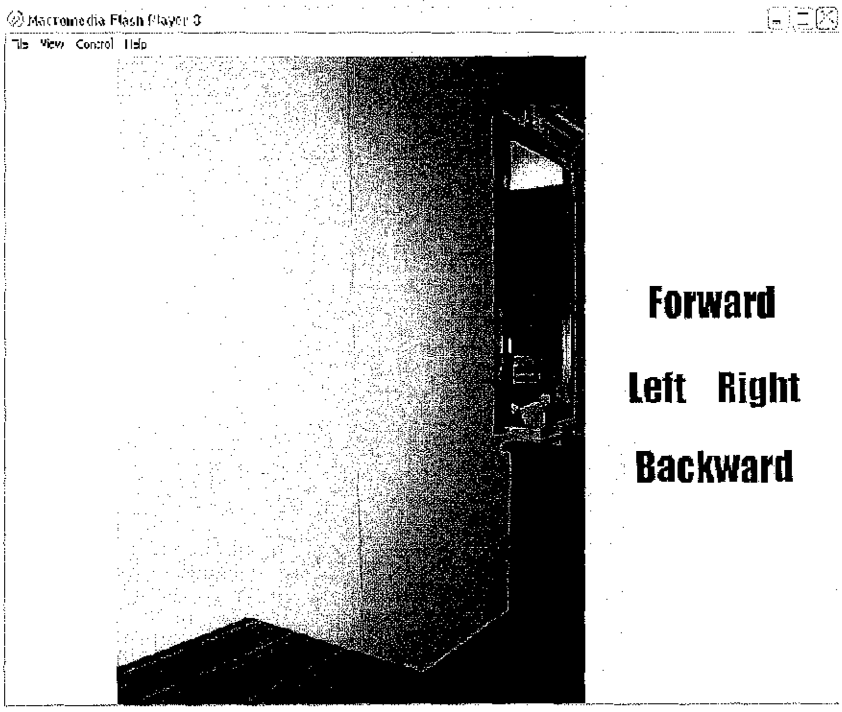

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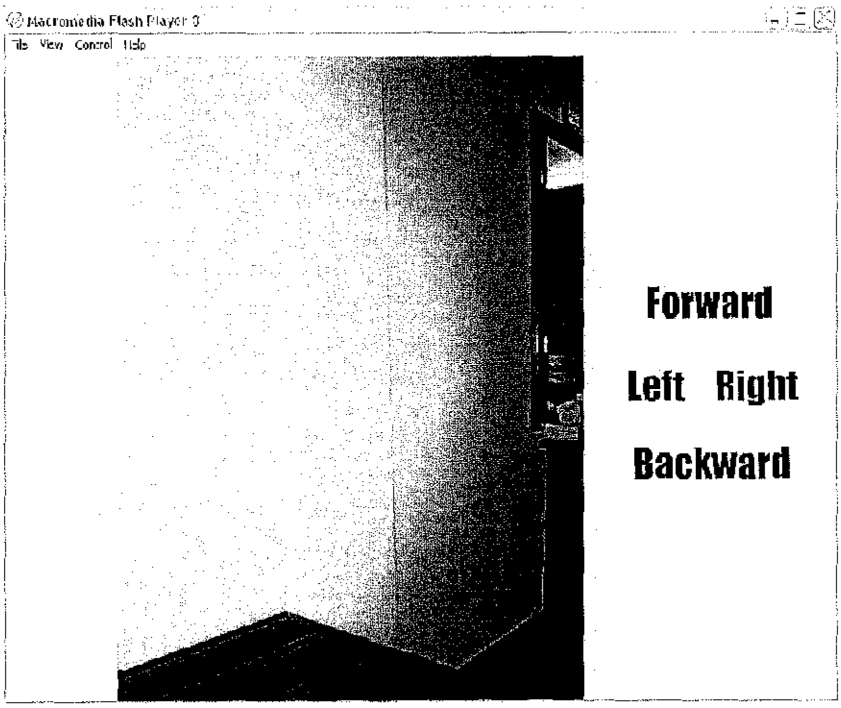

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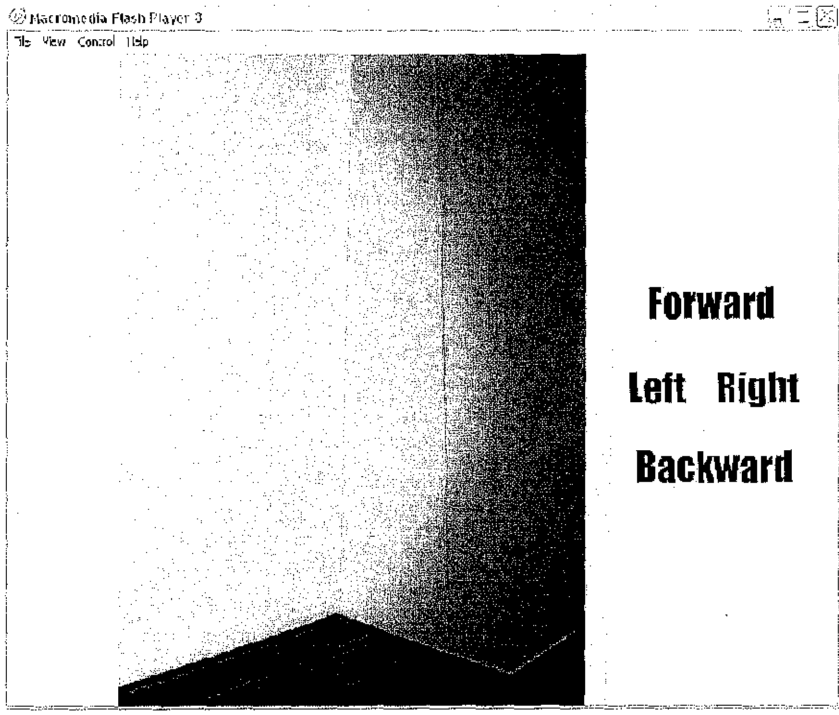

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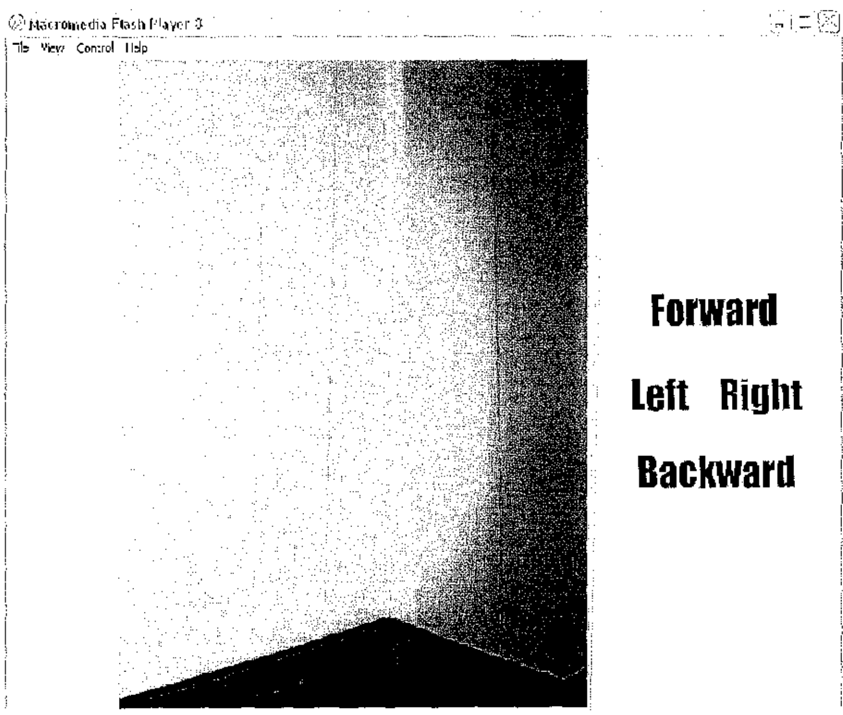

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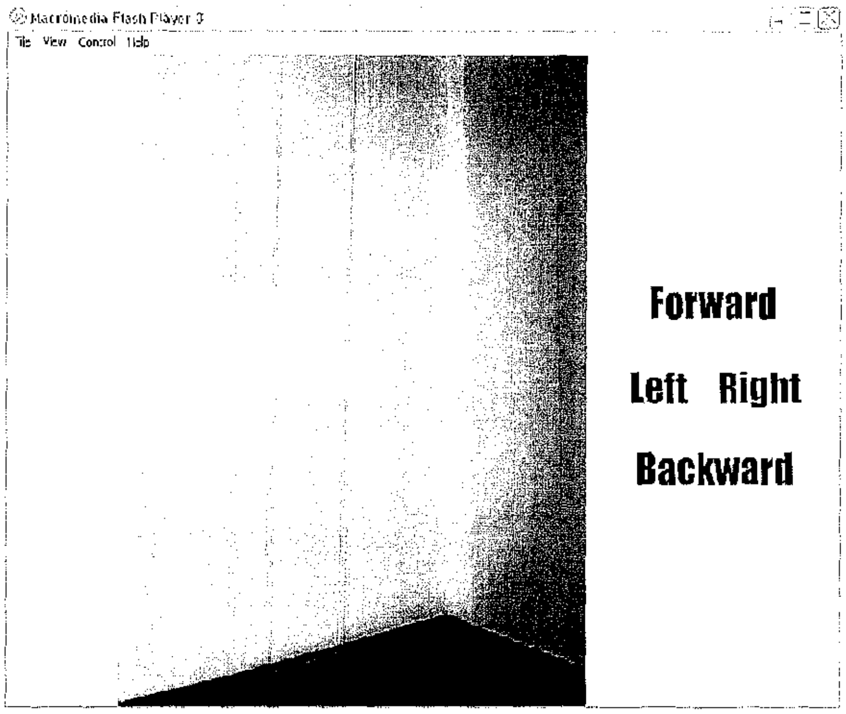

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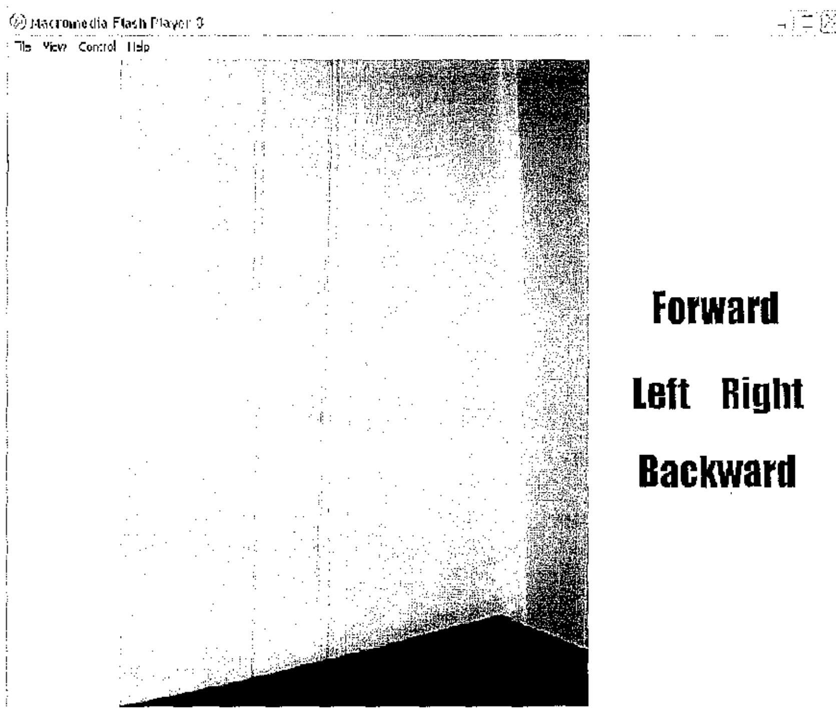

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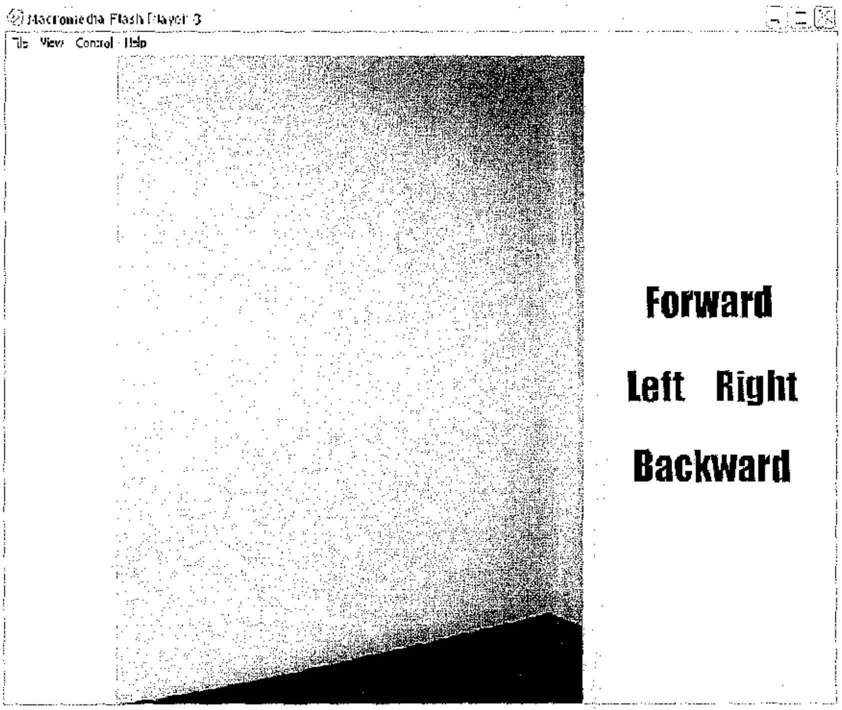

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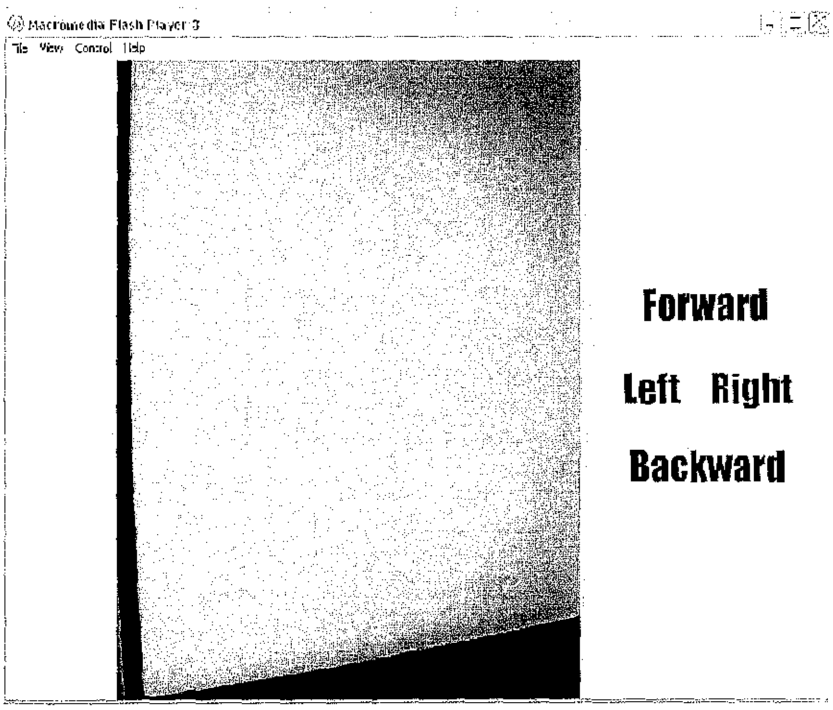

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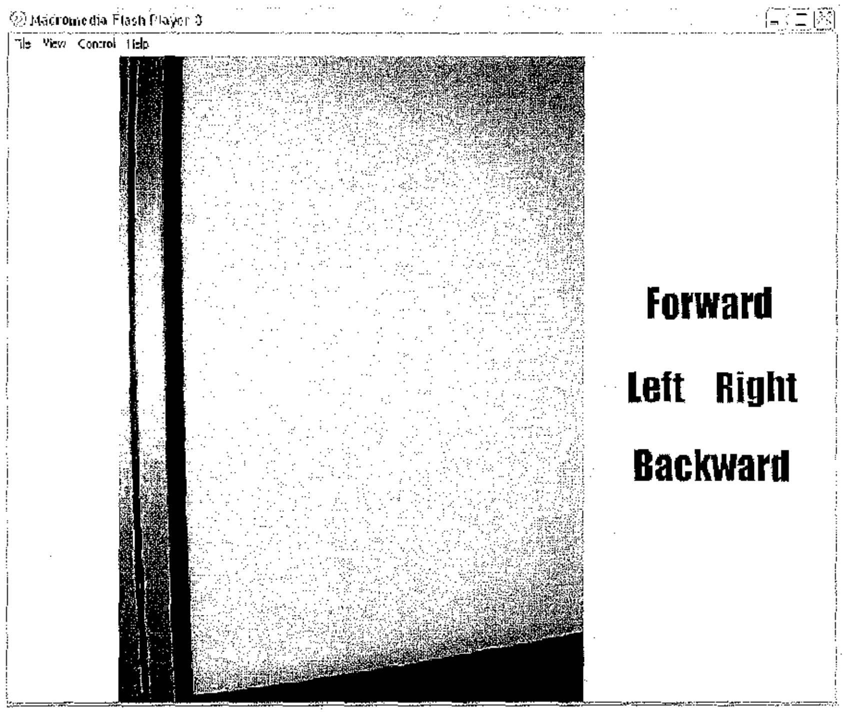

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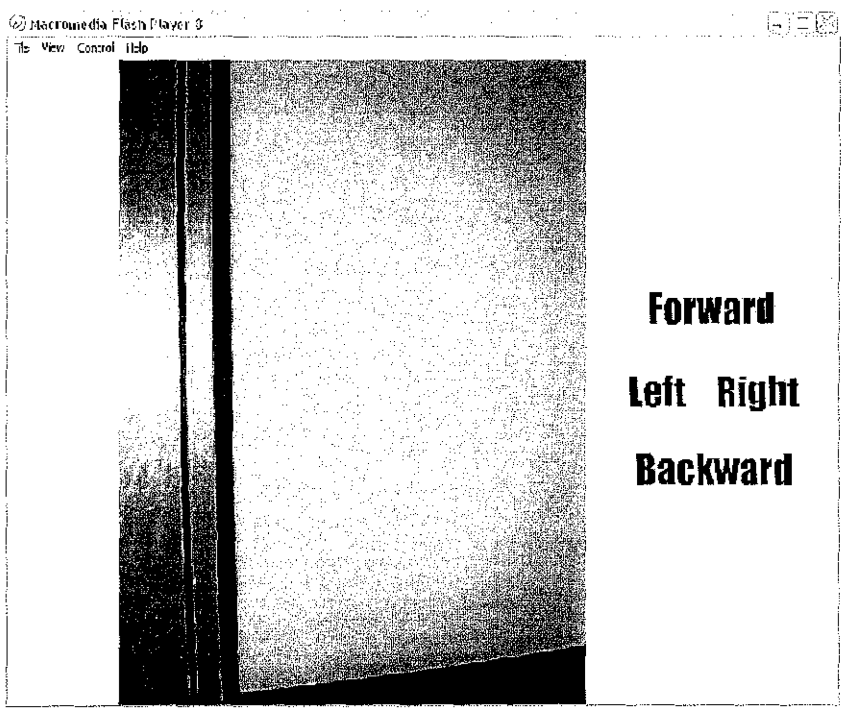

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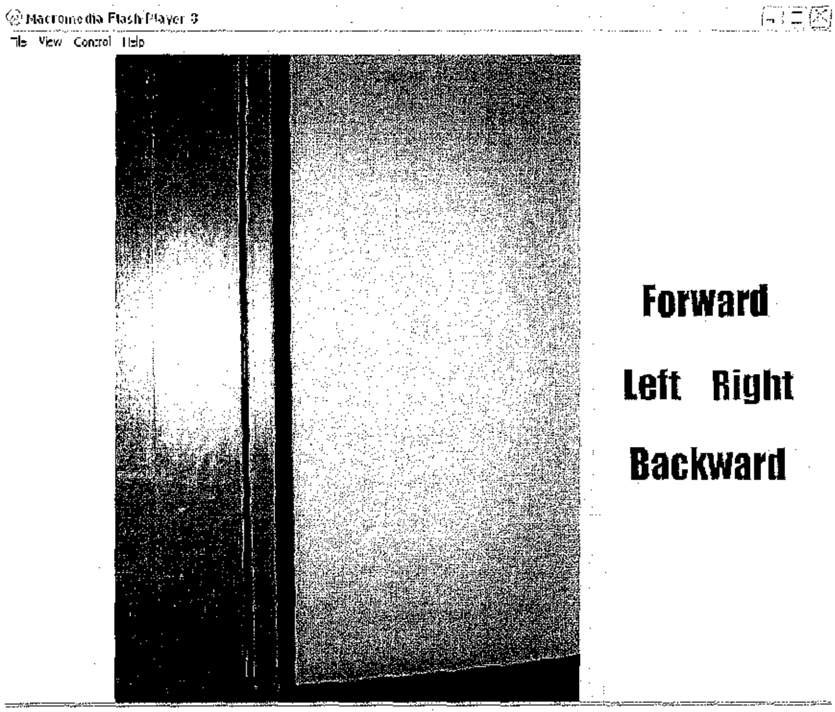

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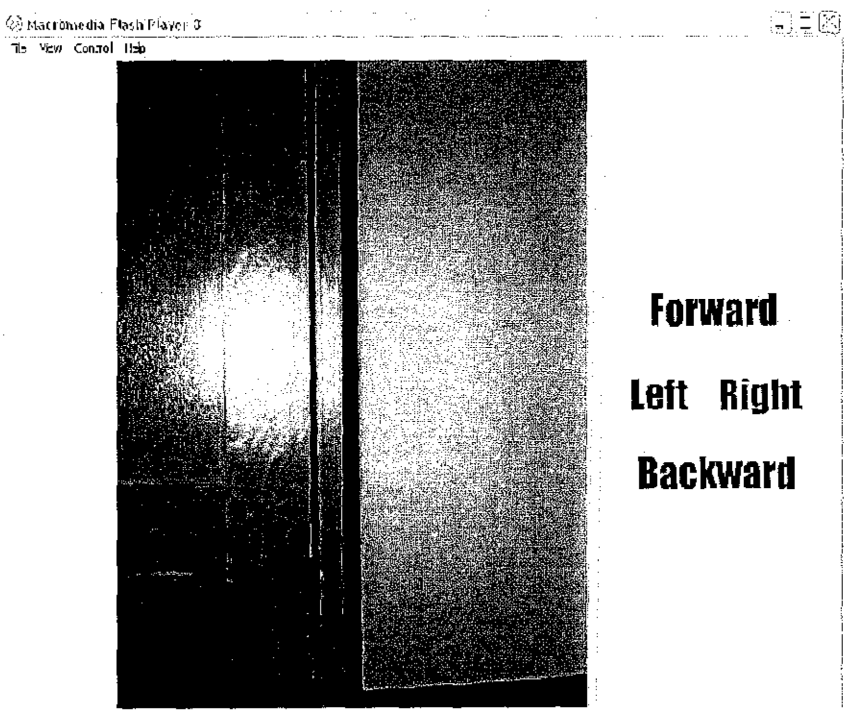

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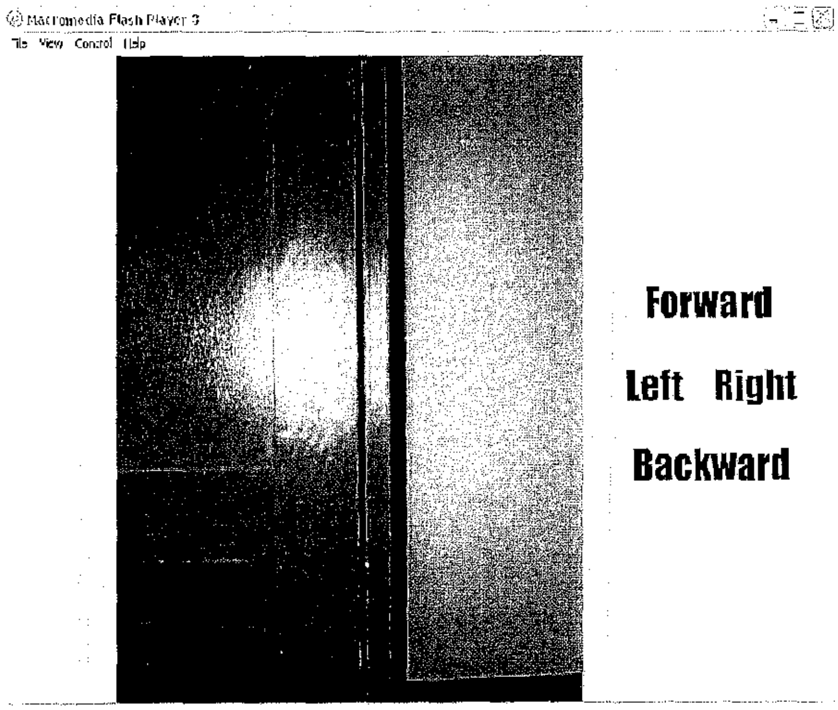

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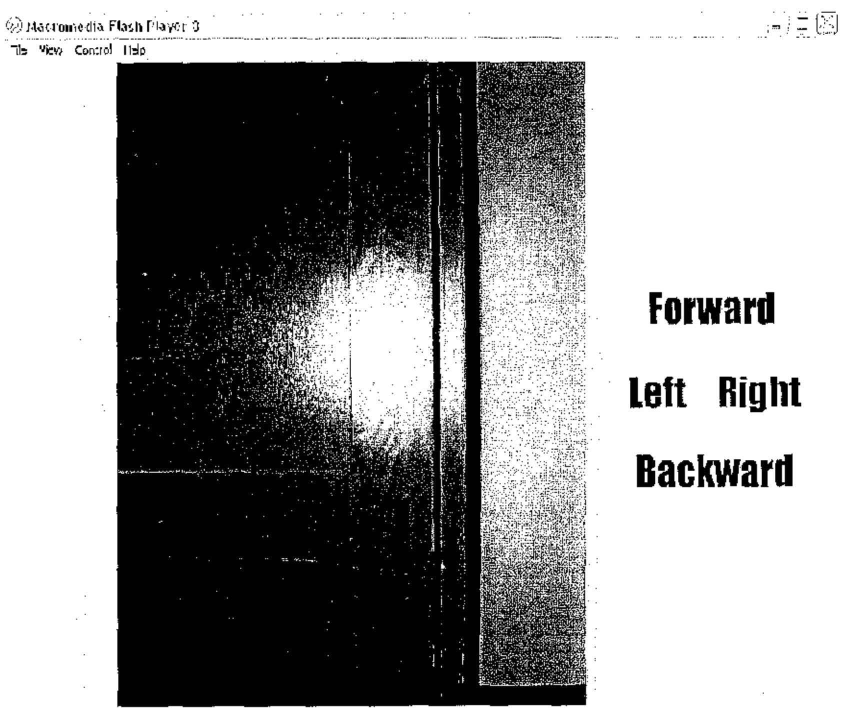

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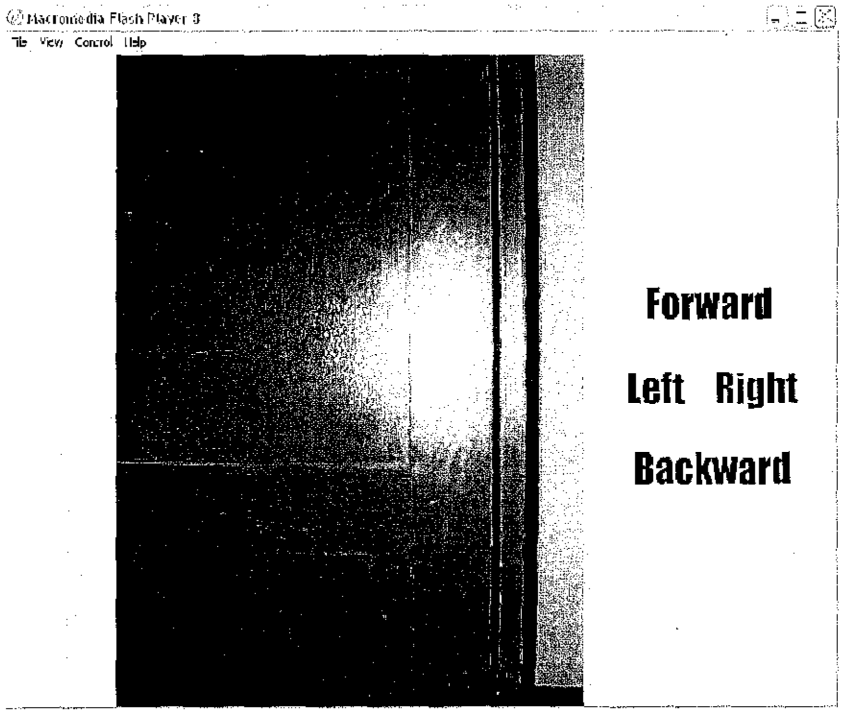

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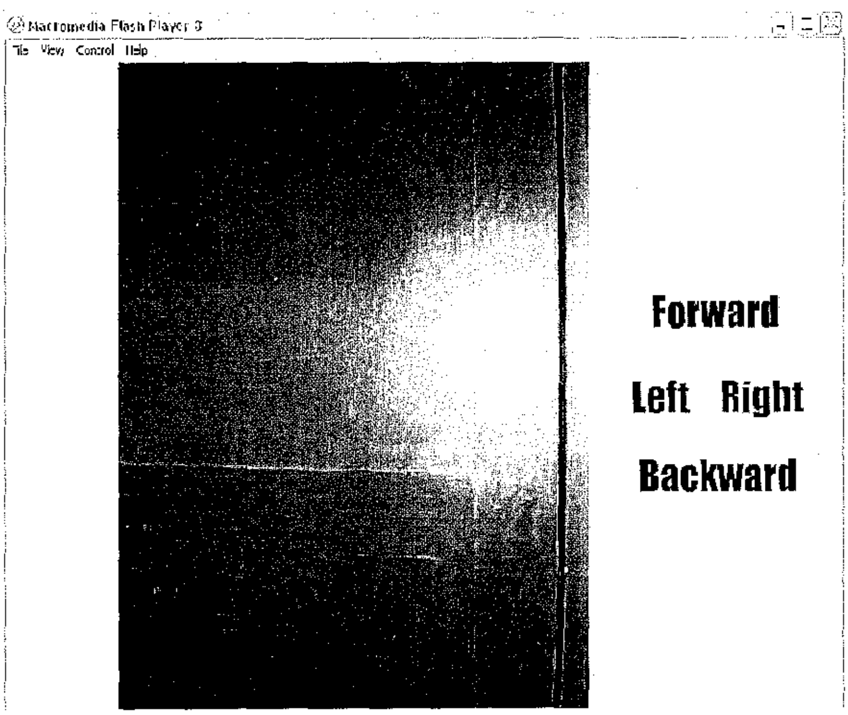

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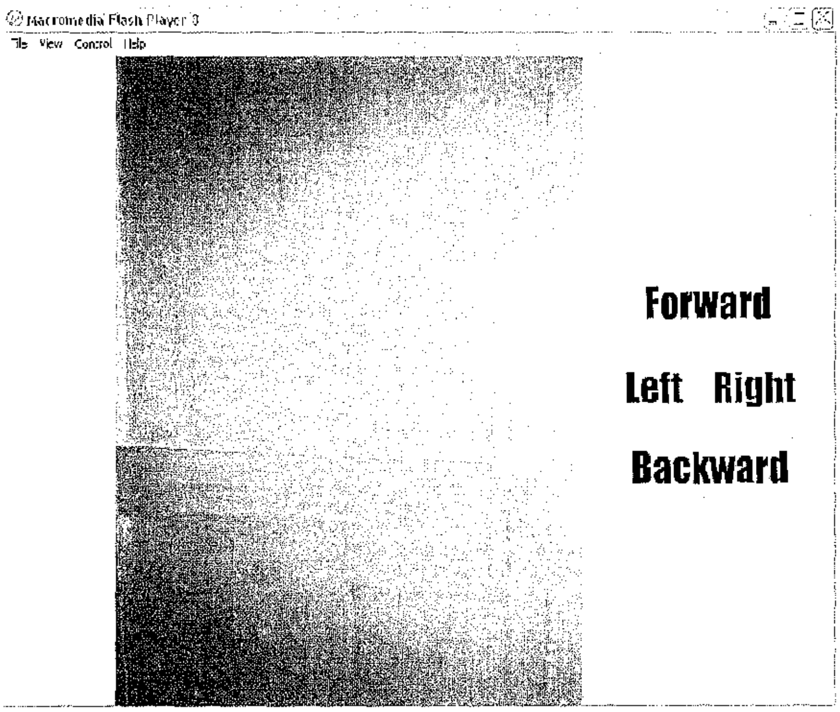

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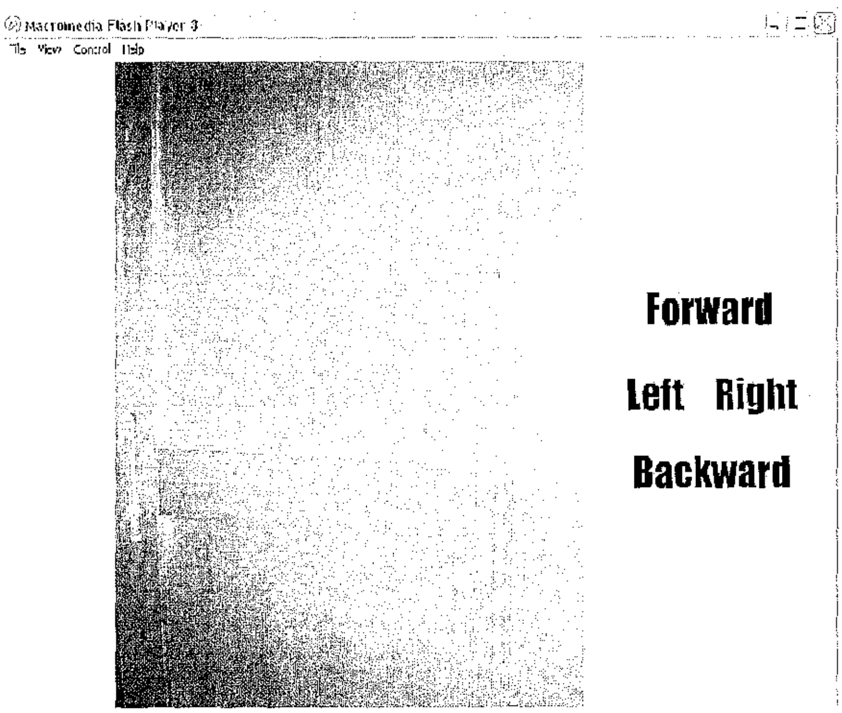

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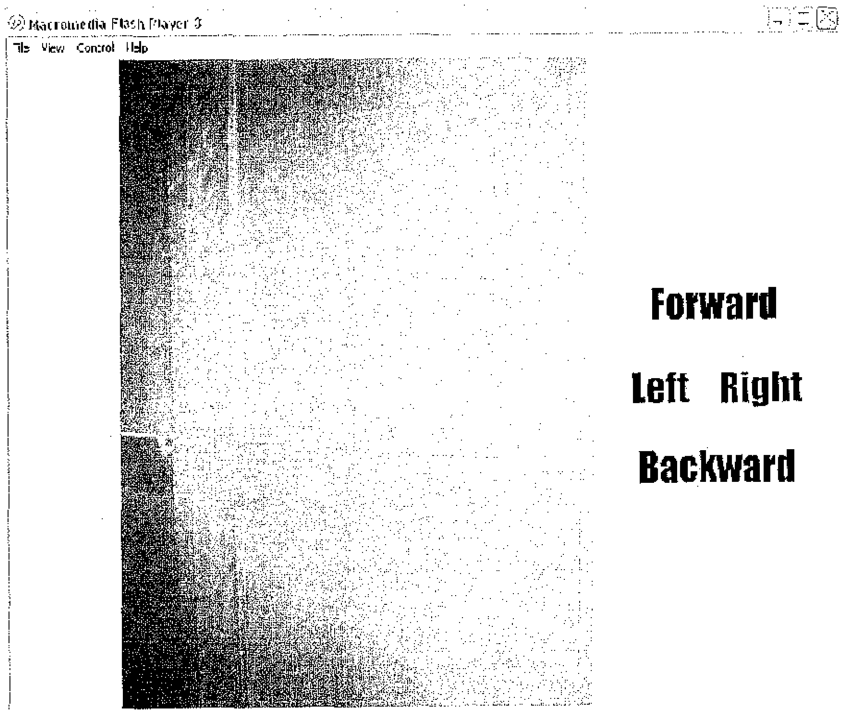

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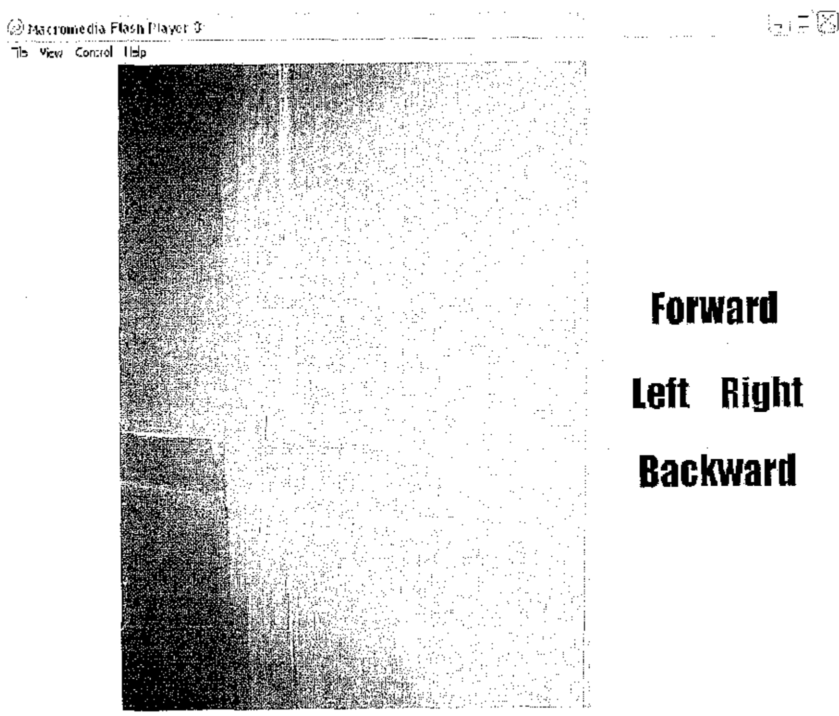

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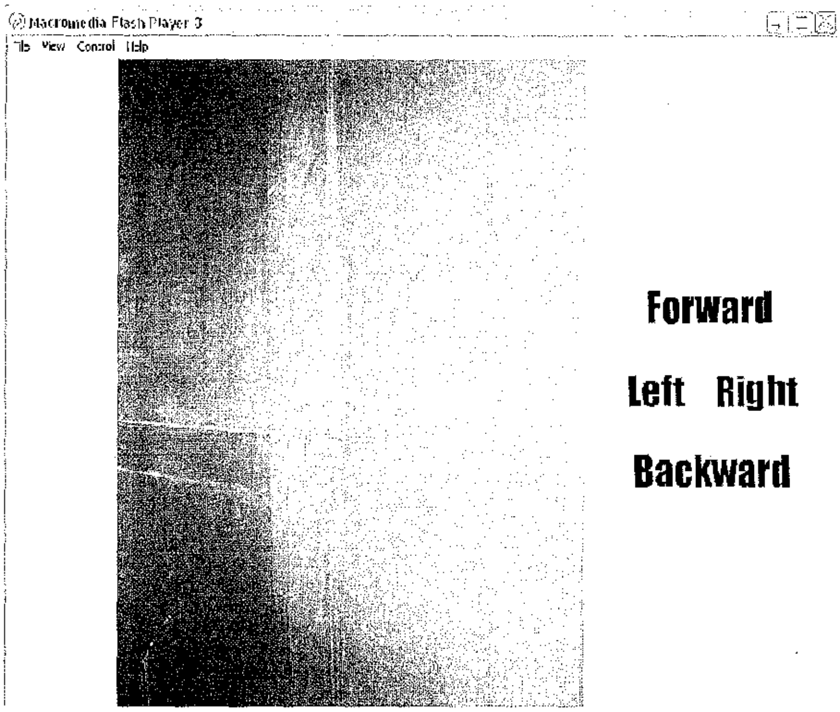

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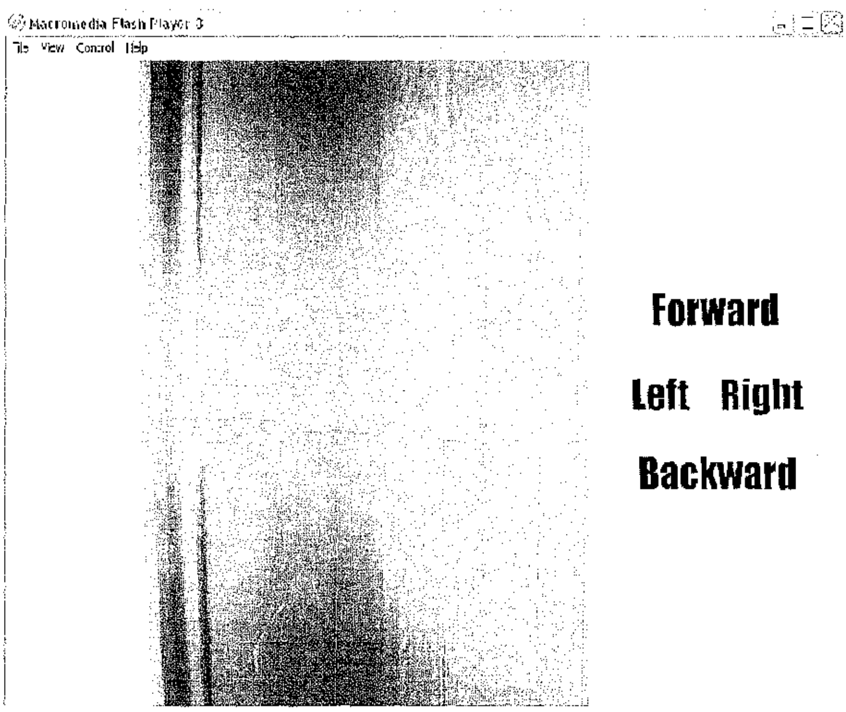

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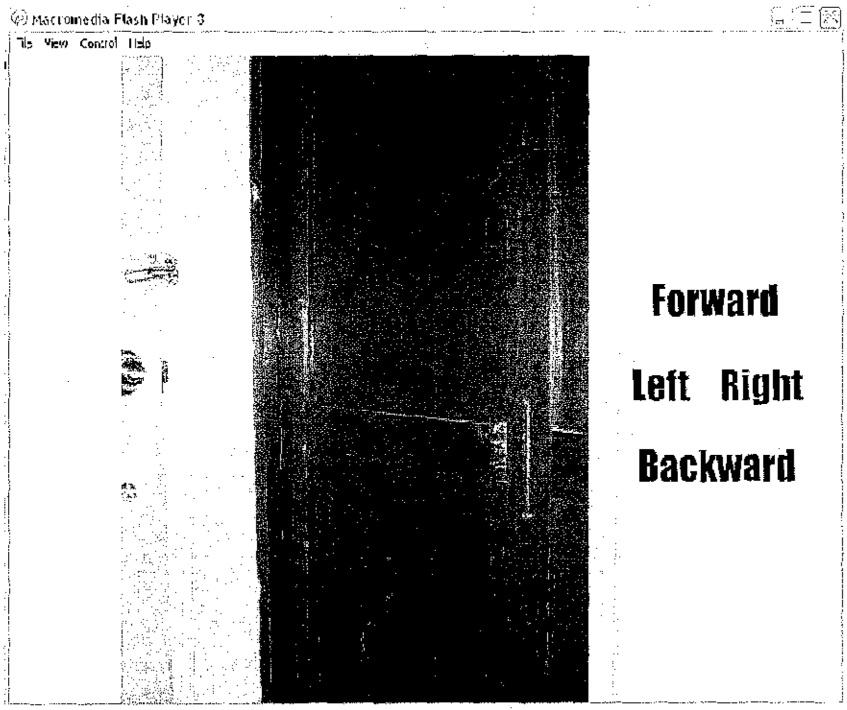

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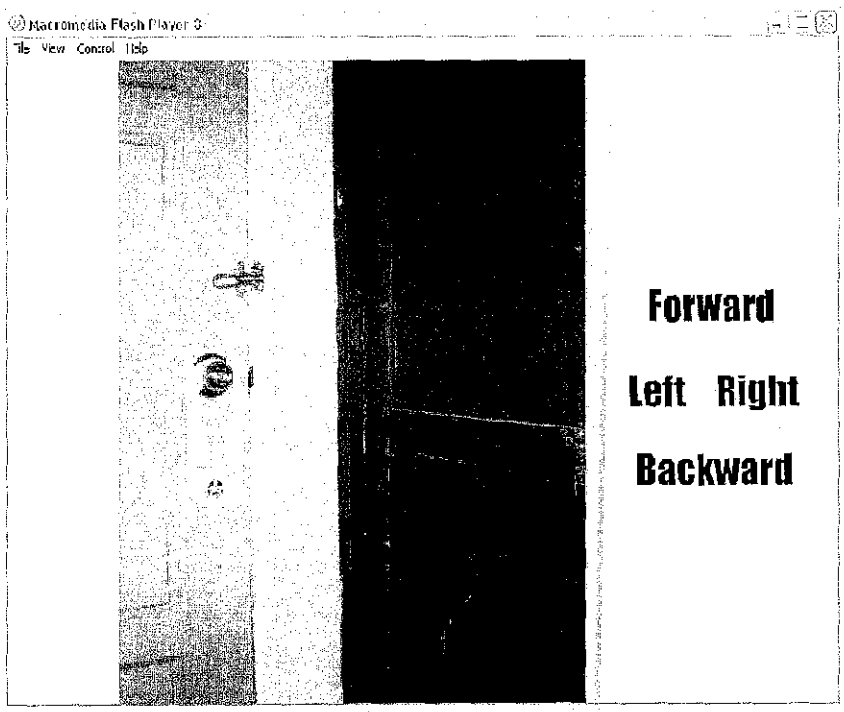

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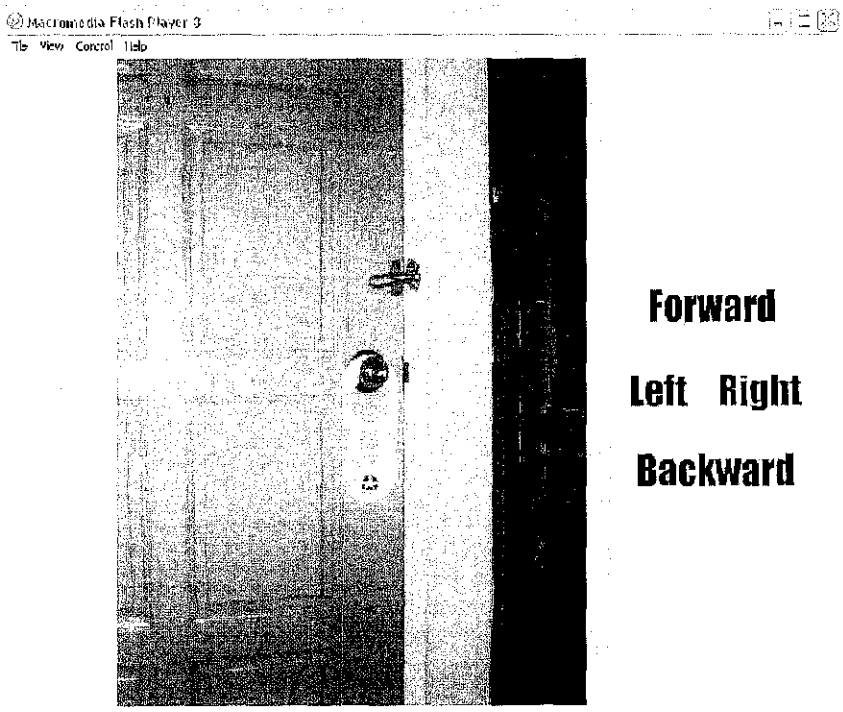

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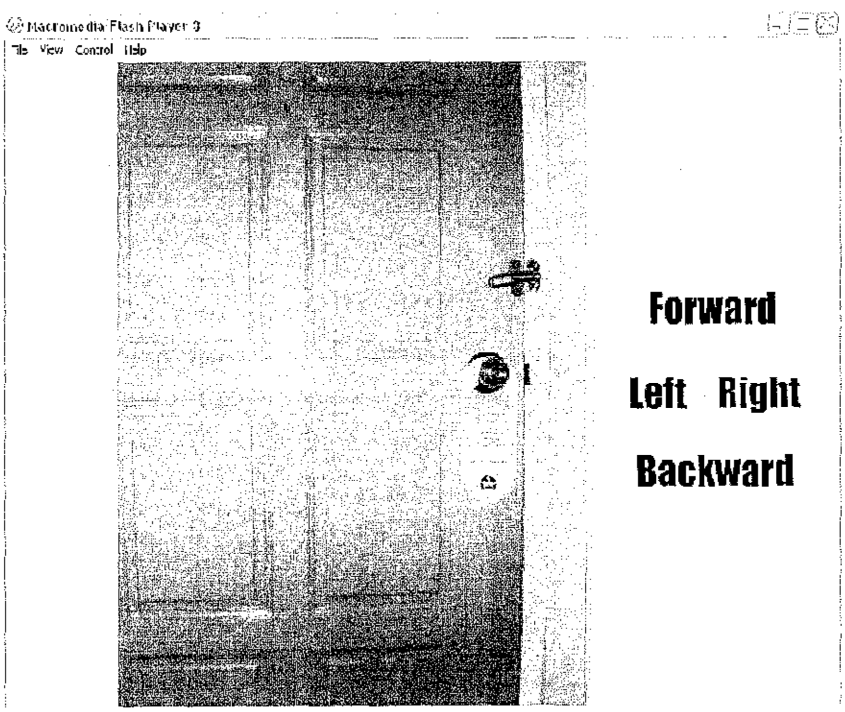

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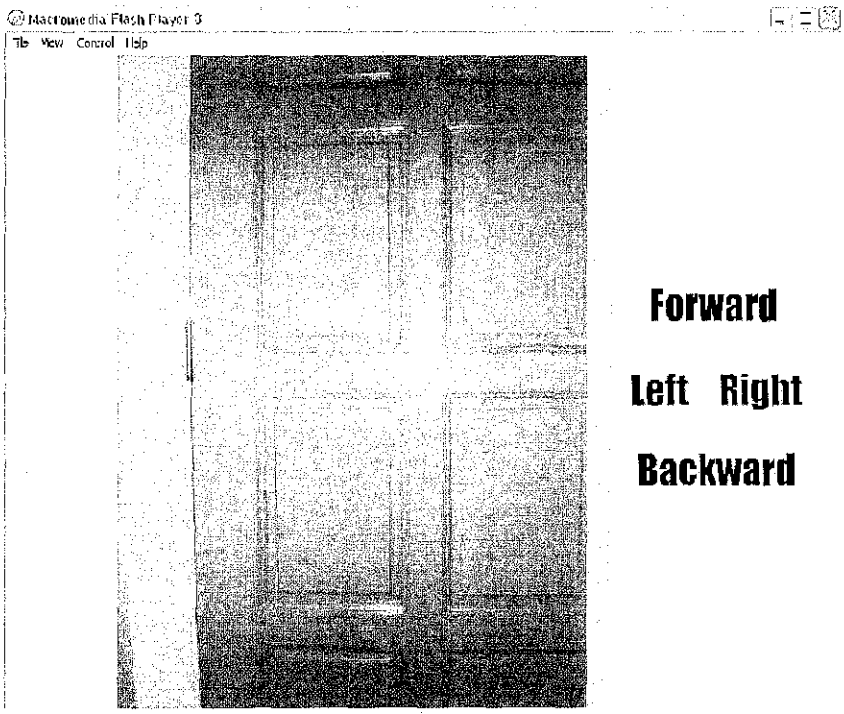

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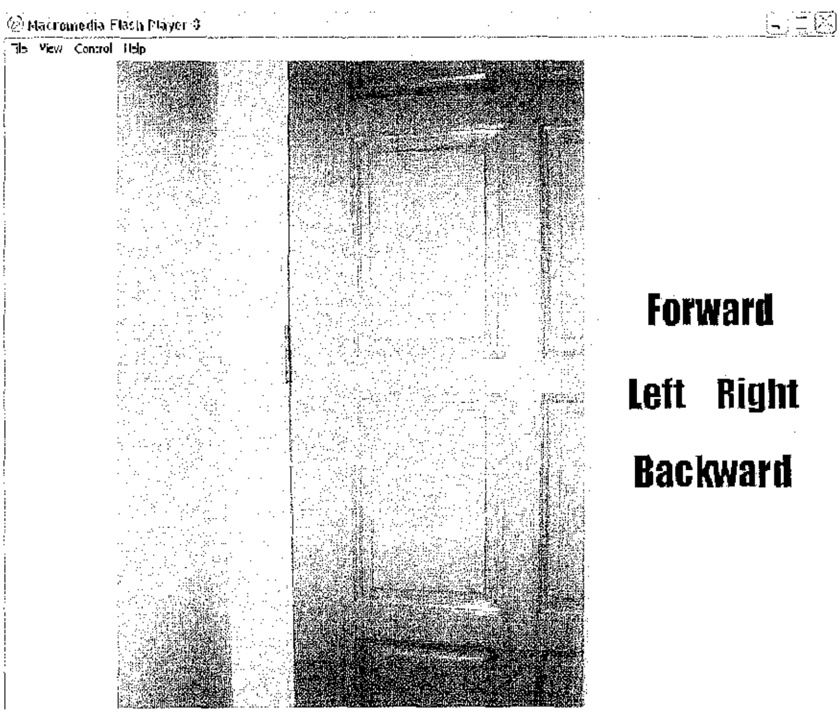

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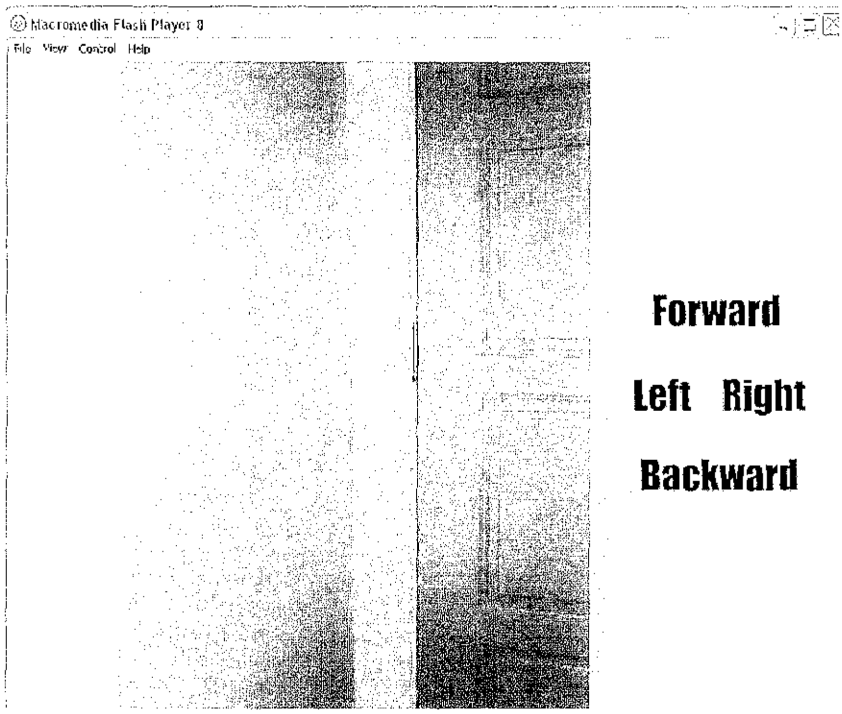

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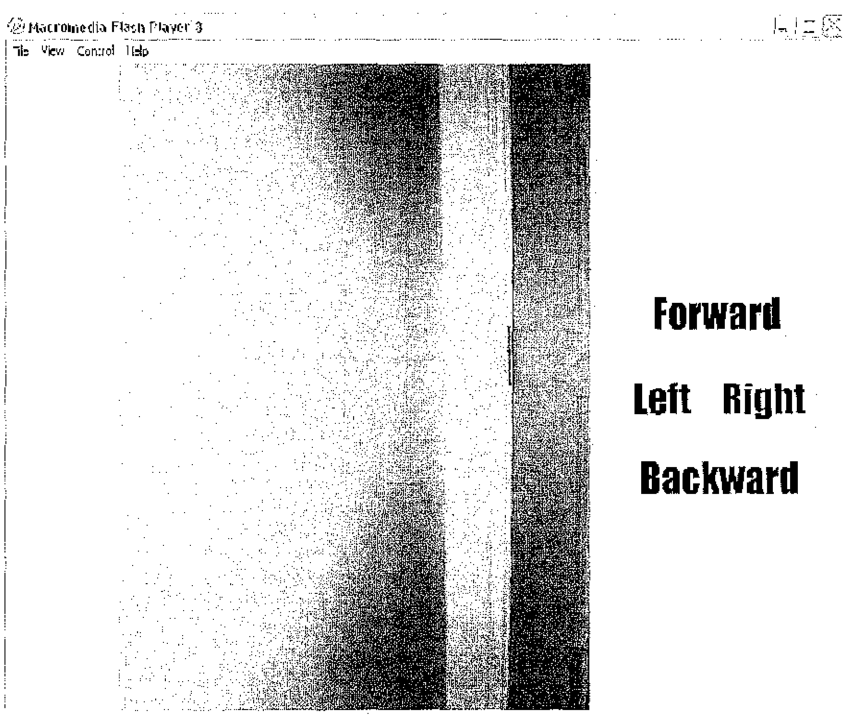

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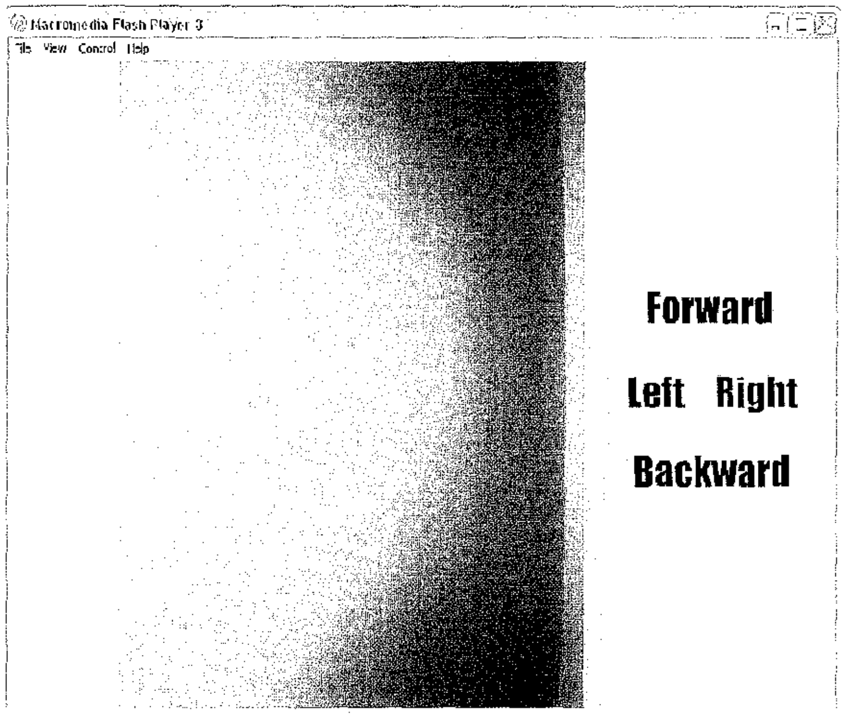

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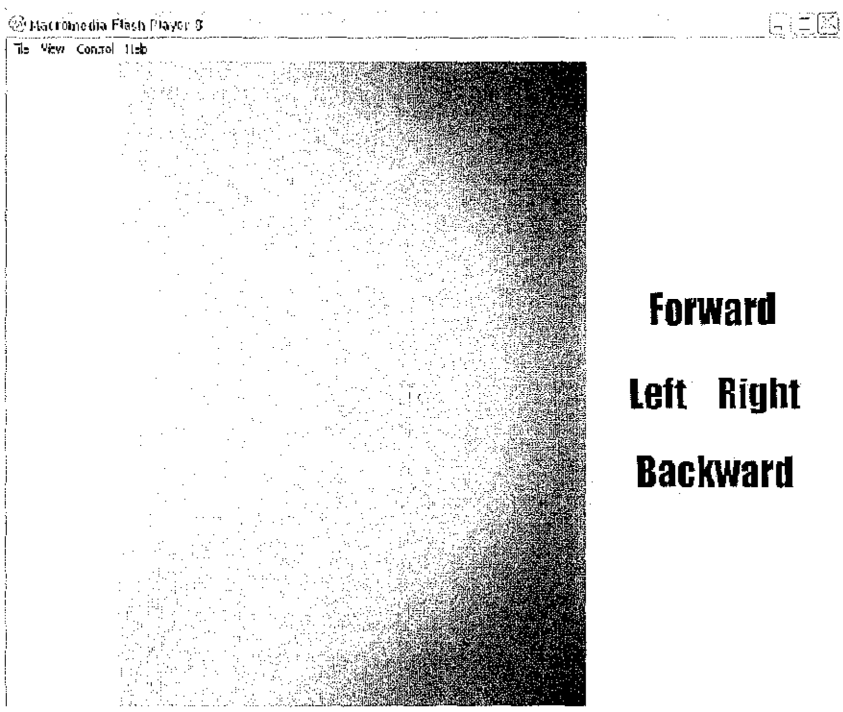

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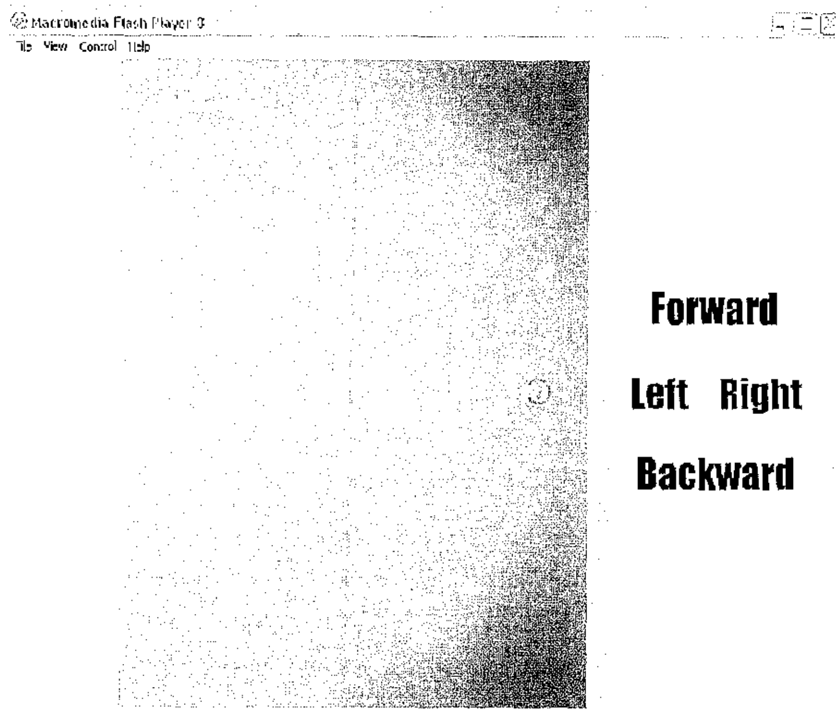

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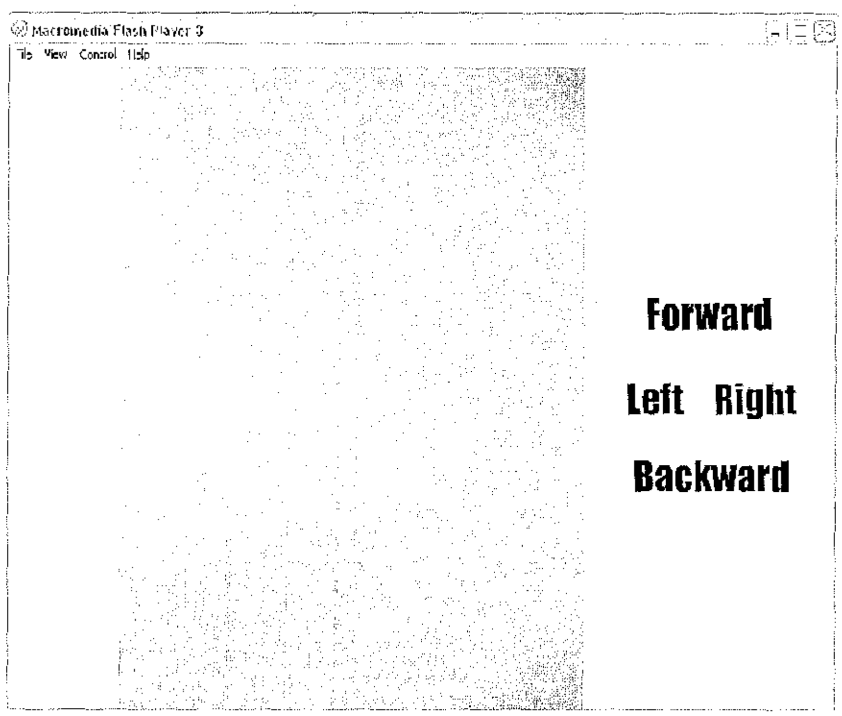

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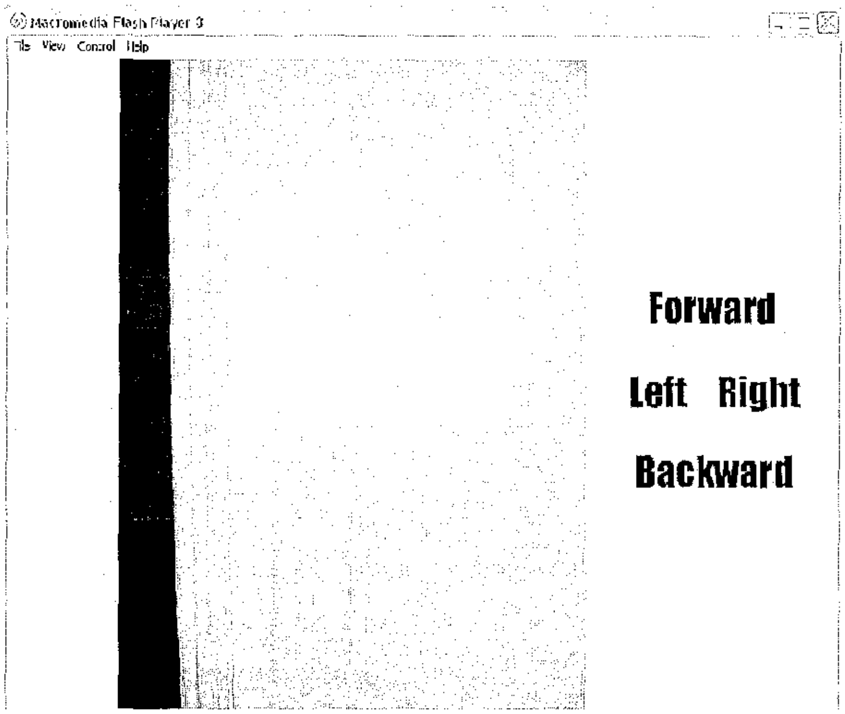

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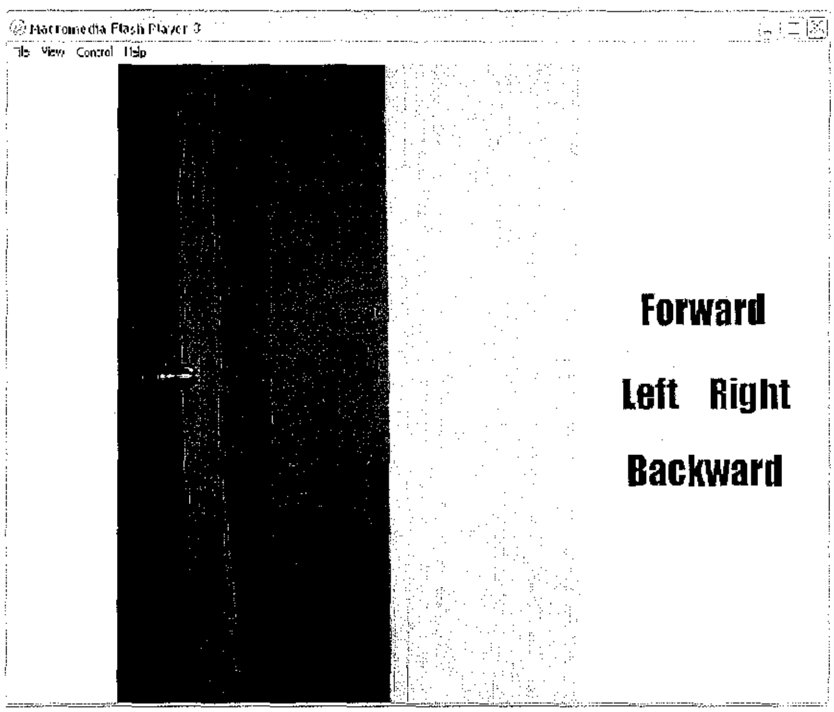
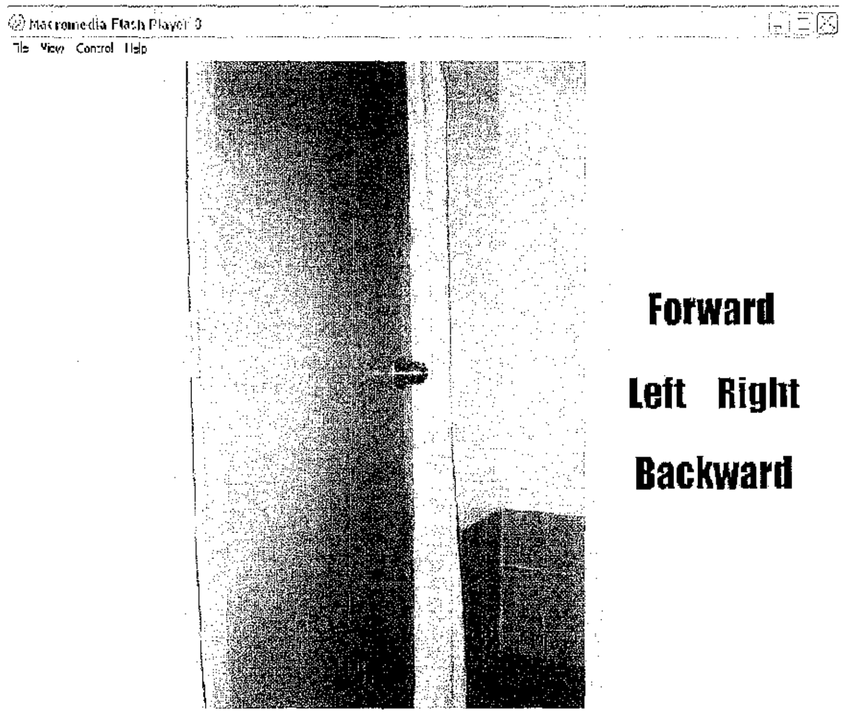
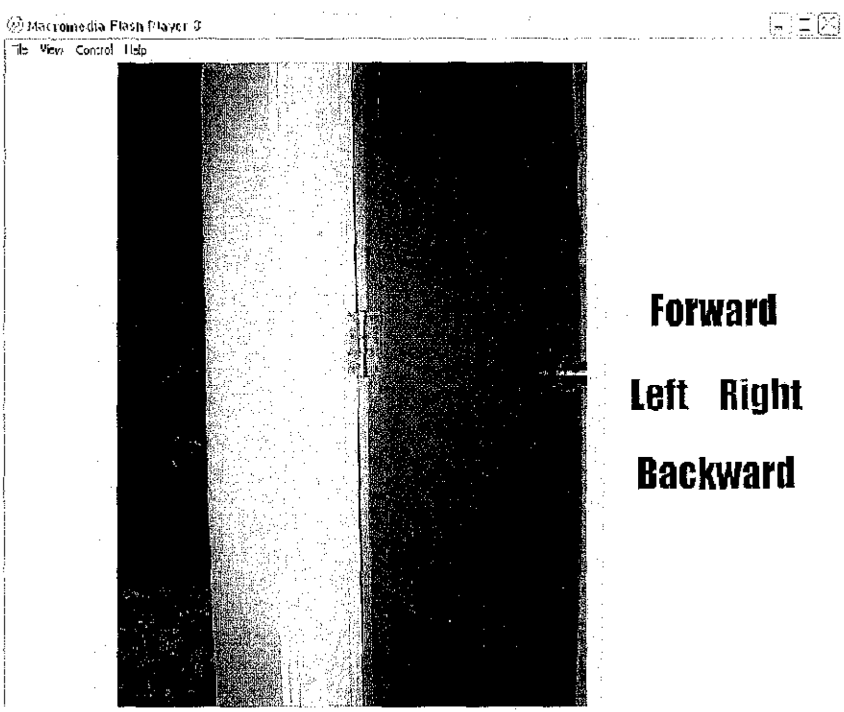


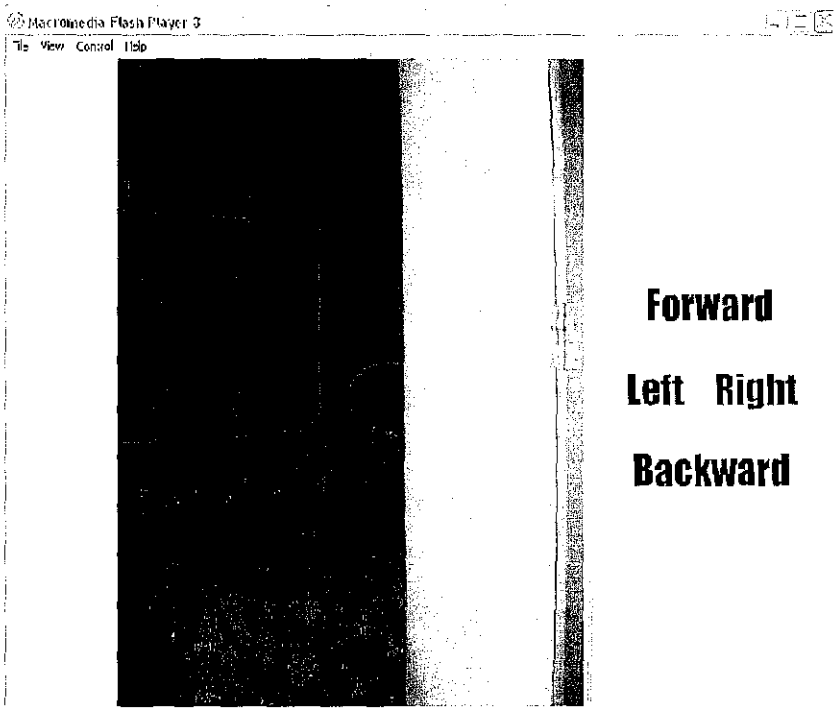
47th turn



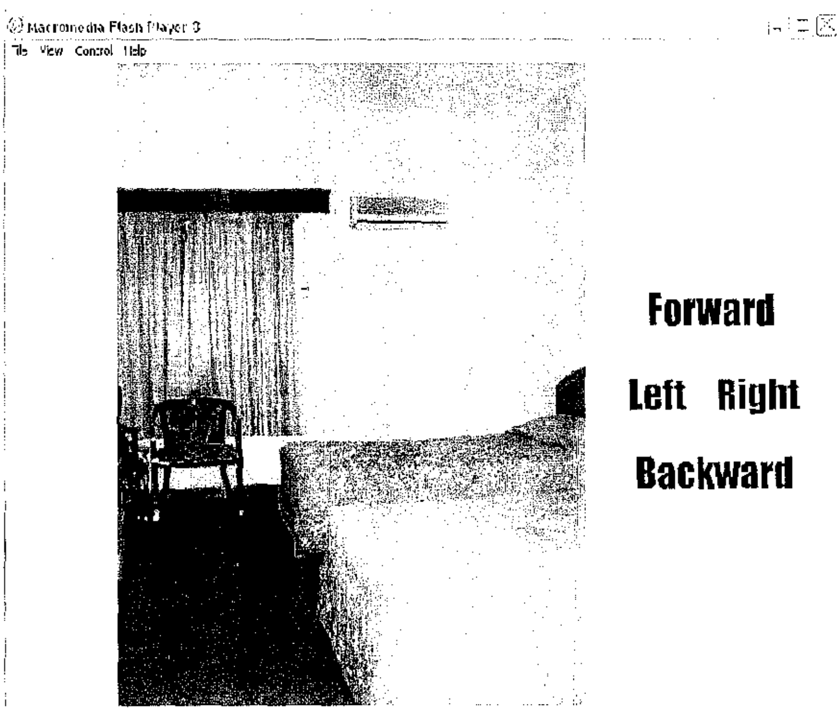
48th turn



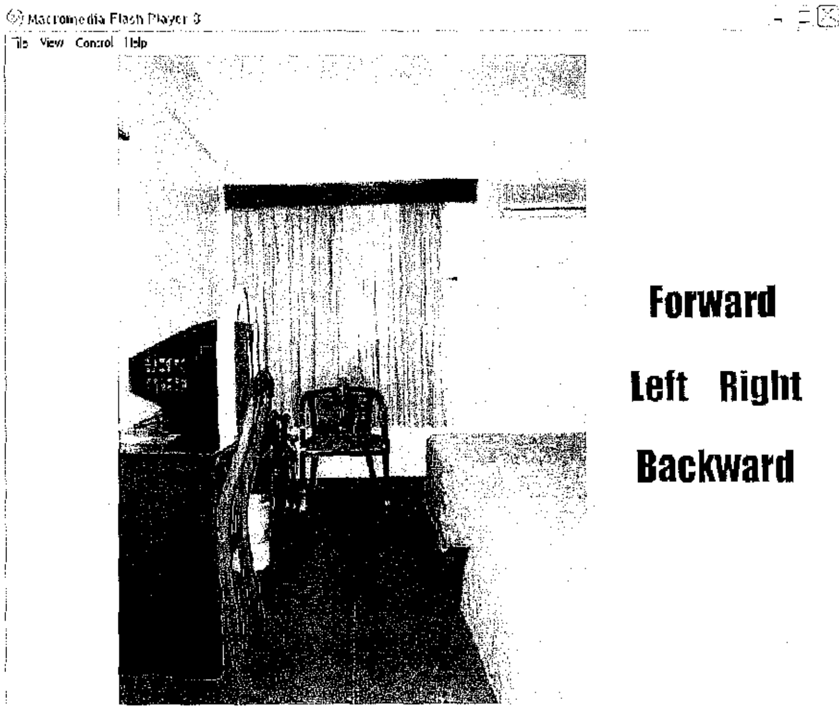
49th turn



50^{th} turn



51^{st} turn

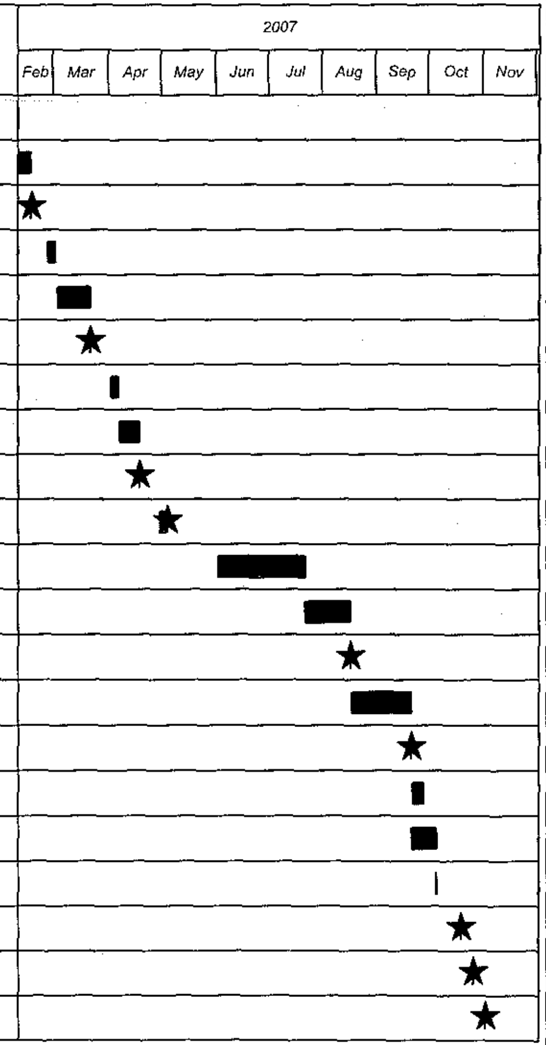

Macromedia Flash Player 8
File View Control Help
Forward
Left Right
Backward

52nd turn

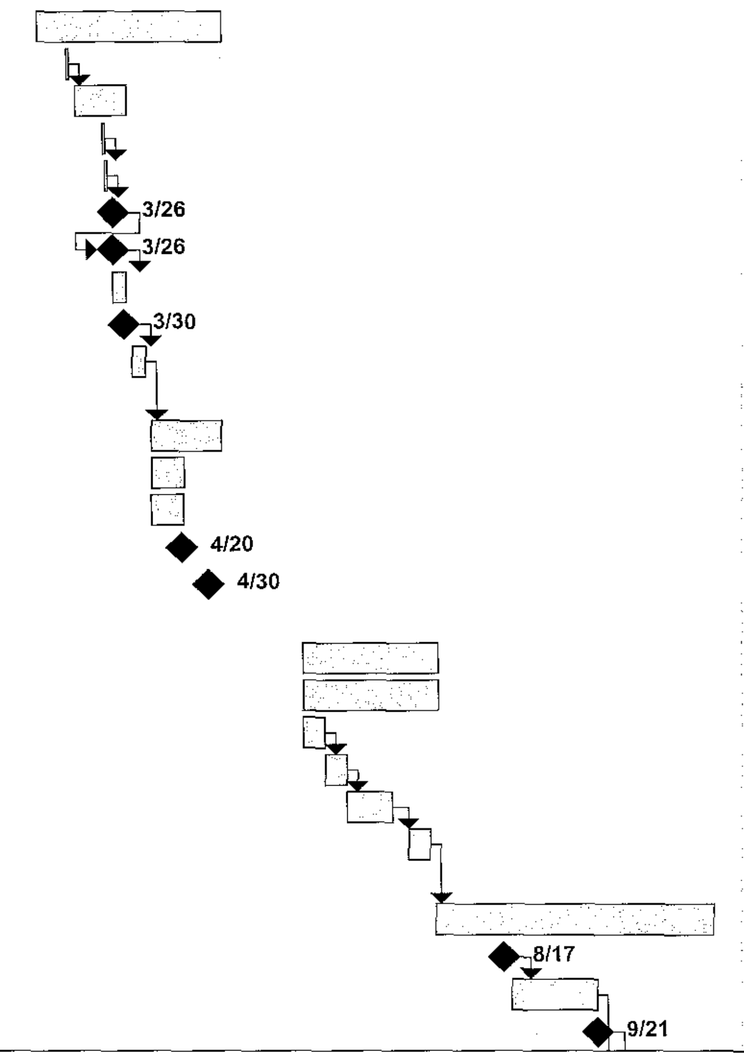
A4. FYP Gantt chart - In Microsoft Visio (General) and Microsoft Project (Detailed)

Final Year Project Gantt Chart

ID	Task Name	Start	Finish	Duration
1	1st Phase- Selection of project topic	2/9/2007	2/9/2007	1d
2	Project Work - Research, Project background	2/9/2007	2/16/2007	8d
3	Submission of Preliminary Report	2/16/2007	2/16/2007	1d
4	Seminar 1 - Preliminary Reporting	2/26/2007	3/2/2007	5d
5	Project Work - Approach, General Design	3/3/2007	3/21/2007	19d
6	Submission of Progress Report	3/21/2007	3/21/2007	1d
7	Seminar 2 – Progress Reporting	4/2/2007	4/6/2007	5d
8	Project Work Continues – Prototype design	4/7/2007	4/18/2007	12d
9	Submission of Interim Report	4/18/2007	4/18/2007	1d
10	Oral Presentation	4/30/2007	5/4/2007	5d
11	2nd Phase - Project Work Con't (Semester Break) – Design & Implementation	6/2/2007	7/22/2007	51d
12	3rd Phase – Project Work Continues (New Semester)	7/22/2007	8/17/2007	27d
13	Submission of Progress Report 1	8/17/2007	8/17/2007	1d
14	Project Work Continue – Prototype review & testing	8/18/2007	9/21/2007	35d
15	Submission of Progress Report 2	9/21/2007	9/21/2007	1d
16	Seminar	9/22/2007	9/28/2007	7d
17	Project Work Continue – Final testing & Improvements	9/21/2007	10/5/2007	15d
18	Poster Exhibition	10/5/2007	10/5/2007	1d
19	Submission of Dissertation (Soft Bound)	10/19/2007	10/19/2007	1d
20	Oral Presentation (Final)	10/26/2007	10/26/2007	1d
21	Submission of Project Dissertation (Hard Bound)	11/2/2007	11/2/2007	1d



ID		Task Name	Duration
2			
3		**1st Phase - current semester**	50 days?
4		Seminar 1- Preliminary Report	1 day?
5		**Project Work - Requirement study & analysis**	15 days?
6		- Borrow tripod from Civil Engineering Department	1 day?
7		- Takes 360 degree images of hotel room	1 day?
8		- Gathered all the images taken according to the points	0 days?
9		- Place the images number of location	0 days?
10		- Study how to use Macromedia Flash	5 days?
11		Submission of Progress Report	1 day?
12		Seminar 2 - Progress Report	5 days?
13			
14		**Project Work Continues**	20 days?
15		- Prototype of image-based walkthrough (Concentric mosaic)	10 days?
16		- Research methodology	10 days?
17		Submission of Interim Report	1 day?
18		Oral Presentation	5 days?
19			
20		**2nd Phase - Semester Break**	36 days?
21		**Project Work - Development & Implementation**	36 days?
22		- Research Methodology	6 days?
23		- Design of web-based hotel booking	6 days?
24		- Prototype of image-based walkthrough (Concentric mosaic)	13 days?
25		- Comparison number of pictures and smoothness	6 days?
26			
27		**3rd Phase - New Semester**	75 days?
28		Submission of Progress Report 1	1 day?
29		**Project Work - Prototype review & Testing**	24 days?
30		Submission of Progress Report 2	1 day?



Project: FYP Gantt Chart
Date: Tue 11/13/07

Task	Rolled Up Task	External Tasks
Progress	Rolled Up Milestone	Project Summary
Milestone	Rolled Up Progress	Group By Summary
Summary	Split	Deadline

33		Comparison concentric mosaic and image mosaicing	9 days?	
34		Poster Exhibition	1 day?	
35		Submission of dissertion (Soft Bound)	1 day?	10/19
36		Oral Presentation (Final)	1 day?	10/26
37		Submission of Project Dissertation (Hard Bound)	1 day?	11/2

Project: FYP Gantt Chart
Date: Tue 11/13/07

Task	Rolled Up Task	External Tasks
Progress	Rolled Up Milestone	Project Summary
Milestone	Rolled Up Progress	Group By Summary
Summary	Split	Deadline