

# Fog Screen Technology

**D.DEEPSHIKA**

B.Tech Student, Department of CSE  
Sphoorthy Engineering College  
Nadergul(Vill),Sagar Road,  
Saroornagar(Mdl),R.R Dist.T.S.

**Mrs.V.ARUNA**

Associate Professor, Department of CSE  
Sphoorthy Engineering College  
Nadergul(Vill),Sagar Road,  
Saroornagar(Mdl),R.R Dist.T.S.

**J.DEETHI**

Associate Professor & HOD, Department of CSE  
Sphoorthy Engineering College  
Nadergul(Vill),Sagar Road,  
Saroornagar(Mdl),R.R Dist.T.S.

**Abstract:** The technology of immaterial projection systems are in constant development and will be more applicable on the market in the future. Therefore, there is a need for color management to improve the image reproduction on these displays, as they are more complex to manage than normal fixed screens. The FogScreen® projection screen produces a thin curtain of “dry” fog that serves as a translucent projection screen, displaying images floating in the air. This thesis aims to optimize the viewing experience by considering the technical aspect as well as the application aspect in order to reach reliable results, as they both have equal impact on the viewing experience. The technical approach is the characterization of the device in terms of color management and profile generation. Based on the device’s characteristics, we are able to determine how the image projection can be optimized under given viewing conditions and installation settings. Furthermore, the application aspect is approached by designing innovative concepts for Norwegian companies. The concepts include consideration of location, the screen’s functionality and purpose, media content management and business innovation.

## I. INTRODUCTION

Inspired by science fiction movies such as Star Wars, two finish virtual reality created the fog screen to recreate some of the effects from these movies in real life. Fog screen is an exciting new projection technology that allows to project images and video onto a screen of “Dry” fog, creating an illusion that the images are floating in mid-air. Fog screen is immaterial walk through screen projection. It allows for projection on a thin layer of dry fog. Imagine the traditional pull down screen that is found in many class rooms. Instead of a screen that is pulled down from ceiling. Fog is pushed down and held in place by several small fans, allowing for consistent surface for display.

### **HISTORY OF FOG SCREEN**

It was invented by two finish virtual reality researchers Fog screen, which was initially known as WAVE (Walkthrough Virtual Environment), was announced in December 2001. The first demonstration of fog screen was in Finland in October 2002. Till then it is in use in different areas and improvements are being done to increase its effectiveness. Fog Screen is a patented technology, which Rakkolainen, one of the senior researchers and founders behind this technology, describes as, “It is an immaterial projection screen that consists of air and a little humidity, and enables high-quality projected images in thin-air, as well as many new applications.” (2006). Palovuori(2006) writes that the fog screen creates a large non-turbulent airflow to protect a dry fog flow inside it from turbulence.

The fog screen debuted at the 2002 Turku science fair. The fog screen company was founded in 2003 and volume production began in 2004. An interactivity add-on, which lets you write “in the air” and even control a computer, debuted in 2005. The fog screen one launched in 2006.

### **FOG SCREEN**

It is one type of advanced projecting device which consumes water and electricity to form fogs on which images are projected.



**Figure 2D projection screen**

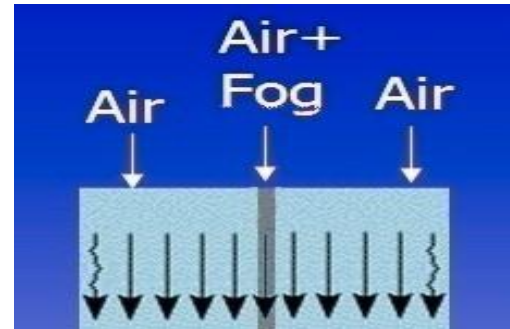
Fog Screen is a just that, a 2D projection screen, but not a common opaque screen like hundreds of others in the market, rather an *immaterial* screen. The word *immaterial* in relation to display systems refers to those that create that sense of imagery floating in mid-air, usually created using water, smoke or fog. Fog screen is one such immaterial screen and uses the method of fog on which to project imaginary. The fog screen is an innovation display technology that allows for projection on a thin layer of dry fog. Imagine the traditional pulldown screen that is found in many classrooms. instead of a screen being pull

down from ceiling fog is pushed down and held in place by several small fans, allowing for a consistent surface for display. A user may simply stand back and view the material but can also reach or walk through a fog. A user may also interact with objects displayed in the fog with the use of an input device like a data glove, traced wand or simply using hands.

Currently there are only nine fog screens available in the world. Fog screen is an exciting new project technology that allows you to project images and videos onto a screen of “dry” fog, creating the illusion that the images are floating in mid-air. You can use the air as the user interface by touching only the air with your bare hands. The screen is created by using a suspended fog generation device with no frame around, and works with video projections. The fog they use is dry, so it does not make you wet even if you stay under the fog screen device for a long time. The fog is made of ordinary water with no chemicals. The system starts with water that is held in a larger water pipe. The water is drawn through a plastic tube via small engine. Users have the ability to control the density and flow of the fog and the strengths of the sandwiched airstreams. With the two projectors we can project different images on both sides of the screen the fog screen is a new invention which makes objects seem to appear and move in thin air it is a screen you can walk through the fog screen is created by using a suspended fog generating device there is no frame around the screen the installation is easy just replace the conventional screen with the fog screen we don't need to change anything it works with standard video projections. The fog we are using is dry. So it does not make you wet even if you stay under the fog screen device for a long time. You can project different images on both sides of the screen crisp, and protected from turbulence. All the important principles of fog screen technology have patent. The basic component of the screen are a laminar, on turbulent airflow, and a thin fog screen created this way, this fog screen is an internal part of the laminar airflow and remains thin a turbulence.

### UNDER THE SURFACE

As already mentioned, the screen is made up of a layer of fog. It is therefore quite unique that such a substance could allow for clear and undisturbed image projection. The secret lies in how this layer of fog is maintained. Palovuori (2006) writes that the Fog Screen creates a large non-turbulent airflow to protect a dry fog flow inside it from turbulence. The outer airflow may get slightly turbulent, but the inner fog layer remains thin and crisp. In a sense, the outer air-flows are like air curtains that sandwich the fog flow and maintain its integrity (Woods, 2007).



**Figure principle of the Fog Screen**

Diverdi (2006) further explains that ordinary tap water (droplets of 2-3 microns) becomes trapped inside this inner layer, and that “even though the fog is made of water, it appears dry to the touch, just like air.” Therefore, the technology is rather simple in nature, making use of water and one device located above the screen. Even a person can stand under the screen for a long time and he won't get wet. In this technique, we are not using any chemicals. Its natural way of projecting the fog screen.

## II. FORMATION OF FOG SCREEN

Fog screen is used by forming ordinary tap water and digital technology like ultrasonic device to create a thin layer of dry fog which is sandwiched between two air curtains. The fog is created by suspended fog generating device. It is made of ordinary tap water with no chemicals. Fog screen creates a “dry” fog by ensuring the water droplets are in the range of 2-3 microns in size and electrostatically charged and they move around and away from the objects. The fog is made within the device using water and ultrasonic wave. If you hold your hands in the fog flow, the fog feels dry and cool and your hands do not get wet. After the screen is formed, images can be projected onto it. The screen is opaque. The founders of the fog screen were intrigued with the prospect of creating an image that float through the air and people could walk through. They set out to make a projected image float in the air by using a different media like sand, dust, water. And then a mist of tiny water droplets. They had to iterate their design repeatedly to ensure that people could not get wet and that the fog screen could operate within a broad range of environmental conditions. The ultrasonic transducer used to divide the water into small tiny water droplets as the fog which we are using is completely dry and it is light. If we take large water droplets then it will create wet fog and which is used in the formation of screen.

### WORKING OF FOG MACHINE

Fog screen technology is a hi-tech version of the technology in cool air humidifier. Tap water is pumped into the fog tank where it is blasted with an ultrasound, turning instantly into a fog made of tiny water particles 2-3 microns in a diameter. The tank

internal design and 3 set of fans work together to create a very thin mist walkabout half an inch thick. One set of fogs blow downwards while the other two sandwiches the fog in air curtains so that it becomes a smooth projection screen. Fog screen works like many screens in projection and requires a 2kv power supply. A major difference is the need of water supply with onscreen fifty litres of tap water per hour. The device situated above the fog screen enables the purification of water via silver ion channel and minerals within the tank are cleaned out through regular maintenance. The opacity will be depending on number of factors mainly the fog density, projector, image brightness and background. It appears to be very versatile technology and can be combined with many methods in order to achieve the imaginary required such as pseudo 3D display and mechanism to allow further interactivity via tracking. The founders of the fog screen were intrigued with the prospect of creating an image that could float in the air and that people could walk through. They set out to make a projected image float in the air by using different media such as dust, water, fog, and then a mist of water droplets then they had to iterate their design repeatedly to ensure people would not get wet.

#### **FOG SCREEN THINGS MOVES FORWARD**

It is important to recognize the uniqueness of Fog Screen technology. It is not the world's first immaterial screen, but the first immaterial walk-through screen. This simple fact is what distinguishes Fog Screen from all other displays (Rakkolainen, 2007). Rakkolainen continues to explain the uniqueness of the technology by mentioning how other displays can create the floating imagery effect but none are penetrable. There are water screens creating huge displays for large audiences but they provide poor image quality. Such large water based displays are also wet and so impractical for indoors, and walk-through interaction. There have also been earlier technologies closely similar to Fog Screen making use of fog rather than water. However, they are typically wet and turbulence affecting such screens seriously reduces the fidelity of imagery. To reiterate what has been mentioned above, Fog Screen creates a non-turbulent airflow of dry fog, cool to the touch. Erdem (2006) mentions in an article on performing arts how this quality means that performers or anyone interacting with the screen for that matter will not be restricted by the fog layer. One can walk freely through the layer and the imagery will not be dispersed or distorted. FogScreen technology not only is unique as a stand-alone display. Its qualities, mainly the immaterial nature and walk-through capabilities, allow for very advanced interface design. Olwal and other researches (2006) have written that Fog Screens dual-sided nature allows for new possibilities in multi-user face-to-face collaboration and pseudo-

3D visualization." Images can be projected on both sides of the screen creating a 3D virtual effect.



**Figure dual projection**

Olwal has created several pseudo-3D interactive applications, an example being Elastic Surface Denominator. This interactive application allows a user to stretch and sculpt, as well as to move and rotate a 3D model of a head. Not only has Fog Screen been used with such pseudo-3D displays, it is the centre part of many ongoing efforts towards real volumetric 3D displays. Dr Benzie (2007) in a large survey of 3D displays writes how volumetric displays are in a more advanced stage of development with many already having a profitable market as with Fog Screen. It appears therefore, that Fog Screen is a vital display for many researches in the world of 3DTV.

#### **FOG SCREEN ONE**

Fog screen one creates a screen that is 1 meter wide and 1.5 meters high. The dimension of the unit is height 64cm, depth 75.5cm and width 1.09m. The measurement is without end fans. The fan caps will make the device 2.6cm longer. The weight of the device with the end cap is approximately 60kg. The screen requires either water mains connection or a water reservoir 1 -phase 10A/230V or 20A/115V electricity. Fog screen one is seamlessly linkable screen. The screen size starts from 1 meter, but the width of the setup is scalable by joining several one units together. The result is a seamless fog screen of any width unlimitedly. The interactivity add-on of fog screen makes it possible to write and draw in the air with your hand by using your finger as a pointer. The interactivity fog screen the interactivity set includes uses a laser tracker to track hand movements the hands becomes a mouse. This turns the passive projection screen into an immaterial touch screen, and extends greatly its applications possibilities. The interactivity set includes our proprietary software enabling the creation of fiery character or fireworks. It is also possible to design special customised interactive software. With the interactivity add-on, it is possible to create multimedia shows that user can control by touching images in air.



- walk through and by doing so screen afterwards. Fog screen has been well received.
- Create a luxurious interior with fog screen.
- Immersive projection technology could use CAVE-like virtual rooms with fog walls, making them effectively “virtual rooms”.
- Entertain your guests with fog screen whether you are planning a rock concert, any commercial or private event, we use magical fog screen. Guest can enter through the screen to an event.

### III. THE PSEUDO-VOLUMETRIC 3D SCREEN

Even though the basic walk-through Fog Screen is a plain 2D projection screen, it is a volumetric display in the sense that the floating image is formed within a volume of empty, freely accessible space. The basic Fog Screen can be extended to become a pseudo-3D display, while still fundamentally being a 2D display technology. Our contribution is a novel interactive, dual-sided, wall-sized system that allows a single user to view objects floating in mid-air from any angle, and to reach and walk through them. Two individual, but coordinated, images are projected onto opposite sides of a thin film of dry fog, and an integrated 3D tracking system allows users on both sides to interact with the content, while the non-intrusive and immaterial display makes it possible to freely pass physical objects between users or move through the shared workspace. Our system opens up possibilities for a wide range of collaborative applications where face-to-face interaction and maximum use of screen estate is desirable, as well as the maintenance of individual views for different the screen affords an image of 2 meters' width (or 2.5-meter screen diagonal at 4:3 screen ratio) in the centre of a large open viewing area that is limited only by available space and coverage by a 3D position tracker. By tracking a single viewer's head, using correlated projectors on each side and adjusting the projected 3D graphics rendering accordingly, we create a pseudo-volumetric 3D display. This makes the 3D effect more convincing by showing the 3D object from the appropriate angle. The viewer can see objects floating in mid-air from both sides and freely walk around and through them to examine the scene from almost any angle. The eye cannot correctly focus at a real point within the image, but an impression of depth is still achieved due to other monocular cues, most notably motion parallax. The immaterial nature of a thin sheet of fog allows a user to penetrate and even walk through the screen, while tracking a single user's head enables the pseudo-3D visualization. Using the dual-sided option of the screen, projecting coordinated opposing views, 3D objects can be observed from all sides. Also, stereoscopic imaging techniques can be used with the Fog Screen. These

techniques were all demonstrated to a small number of viewers for an informal user study to get an idea of 3D perception performance.

#### *Stereoscopic projection*

We experimented with a variety of passive and active stereoscopic rendering techniques on our display. Passive stereoscopy with linear polarized glasses and filters works without difficulty, as a thin fog layer accurately preserves light polarization. We used standard polarization filters and glasses for our experiments. Cross-talk between the left and right images is comparable with that resulting from the use of a standard silvered screen. Polarization requires two projectors, which raises the system cost. The computer must also be able to drive two separate projectors for a single-sided display, requiring four different views being rendered for dual-sided polarized stereo. We also tested passive stereoscopy with red-cyan coloured glasses which worked fine with the Fog Screen as it maintains proper image colours. Red-cyan stereoscopy only requires a single projector, making the system less expensive and complex than polarized stereoscopy, but the effect is limited to monochromatic imagery. Since the Fog Screen preserves image colours, the InfoTech passive stereo system could also be used, but we did not have one available for testing. The last passive stereoscopy technique we tried was Chroma Depth, which colour codes an image by depth value, with red pixels being nearest to the camera, followed by orange, yellow, green and finally blue in the background. A pair of diffraction grating glasses shift colours so red areas appear near the user, while blue appears far away. The main advantage of this technique is that if the users are not wearing the special glasses, they still see a single coherent image, instead of two superimposed views as with red-cyan or polarized stereo. However, the trade-off is that Chroma Depth is more of a heuristic and does not actually simulate eye separation and focal length of the user's visual system. For active stereoscopy, we used a Depth 3D projector with shutter glasses. While this projector model is quite affordable and may serve as an example for the ongoing reduction in costs for active stereo systems, this was still overall the most expensive option we tried, and the projector's brightness was lower than that of cheaper passive stereo solutions. Initial results indicate that the quickly changing turbulence pattern of the fog's surface over time causes a subtle difference between the left and right images of an active stereo projection, disrupting accurate separation and making it somewhat difficult to see a clear stereoscopic image. This problem will be partially solved as the screen quality will improve in the future.

#### *Additional depth Cues*

Tracking the viewer's position in 3D Motion

parallax, achieved by tracking the user's head position, is a strong monoscopic depth cue. Most any tracking technology suitable for virtual or augmented reality work could be used with our system. For this work, we employed a World Viz Precision Position Tracker (PPT) wide-area 3D optical tracker for head tracking. The PPT is a wireless 3DOF vision-based system that uses 2 or 4 cameras to track small near-infrared LEDs, which in our system are head mounted. Each LED marker needs to be visible by at least two cameras at all times. The PPT can track up to 8 LEDs, but we need only one to track the viewer's head position. Our setup uses four cameras, two on each side of the display. The Fog Screen is invisible in IR spectrum so it does not hinder the visibility of our IR LEDs. We developed a proxy VRPN tracker server that filters the PPT output into more reliable data. The VRPN proxy analyses the position and velocity of tracked objects to predict future positions and remove spurious detections. The use of IR LEDs imposes the requirement of controlled lighting, since many regular light sources have IR radiation that will generate noise in the near-IR camera image. This problem is evident especially in environments with daylight or bright incandescent spotlights. Standard fluorescent lighting works fine, and the use of specific spotlights (i.e. with minimal IR radiation) or IR filters additionally allow incandescent light sources. We use an IR LED on a headset for 3D position tracking. The marker could also be custom-made into a miniature version for stereoscopic glasses.

#### IV. FOG SCREEN RELATED TO MULTIMEDIA

Displays are hugely important to multimedia. All imaginary needs some way to be displayed, even in its creation. For this reason, there are many technologies out there and as a result many products with a recent one being the plasma screen. Fog screen breaks this mould being the first immaterial capabilities of fog screen products have enabled its success in the world of multimedia and its application can be seen all over the world and in many different industries.

##### **FOG SCREEN ADVANTAGES**

- The fog screen developers say the unique nature of fog screen will make it a memorable experience for customers.
- Fog screen is environmentally friendly, as it uses only water as requirement and produces chemical free fog.
- Increase product skill and quality of products safety for kids, fun and play time for the kids. It is immaterial you could walk through it.
- Increase production skills-technology transfer reduce competition-increase quality of product enter

to new market.

- Increase for workers with an increase in marginal cost fog screen is working on new hardware products fog screen with specialised capabilities. There are also significant enhancements being made to the interactivity and 3D imaginary capabilities of the screen.

##### **FOG SCREEN LIMITATIONS**

Fog screen works best indoors with a dark background that enhances the brightness of the image on the fog screen behind the projector. So, it, can't be used in day light.

It is presently very much expensive, but the fog screen is working on providing it in a reasonable price.

- Price is one weakness, with the cost fog screen will have to cater for a specialised market, unlikely ever to be used in the normal household or to replace plasma/LCD displays.
- Need 1kw of energy to produce 1m long fog screen. And it will produce 3-5 litres of water in one hour which should be vent and high fog screen can't be made because it would diffuse the distance.

##### **FOG SCREEN OPPORTUNITIES**

- There are endless opportunities to use the products, but for now these have been mostly innovative
- Development are being carried out in making fog screen a touch fog screen to make it more marketing solutions and different exhibitions.
- Stream of fog can appear and disappear within a fraction of a second, making it a possibility for use in a live theatre setting to aid with special effects.
- Presently it is demand in countries like japan, Malaysia, Germany, France, Greece, Russia, UK and in recent future it will replace the existing method of projection. Interactive for the viewer

#### V. CONCLUSION

We have described a novel mechanism to create a pseudo-volumetric 3D walk-through screen. The implemented system enables one to view 3D objects in mid-air and observe them from almost any angle. Using it as an immaterial, head-tracked dual-sided display, has led to an enhanced visualization experience. It creates a strong visual effect of 3D objects floating in air, even when the image is not stereoscopic. This is a first step in the direction of a truly volumetric walk-through display. Unlike many other volumetric displays, the pseudo-volumetric Fog Screen is very large and does not restrict the user from "touching" the objects, leading to a more immersive experience. Interaction with the immaterial 3D objects can be supported, as we did in

our demonstration at SIGGRAPH 2005 Emerging Technologies. The Fog Screen has shown itself to be a captivating display technology that immediately generates interest and excitement in the audience. The feedback from our SIGGRAPH 2005 demonstration was unanimously enthusiastic about the dual-sided, interactive experience. Since then, our demos of head-tracking and stereoscopy have been met with similar enthusiasm about the further improved perception of 3D imagery.

## VI. REFERENCES

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## AUTHOR's PROFILE



**D.Deepshika,** B.Tech Student,  
Department of CSE, Sphoorthy  
Engineering College,  
Nadergul(Vill), Sagar Road,  
Saroornagar(Mdl), R.R Dist. T.S.



**Mrs.V.Aruna,** Associate Professor,  
Department of CSE, Sphoorthy  
Engineering College,  
Nadergul(Vill), Sagar Road,  
saroornagar(Mdl), R.R Dist.T.S.

**J.Deepthi,** Associate Professor & HOD, Department  
of CSE, Sphoorthy Engineering College,  
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