Implementation of Haptology using Haptography and Hologram technology

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Abstract— Soon after the world was in awe of the ‘Hologram technology’, came in a new technique which can capture and recreate the rich feel of real surfaces. It is a combination of Haptic technology and virtual touches which is known as ‘Haptography’ or ‘Haptic photography’. The focus here is to present the way in which the feel of a surface is recreated virtually and also the applications of this advanced technology. Haptography uses different tools for capturing the feel of a surface and then recreating the same feel on a different surface. The tool uses different sensors to capture the surface’s feel and then the outputs of these sensors are used on different devices who recreate the same feel on a different surface using a different tool. Haptography is believed to help science and technology reach a whole new level and establish a milestone towards success. The paper describes wide variety of applications of this innovative technology, which can be used in different fields for greater advancements in their own fields and give users a very friendly and rich experience. This paper also proposes an innovative and a new application of this tech called ‘Haptology’ and the implementation of the same. Further, it discusses its applications and how it will prove to be a successful innovation.

Keywords— Haptology, Haptography, Hologram technology, recreate feel, feel the virtual, Innovation, Haptography with holography.

I. INTRODUCTION

‘Haptography’ is an emerging technology that gives the users an opportunity to feel the object virtually. It marks a milestone in the Virtual Reality domain by not only allowing an individual to see but also to feel any particular object. Haptography is the art of recording touch metrics and recreating the feel of it by using a mathematical model. This mathematical model varies for different surfaces. It is characterised by 3 different elements namely Acceleration, Speed and Force. The actual process used by the software to perform its calculations is called haptic rendering.

Touching a substance in an environment gives a feedback which initiates the touch. Haptography captures this feedback. This feedback is characterised by 2 metrics: Tactile and Kinesthetic. Tactile, which can be defined as something that is connected with the sense of touch, has the following sub-metrics: Contact location, Pressure, Shear, Slip, Vibration and Temperature. Kinesthetic on the other hand involves the ability to feel movements and consists of various sub-metrics: Position, Orientation and Force.

These touches can be recorded and recreated in different ways. In today’s world, there are many areas where Haptography can be used to enhance any application in numerous fields namely medical surgeries, virtual learning of sports, dancing, etc., e-commerce websites and many more.

This paper discusses all the methods used to implement this technology and also the applications of these methods. Further, an idea of implementing Haptography with Holography, its method of implementation is proposed and discussed.

II. METHODS OF IMPLEMENTATION

There are several approaches in which Haptography can be implemented. This paper deals with 2 approaches to implement it, which are:

1. Implementation of Haptography using a stylus and a haptic interface.
2. Implementation of Haptography with holography to feel virtual surfaces.

Although they may look a lot different, they all have two important things in common – the software to determine the forces that result when a user’s virtual identity interacts with an object and a device through which those forces can be applied to the user.

III. IMPLEMENTATION OF HAPTOGRAPHY USING A STYLUS AND A HAPTIC INTERFACE

The aim of Haptography is to capture the feel of the object and make its users relive the touch. This can be done in different ways, one of them being with the aid of a hand-held or tele-operated tool namely stylus. To recreate the touch, the stylus yields interaction data which is further
condensed to form a mathematical model for surface’s salient haptic properties which can be further analysed.

While interacting with the object, high frequency accelerations occur during the interaction, as opposed to the low frequency resistance of the contact. This approach uses measurement-based mathematical modelling to derive perceptually relevant haptic surface models. It also derives dynamically robust haptic display paradigms, which have been tested via both experimental validation and human-subject studies.

Now, at the receiving end we have a haptic interface which handles the stylus and helps the user recreate the feel of the substance. We use this haptic interface for several reasons. First, the dual-actuator feedback strategy increases user performance and also improves the feel of the interface, one of the main goals of Haptography. Second, when a user handles the stylus he does not know how much pressure, force or speed to apply. In this case, it is very tough to recreate the feel since the user might put some extra pressure on the stylus because of which the feel created by the stylus will be disturbed and it won’t work efficiently.

A haptic interface handles the stylus and helps the user. This haptic interface handles the stylus mid air and the user while handling this gets vibrations which help in recreating the touch of the surface. The only input this device needs is the ‘JHEG’ file. Refering to figure (a), we can see that there is a wire type thing which connects the device and the stylus. This acts like an input to the stylus about the variations in vibrations. The device uses various mechanisms to move the handle so that the user can feel the movement. All the inputs given to the handle via the haptic device are based on mathematical calculations done on the JHEG file. The device sets variations in vibrations by keeping speed as a common reference. In simpler words, all the components such as acceleration, force and many more are all implemented by refering to the values they hold for the corresponding value of speed. This way it recreates the feel and gives the user an experience of a lifetime.

Application –
E-commerce nowadays is an important part of the trading world. Hundreds of thousands of these business transactions take place everyday between either two companies or between companies and their customers. However, the consumers, be the companies buying material from other supply companies or the customers buying the final product, are always skeptical about the quality of product and its feel as well. Using this stylus approach, the feel of the material can be captured and recreated.

This works in the following way: the stylus moved over the product, say for example - a cloth for about 10 seconds. This gives the stylus enough time to stores all the 3 important components namely force, acceleration and speed for almost all the variations possible. These values are then processed and a mathematical model of the feel of this object is captured in a ‘JHEG’ file, which is uploaded over the internet in the specific products page for customer to test. This process is repeated for all the products. On the customers end, he is required to have the haptic interface in
which the ‘JHEG’ file of the product can be given as input
to recreate the feel via actuators present inside the handle
stylus. In this way the customers can assure themselves of
the good quality of the product. However, the drawback
here is that the haptic device is an expensive module to own.
It cannot be assumed that every consumer will own this
device. This can be overcome by keeping centres of a
particular company where people can visit the store closest
to them and can acquire the benefits of this technology. As
easy as it is, this technology can be used by anyone.
This technology can also be applied to other professions
like for example - dentists use this technology to practice
and feel whether a particular tooth has started decaying or
no.

IV. IMPLEMENTATION OF HAPTOGRAPHY WITH A
HOLOGRAM DEVICE
Haptography can be used with hologram technology, to
touch, feel and see virtual surfaces. This will mark a
milestone in the domain of Augmented Reality. To
understand the implementation of haptic feedback
technology with hologram technology, let us first learn
about holograms.
Hologram Technology –
A hologram is nothing but a 3D rendered image of an
object. It is created by using various laws of physics and it
has the ability to regenerate the view of an object that it has
recorded. Referring to the research and projects done under
this field, a project named ‘HaptoMime’ was implemented
by various researchers at University of Tokyo. This product
allows us to use touchscreen technology without actually
touching the screen. To understand its working in a better
way, let’s refer to the diagrammatic representation of
hologram technology.

Working –
The arrangement consists of around 4 different components
namely – LCD screen for generating the original image,
Aerial Imaging Plate for creating a floating image out of the
original one, IR touch sensor frame for tracking the finger
position and Ultrasound phased array transducer for
presenting tactile feedback. Once the arrangement is done,
we can successfully see the hologram of the original image.
Now, when we try to insert a finger inside the arrangement,
the IR sensor frame detects the finger and is activated. This
in turn activates the ultrasound transducer due to which we
feel a small vibration on our finger. By using the reflection
laws, the ultrasound currents are converged to form a
pointed beam which means that at that point, only the
location where the user’s finger is present will be getting
the ultrasound beam.

We can see that, this project allows you to touch the
unreal by giving you a haptic feedback. The only drawback
is that it doesn’t let you feel the object or in simpler words
it doesn’t distinguish between the feel of different objects,
which are created virtually.

What if we can increase the functioning of this project by
increasing the role of haptography? Our idea is to
implement a project where we can virtually create an object
using hologram technology and feel them using
haptography.

V. OUR PROPOSAL – ‘HAPTOLOGY’
Motive –
To implement hologram technology with haptography so
that people can see and feel 3D objects as if they are real.
The name of this project is ‘Haptology’.
Implementation –
Let us consider an example where we take a ball as a virtual
object. As mentioned above, HaptoMime has the ability to
create a hologram of an object.
First step would be creating a 3D object we need more
IR touch sensor frames. Any object to be recreated will be
under the height and breadth of the above mentioned stack
of frames. Lets say we have a stack of IR touch sensitive
frames, which can create an object the maximum
dimensions of 10 cms on any axis. Here, we won’t need the
ultrasound haptic feedback since we will be using some
other device to feel the object. Another reason why we
won’t need this ultrasound device is because we won’t be
needing the haptic feedback only, we will be needing the
real feel of the object.
Second step would be creating a haptograph of the ball.
This can be done by recording the feel of the ball as a real
object. To record the feel we use a different device here
known as the exo-skeleton. It can be diagramatically
illustrated as –

This exoskeleton is connected to the front side of user’s
hands using a thin vibrating film, which accepts different
values for its intensity of imposing vibrations. These values are very small since user feels a very minute force when he interacts with a surface. First, these values are recorded by moving this exoskeleton over the ball. It takes inputs from all sides and records the data with various components. Now, these components are compiled into one graph and the vibration values are given corresponding to speed and acceleration and also the mapped co-ordinates. The feel of the ball is covered almost entirely from all the perspectives by touching all the areas in it.

The third step is to prepare an arrangement by connecting the hologram setup with the exoskeleton using a chord, which will help to transfer data. The data will include certain mapped co-ordinates of the virtual object and other mathematical quantities.

Working –
The entire will work in a flow described as follows –

After the object is regenerated virtually in 3D using the hologram device, the user will be able to touch the object and feel it. Once the user touches the object at a particular place. The co-ordinates of that spot are passed to the exo-skeleton, which is handling the haptography part of this project. After passing these values, the controller in the exo-skeleton will refer to the graph it had made while capturing the feel of the object. When the graph will be referred using those particular co-ordinates, based on the speed, acceleration and force values for the corresponding particular co-ordinates, the value of intensity of vibrations, which are supposed to be passed to the thin vibrating films will be generated mathematically. These values will be very small. When an individual touches something in its surrounding, the touch he feels is because of the kinetic feedback. In this case, since the touch is created virtually we call it ‘Haptic Feedback’.

Once the values are computed they are passed to the vibrating film and the part of the film which is in contact with the virtual object will start vibrating based on that value. This vibration will make use feel as if it is a touch. In this way the user will be able to feel a certain object virtually.

We can also increase the application area of this project by implementing another function which lets you feel the object while moving your hand around it. To implement this, the same technology is used and it will be a bit more faster since the user’s hand will be moving at a certain speed around the object.

Other applications of this technology are that it can be used in medical fields to train aspiring medical students. These students can practice operating and studying different parts of body without touching a real body.

VI. CONCLUSIONS
By studying Haptography in detail we were able to think of an innovative idea to use the same for a different application with a different approach. This gave us a better perspective of the working of this technology and do the research.

REFERENCES