

# Immersive Virtual Tour of Difficult Terrain Based On Virtual Reality

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**Abstract-** Virtual Reality can be referred to as immersive multimedia or computer simulated life, replicates an environment that simulates physical presence in places in the real world or imagined worlds and lets the user interact in that world [2]. Virtual reality artificially relates sensory experiences, which can include sight, hearing, touch and smell [6]. The simulated environment can be similar to the real world in order to create a lifelike experience for example, in simulations for pilot or combat training or it differs significantly from reality, such as in VR games [4].

The proposed solution stands on virtual reality, for providing a virtual tour of a mine. Cardboard, an easily affordable gadget which enables virtual reality for the headset, is used for this purpose. Software magic takes over, then. The software splits the screen into a right and left pane, one for each eye. The effect is a stereoscopic image that completely fills the field of vision, and immerses into a virtual world.

**Key Words:** Virtual Reality, Google Cardboard, Spherical Panorama, Virtual Tour, Coal Mine

## I. INTRODUCTION

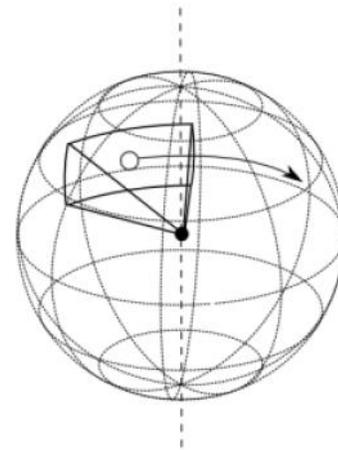
Individuals who are interested in a career in the mining and/or energy technology industries have to undergo trainings as they have to work under difficult conditions. Working in a mine comes up with so many challenges as there are safety hazards involved in it. In the current scenario the training aids includes only the literal descriptions and the guidelines for the do's and don'ts to be followed inside the mine. The real time immersion into the mine is lacking, to bridge this gap we are proposing a virtual reality solution [5]. This solution will enable the individuals to get the feel of mine, how the user will feel when user will be inside mine without even going there and with least expenditure. The proposed solution will comprise of cardboard and a device that will contain the application developed for the mines training. Panoramic images will be captured by an experienced person; these images will be used to make a virtual tour of the mine.

These images will be rendered as a spherical panorama, and will be shown identically on a split screen. The cardboard, with the device inside it will be mounted over the users head. As brain is bleeped up, it will perceive both the images as a single image, and will feel that the images are coming from a real object. The solution will be enabled with head tracking and speech recognition tools, the

user can look into the mine with the updated view exactly as user would get while being in a mine.

For viewing panoramic images, spherical panoramic projections are used. Every single frame is used to fill up the sphere. At the time of viewing, OpenGL [4] library is used for updating the panoramic view. OpenGL is a cross-platform graphics API that specifies a standard software interface for 3D graphics processing hardware.

For e.g. in Fig 1 spherical projection is shown. A part of the sphere is filled up with a particular frame of the spherical panorama captured before. Following the sequence spherical panoramic image is projected on the sphere [10].



**Figure 1: Spherical projection**

## II. SYSTEM ARCHITECTURE

### A. Work flow

The proposed solution will comprise of cardboard and a device that will contain the application developed to ease the training process for mine workers. Panoramic images will be captured by an experienced person; these images will be used to make a virtual tour of the mine. These images will be rendered as a spherical panorama, and will be shown identically on a split screen. Fig 2 shows the complete workflow of the proposed application.

The cardboard, with the device inside it will be mounted over the users head. As brain is bleeped up, it will perceive both the images as a single image, and will feel that the images are coming from a real object. The solution will be enabled with head tracking and speech recognition tools, the user can look into the mine with the updated view exactly as user would get while being in a mine.

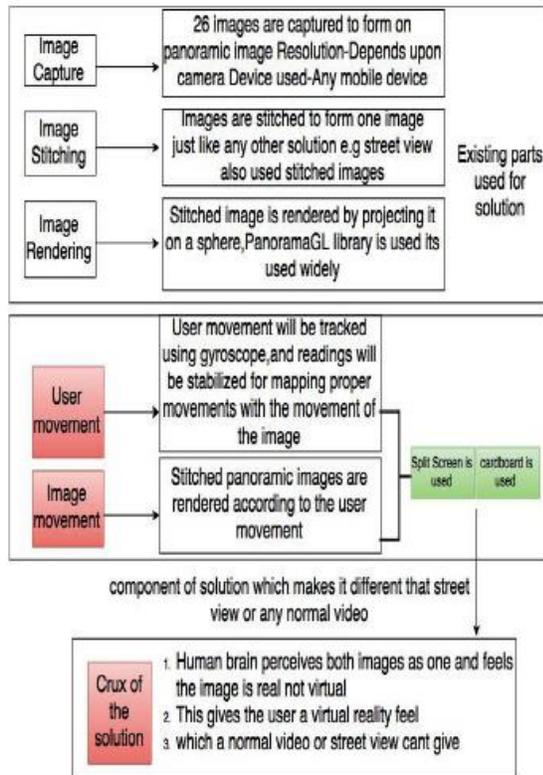


Figure 2: Architecture diagram of the solution

The user will be able to interact with the application as it will be speech enabled and it will work as complete guide for the new comer to dive deep into the mine and get familiar with their work environment. Moreover this solution will turn work place into a safer one, new comers won't be scared as they would have already experienced how it feels being in a mine and this work

space awareness will definitely help them to learn and perform productively.

### B. Content Creation

For creating the virtual tour capturing the images is an important factor for experiencing the virtual reality. Spherical panoramic images captured at the eye level create the best virtual tour. The renderer used for the purpose works with image of size 1024\*512 or 2048\*1024. So the images resolution should be changes in accordance with the above specified size.

### C. Hardware Used

**Gyroscope-** Smart phones use gyro sensor to detect the orientation of the device. It's a gyroscope in the form of a small sensor. It is calibrated to give a reading of zero when the device is kept on a plane horizontal surface. Any change in orientation of the device is measured by the gyro sensor. Fig 3 shows an example of how a person views at a particular frame after the image is rendered using OpenGL library for the viewing purpose.



Figure 3: Rendering of spherical panorama

Using the Gyroscope's position the frame is determined and that particular frame is rendered, as the person rotates, view is updated, in this way spherical panoramic image projection and rendering plays an important role in enabling the virtual reality.

### D. Head Tracking-

In the real world, we get rays from the objects all around us. As we move we get new view. For enabling the same feature in the application gyroscopic reading is used. As mentioned above any change in the device orientation is captured by gyroscope, but for providing smooth transition between the rendering of frames, speed has to be synced between user and mobile application. Based on the observation, gyroscopic readings were observed and a factor is multiplied with the reading.

### E. Card Board-

For enabling virtual reality on the handset cardboard is used. The hardware side of Cardboard uses low-cost viewers, with the reference design made of foldable cardboard (hence the name) 45mm plastic lenses, and a magnet or capacitive-taped lever to operate the screen. Once you get everything folded into the right configuration (most kits come pre folded and assembled) you slip your phone into the front of the viewer (usually held in place by velcro or rubber bands) and run an app designed to work with Cardboard. Fig 4 shows a cardboard with an android device.



Figure 4: Android device along with the cardboard

### III. RESULTS AND DISCUSSION

Android application has been developed for creating a virtual reality walkthrough of a coal mine for enabling the new joiners dive deep into the immersive experience. Fig 4 shows the android device inside the cardboard and Fig 5 shows the screenshot of the android application running on the device. A virtual tours has been developed which has multiple spherical panoramic images lined up in a fashion similar to a real coal mine tour. Users of this application can navigate inside the tour using the speech, as speech recognition tool are being used for this purpose. Google speech recognition library is used for it.



Figure 5: Screenshot of the application on android devices

Head tracking is an important feature when we talk about immersive experience because the view should change if there is any movement. In this application gyro reading are used for rendering the panoramic images. Gyroscope reading obtained from the sensor is in raw form, values are needed to be modified so that they can be used. For this purpose gyroscope reading are captured, stabilized and normalized.

As a user moves the rotation should be smooth, and once the user has taken a complete turn, user should come back to the starting point of the rotation inside the panorama. For this purpose a movement factor was calculated.

Sometimes there are some machinery inside the mine or some terrain for that special instructions are there which can be in the form of videos, for this reason videos are also embedded inside the application wherever required. In this was a complete virtual tour is developed.

### IV. CONCLUSION

An application containing the virtual tour of coal mines is presented in this paper. This idea can be extended in various areas like trekking for disabled people or virtual campus tours. Component wise application development makes it reusable in various areas. Android operating system is chosen for running the application given the wide spread use of the mobile devices and android being the leader amongst them. People working in difficult terrain will get benefited in the form of training and workplace awareness.

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