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A FEASIBLE VOLUMETRIC DISPLAY WITH GESTURE BASED INTERACTION SYSTEM

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Abstract—The immaterial display system is a technology that enables high-quality images to be projected in mid-air on suspended transparent particles . Video game and augmented reality are also an extension of mid-air displays. Immaterial mid-air displays are formed from light-scattering particles that are feasible for displaying information in mid air and also allows us to interact with the display midair.A feasible volumetric display will be ideally a small modular and low cost system which will contain a fog screen generator and a gesture based interaction system.

Index Terms—Virtual Reality, Augmented Reality, Fog Screen, Feasible, Volumetric

I. Introduction

A display system that can view the contents in mid air is a technology that has been speculated for many years. However this Mid air display technology is little more than a science fiction to the common masses. There are many advantages to the application of immaterial display. However the high cost that is required for the construction and the big size of the machines used for this technology makes it to be used as a simple eye catcher.

However it has a much broader potential as an immaterial, unobtrusive information display. It has also been envisioned to be an integral part of the long-term future display systems [1] and user interfaces. The high cost of production of such a display system is the major reason why the technology is not widely used.

In this paper we describe a immaterial volumetric display system that is small, modular and low cost. these character-istics can easily remove the limitation that previously held back this technology. These factors can also enable a broader spectrum of the masses to obtain and use the immaterial display technology. An immaterial display system has many advantages over the traditional screened display systems. In the Displays of the current senario, They include a lot of advantages to the crispness of the image displayed. However these displays also at as a reason for the slow innovations in the field of VR and AR[2]. The most notable among these advantages are that the immaterial display system can produce a true seamless display. the modular design and small size along with the seamlessness can easily allow multiple such systems to be used together to form an even bigger screen.

The paper is an implementation of a feasible immaterial display that is small, modular and low-cost.

II. Related Work

The air-based display which uses the air for its operation is called Heliodisplay. IO2 Technologies developed it in 2001. Immaterial particles of micro-size are created using Ultrasonic atomizer. These particles appear to be floating in mid-air and projection is made onto these particles. [6] The cinematic technique principle for rear projection is similar to this and even 3D content can be projected. The dark colors or black color in the image will appear as invisible which gives it a realistic touch. But multiple viewing angles are not allowed in the system. A combination with 2 light sources allows it to be viewed it in 2 different directions. The oblique viewing angle of 30 degrees is required for the rear-projection requirement.

Displair is a technological display that is similar to a volumetric display. The Displair was introduced by Maxim Kamanin at Seliger 2010 and the company and the product were named it that year itself. The name was obtained for the words display and air.[8] Huge investments were obtained by the company[4] and different applications include kiosks and in-store advertising.[3]

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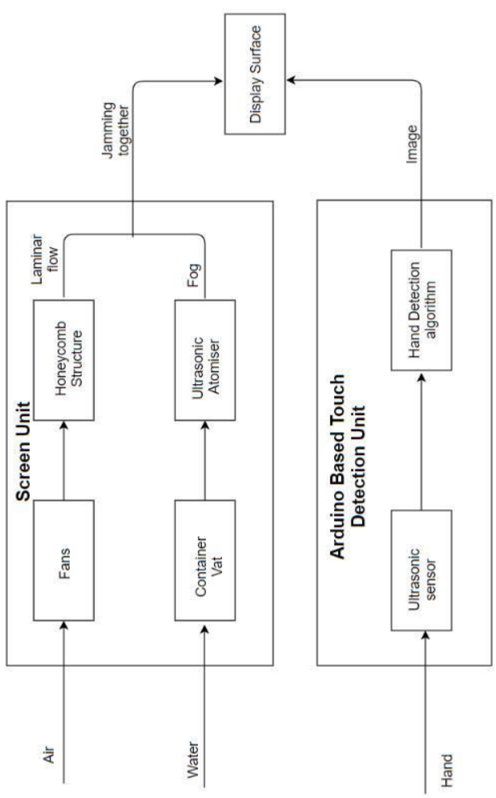
The cavitation method is used in Displair and the images are projected onto the immaterial display. The display consists of cold stable airflow in which water particles are contained. Since the water particles are really small no traces of moisture are made on the object. The stability is maintained due to high surface tension so that contact with wind or other objects won't destroy the display.[7] The hand may become wet due to interaction with the display.

Multi-touch technologies which are computerized are used to control images in Displair. 1500 touchpoints can be pro-cessed simultaneously within a time delay of 0.2 sec using this revolutionizing technology.[5] Hence multiple users can use it at the same time and complex gestures can be identified using this technology. In the future, the company expects to integrate the taste of the projected images into the system.[6]

III. Mid Air Volumetric Display

A. Laminar Flow

The creation of a proper structure for laminar flow is the main challenge with a fog screen. It is easier to achieve laminar flow for smaller screens compared to that of larger screens. For a small screen area, lower projector flux can be used.[9] Hon-eycomb structure, flow speed, and the inner flow structures are the Essential parts of the design. Several 3D-printed structure designs and honeycombs structures where tested for our pro-



totypes.

A Block visualization for the proposed system

A complex and straight forward system is used to create the fog screen display. Two parallel air streams which are in laminar flow are used by the machine. For achieving the required velocity the air first flows through a set of fans, then it is passed through a honeycomb structure that is specifically designed.[10] When the air passes through different holes of the honeycomb structure, it is converted into different streams. Hence the airflow of all the divided air flows will be parallel.

The laminar flow of air attained by the rising velocity of the air stream under the terminal velocity. The terminal velocity is attained by using Reynold's number(Re) given by:

$$Re = uL= \ = uL= \tag{1}$$

where:

is the thickness of the fluid (SI units: kg/m3). u is the speed of the fluid with respect to the object (m/s). L is a certain linear dimension (m).

is the dynamic thickness of the fluid (Pa·s or N·s/m2 or kg/m·s).

is the kinematic density of the fluid (m2/s).

There are many aspects that may influence the Re. It is directly proportional to the density of the fluid its velocity as well as the linear dimension. After a number of tests performed by Osborn Reynolds, it was eventually found that laminar flow is acquired when Re is less than 2100. It was also found that the airflow is turbulent in nature if the Re is greater than 4000. The above circumstance is defined for any flow that is placed within a pipe.

B. The Mechanism For Suspending Of Particles For The Display

The Fog Screen creates a non-turbulent particle flow en-closed within a wider airflow. The fog flow remains thin and planar, which allows high-quality, walk-through projections in mid-air. As it utilizes atomized, very slight water particles as a projection medium, it feels dry to the touch. Fog, however, if it is simply let out then it forms a clouded shape. The fog is also influenced by the air currents that are present near it.

This can be solved by keeping the fog in between two smooth layers. As they are looking for an immaterial display they cannot use glass. So they suspend this fog in between two coatings of parallel flowing air currents that are in laminar flow.[11]The laminar flow discerns to it that the fog keeps up within the screen boundaries and gives a certain shape to it. It also stops the airflow in the neighboring environment from disrupting the fog and as a result, it gives strength to the screen. The image or screen that is to be displayed is brought from the processor to a projector. The projector then projects this image or screen onto the fog screen. This means that the light can now project on to material mid-air and thus produces a screenless volumetric display.

The screen resolution relies largely on the fog flow tur-bulence, which is spatially and temporally differing. The resolution lessens if the viewing or projection angles are very oblique [12], as the Fog Screen image plane has a consistency of about 1cm, and thus the adjacent pixels coincide and get blurred. The estimated angular brightness obeys almost the Mie scattering. The sharpest distribution and thus the brightest image can be seen ±30° towards the projector's light.As the huge majority of the light entering the fog is scattered in the forward direction, back projection is required.[13-17] This also allows projecting varied images on each side without quite intervening with each other, as each projector streams over the opposite projector's image.

IV. USER INTERFACE

The idea behind the Arduino based Hand Gesture Control of Computer is quite clear. Two Ultrasonic Sensors with Arduino are employed. Then place your hand in front of the ultrasonic sensor and measure the distance between the hand and the sensor. Making use of these facts, applicable steps in the computer can be done.

The location of the Ultrasonic Sensors is very important. Place the two Ultrasonic Sensors on the ends of the screen unit. Python Program which collects distance data from a special library named pyAutoGUI and Arduino will modify into key-board click actions.

The python program for implementation is given below

```
import serial
import pyautogui

Arduino_Serial = serial.Serial('com5',9600)

while 1:
    incoming_data = str (Arduino_Serial.
    print (incoming_data)
    if 'next' in incoming_data:
        pyautogui.hotkey('ctrl','+')

    if 'previous' in incoming_data:
        pyautogui.hotkey('ctrl','-')
    if 'down' in incoming_data:
        #pyautogui.press('down')
        pyautogui.scroll(-1000)

    if 'up' in incoming_data:
        #pyautogui.press('up')
        pyautogui.scroll(1000)

    if 'change' in incoming_data:
        pyautogui.press('k')

    incoming_data = "";
```

The arduino code for implementation is given below

```
const int trigPin1 = 11; const int
echoPin1 = 10; const int trigPin2 =
6; const int echoPin2 = 5;

long duration;
int distance1, distance2; float r;

unsigned long temp=0;
int temp1=0;
int l=0;


void find_distance (void);


void find_distance (void)
{
  digitalWrite(trigPin1, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin1, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin1, LOW);

  duration = pulseIn(echoPin1, HIGH, 5000);


  r = 3.4 * duration / 2;
  distance1 = r / 100.00;

  digitalWrite(trigPin2, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin2, HIGH);
    ())
  digitalWrite(trigPin2, LOW);


  duration = pulseIn(echoPin2, HIGH, 5000); r = 3.4 * duration /
  2;
  distance2 = r / 100.00;
  delay(100);
}

void setup()
{
  Serial.begin(9600); pinMode(trigPin1,
  OUTPUT); pinMode(echoPin1,
  INPUT); pinMode(trigPin2,
  OUTPUT); pinMode(echoPin2,
  INPUT); delay (1000);

}

void loop()
{
  find_distance();


  if(distance2<=35 && distance2>=15)
  {
    temp=millis();
    while(millis()<=(temp+300))
    find_distance();
    if(distance2<=35 && distance2>=15)
```

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```
     {
      temp=distance2;
      while(distance2<=50 || distance2==0)
      {
        find_distance();
        if((temp+6)<distance2)
        {
        Serial.println("down");
        }
        else if((temp-6)>distance2)
        {
         Serial.println("up");
        }
      }
     }
     else
     {
       Serial.println("next");
     }
  }

  else if(distance1<=35 && distance1>=15) {
  

     temp=millis();

     while(millis()<=(temp+300))
     {
        find_distance();
        if(distance2<=35 && distance2>=15)
        {
          Serial.println("change");
          l=1;
          break;
        }
     }
     if(l==0)
     {
     Serial.println("previous");
     while(distance1<=35 && distance1>=15)
     find_distance();
     }
     l=0;
    }

}
```

User Test

In order to evaluate the immaterial display, we compared it with and without light. Five participants participated in the experiment. We used two Ultrasonic sensors and an Arduino. Two Ultrasonic sensors were placed at the end of the screen unit. This position made users more comfortable. Users commented that they liked the Arduino based controller, and they also commented that basic functionalities are well working.

The results showed some differences. We observed that visibility was more in a dark room, and visibility was reducing in the lighting room. And we observed that there was no humidity while touching. The image or a screen that is to be displayed is sent from a Processor to a projector are displayed with fine quality. We also noted that it can be used in the normal room.The use of the fan did not cause any damage to the display. A larger user test is needed to measure more precisely the effect of the Immaterial display on user performance or/ and user experience.

Conclusion And Future Work

In this article, we have proposed a strategy to carry out the most sought out theory of a volumetric display which enables for a natural hand interaction technology. The concept is at existing theoretically practical. It can be assigned to formulate novel mid-air user interfaces, virtual reality and augmented reality Fog Screens, and future-generation digital signage.

The forthcoming task that can be carried out to the system is that it can be made as a mobile dependent or independent unit. This unit of the immaterial display can be brought into the pattern of an armed guard that spans across the size of the arm. This implies that all the above-mentioned scheme requires to be decreased significantly in size.

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