Impact Of Augmented Reality in Crime Scene Investigation

(To be submitted in partial fulfilling of the requirements for the course on programming in java)

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Abstract: Crime Scene/forensic Investigation is a methodical, meticulously planned process with the aim of gathering tangible evidence to reveal the physical circumstances of the crime and ultimately identify the culprit. In this paper, we'll explore at how augmented reality (AR) might help recreate a crime scene in order to aid in an investigation. Also, this technique involves taking pictures and recordings of the crime scene in order to analyse the digital evidence more thoroughly for any potential hints. Moreover, this work advances the concept of creating a 3D reconstruction of the crime scene using the footage that was collected. The outcome will offer a model that will enable the investigators to more clearly see the spatial relationships at the crime scene and learn more about the incident through an ex-situ investigation.

Key Words: Augmented Reality, Crime Scene Investigation, 3D reconstruction, Computer vision

1 INTRODUCTION

Our perception of the world is evolving thanks to the innovative technology known as augmented reality (AR). by introducing digital media into the world, such as images, sounds, movies, mix annotation, and holograms. You can interact with actual objects in your environment in real time virtually, just like in science fiction movies. It is predicted that augmented reality will soon displace computer-generated interfaces [1][2].

A technology with great potential, augmented reality (AR), is emerging as the key to realising the full potential of the Internet of Things (IoT). The various types of data produced by IoT devices and components are being used by AR apps to increase staff productivity and effectiveness.

Augmented reality (AR) can be employed as a teaching tool, a product demonstration tool, a gaming tool, an entertainment tool, a marketing tool, a real estate tool, a tourism tool, a manufacturing tool, a dating tool, a sports tool, a gardening tool, and more. Another field where AR can create a revolutionary change is in crime/forensic investigation.

AR technology and its potential uses in law enforcement and forensics are best described by another article published in New Scientist (Nov. 2016) about an AR technology being tested by the Dutch Police, the Netherlands Forensic Institute, and the Dutch Fire Brigade. This technology, developed by researchers at a company in Rotterdam called Twinkls, requires the user to use either a headset or smartphone, as well as a body camera, which streams video back to experts away from the scene. At this point, the experts could use the technology to send virtual messages to the police officers, which they can receive in real-time.

There is no doubt that augmented reality is causing massive changes worldwide. This technology belonged in the realm of fantasy only a decade ago, and now it is commonly seen in the transportation, education, and entertainment industries, among others.

In short, AR will likely have a useful place in the field of forensic science, allowing these professionals to recreate a crime scene for others to witness, or to communicate more efficiently with experts at another location. In this paper we will be studying how AR can aid in recreating a crime scene for investigation purpose.

2 PROPOSED IDEA

We are putting forth a three-dimensional augmented reality system that can transform how the scene actually appears. You'll experience a sense of being present at the real crime scene. In order to do that, a 3D scan of the scene would be utilized to reconstruct the crime scene, which would then be made available as a portal for users to explore. This recorded portal may be used as evidence in court as well as in investigations where it aids in jogging witnesses' memories. Another benefit is that since the portal contains the original scan of the crime scene with everything intact, no additional falsified evidence can be used.

3 Methodology Approaches In CSI

3.1 Existing Practices

The following describes a step-by-step process used to assess the crime scene for potential clues and evidence relating to the perpetrator using traditional approaches according to crime scene investigation:

- Thoroughly examine the crime scene and keep an eye out for people and vehicles coming into or departing the area.
- Set up physical boundaries around the crime site to protect the location and any evidence there.
- Look around to see if there are any hostile individuals who might still be around.
- Sort suspects, witnesses, victims, and medical professionals into batches.
- Access to the crime scene must be denied to unauthorised people.
- Turn over control of the scene to the forensics expert team and the investigator.

3.2 Problems and Threats of the Traditional Approach

3.2.1 Risks and Challenges of the Traditional Approach

We can now pinpoint probable issues and risks of the aforementioned approach while keeping in mind the stages for investigating a crime scene that were previously stated:

- When the region is being investigated, it's possible that clues will be missed. When a large region needs to be scanned, smaller features are frequently overlooked.
- It is more challenging to identify a suspect in public places where there are vast crowds of people because he can use the throng as a cover to conceal.
- The investigator in charge of the crime scene is not privy to the biographical information of the suspects and witnesses, as well as their prior criminal histories.
- The first responder or investigator might not be able to detect whether the subject of the interview is being truthful about his background information.
- There is no standardised method for storing and processing data about a person's biodata or criminal history.

Why Because traditional procedures take so long, the criminal has plenty of opportunity to flee the crime scene.

3.3 Application of Augmented Reality in Crime Related Fileds

Gazi Erkan [7] states that in forensic crime scene investigation (CSI), forensic investigators use a methodical process with the goal of gathering tangible evidence to establish. Identification of the culprit will be made easier with evidence of the crime's physical reality. A key step in analysing the digital evidence for any potential suggestions is taking pictures and recordings of the crime scene. The goal of this project is to create a 3D reconstruction of the crime scene using the footage that was collected. The findings demonstrate that powerful computer vision techniques can be used to produce realistic reconstructions. The paper also goes over a few essential components that a potent interactive CSI analysis tool ought to have.

Receiving information about a crime and choosing the right tools and materials for gathering evidence are the first stages. The following step involves photographing or filming the crime scene and creating a layout of the surrounding area to fit the camera locations while the photos are being taken, such as fingerprints, footprints, items of clothing, hair, etc.

The suggested method records the crime scene as a video series, from which selected frames are taken and used to recreate the scene in 3D. Key framing is the procedure.

H. Engelbrecht [9] suggests that the goal of an AR system is to improve and automate the process of documenting evidence. It also offers a digital platform for accessing crime scene evidence. Finally, it uses AR to create an interactive visual interface that will help investigators better understand the context of the crime scene and the evidence when they return.

Before gathering evidence, ultrasonic sensors are put in the room and used to record coordinate information. A distance/range calculator is attached to the camera equipment to determine the angle of orientation and the distance from the evidence being photographed. A simple and reliable approach for measuring distances is by using sound waves. The object to be tracked is equipped with an ultrasonic receiver that can measure the distance to each of the fixed ultrasonic transmitters placed around the room. The location of the tracked object can be determined with great accuracy by knowing the separation between each sensor at any location in space.

The goal of this project was to create a fully immersive mixed reality experience for the user, where information is added to the environment as the user moves about it in real time. A wide range of technologies would need to be combined and made to work together for such a system to be achieved. The suggested solution is based on the creation of a universal camera (acquisition) and a universal visual interface (representation).

Santhra K Joy [5] proposes an AR application in the paper will be build using the Unity Game Engine. The Unity Game Engine will be used to create the paper's AR application. The initial step in this case is to upload the marker image to the Vuforia database. The augmented reality method used in this project is marker-based. An image that can be scanned using an augmented reality app on a mobile device is necessary for marker-based augmented reality. The additional content (video, animation, and 3D objects) that had been produced in advance will then be triggered by the smartphone scan and appear on top of the marker. The 3D Area of the Battlefield will be the project's initial 3D model.

When creating an augmented reality app, the database will subsequently be downloaded from the Vuforia portal. In the Unity Editor, numerous scenes can be created to serve as the user interface for creating and joining rooms. The Photon ID generated must then be entered into the PUN Wizard in the Unity Editor after creating a Photon Account and setting the Photon ID. The necessary code may then be written to build the lobby and incorporate the complete scene, which will aid in adding Photon to the 3D models.

The state of the Map can also be saved to a local system using the serialisation technique. the user can view the Map at any moment in the future. Serialization is the process of converting an object into a stream of bytes that can later be stored as a.txt or.json file and read back.

Shaheryar Ehsan I Haque [3] proposes a system; ARCRIME which enables law enforcement personnel to make copies of crime scenes. During training, police personnel are given glasses and a headset. Many simulations of prior solved cases have also been exhibited. In this paper, they suggested a fix for a programme for teaching digital forensics and the preservation of crime scenes to police officers. Utilizing Microsoft HoloLens will be required for this.

In this ARCRIME, we're able to join all the various pieces to create a programme that can train police personnel. Microsoft HoloLens will be worn by the on-scene police officer. Data transfer and retrieval will be possible in real time from the cloud network through which the HoloLens will be connected. The crime scene will be scanned by the police, who may be able to recognise 64 faces in a single shot. The identities of the suspects will be logged for further cross-referencing and arrests after they are identified on the scene and communicated back to a cloud repository. Biometric information and criminal history will be collected from the Azure cloud as the faces are scanned. The appropriate information will be shown on the police officer's headset display.

3.4 How Augmented Reality Works

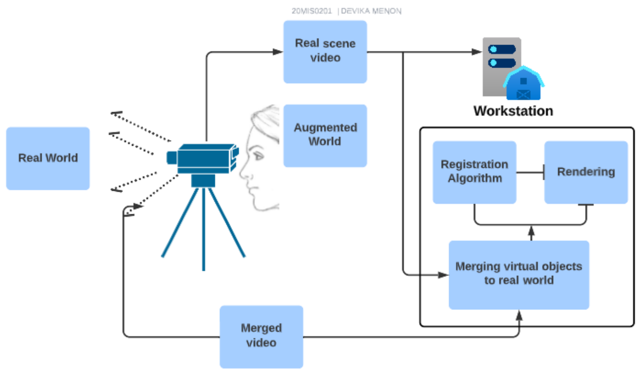

Fig.1 Diagram of how Augmented Reality works

AR projections can be seen on a variety of gadgets, including smartphones, portable devices, glasses, and headsets. It determines the location and orientation of the surrounding objects in reality in order for the perceptual information generated by the computer to appear correctly. Typically, it operates as follows: The device uses a camera and sensors to capture the user's surroundings, and once the programme gathers and analyses data to determine an object's location, an augmented reality (AR) object instantly appears on the user's screen as shown in fig.1.

Based on the AR, sensors such as depth sensors, accelerometers, cameras, gyroscopes, and light sensors can be used to gather information about the user's surroundings. These sensors detect the user's orientation in space as well as the distance to objects and the speed of motion. After then, the data is processed to display animation in real time and at the proper spot.

3.5 Algorithm Used

Simultaneous localization and mapping, or SLAM, is a computer vision technique that compares visual information between camera frames to map and track the surroundings. SLAM is frequently used in AR technologies. It is feasible to accomplish very accurate tracking when using the accelerometer and gyroscope data from a smartphone.

SLAM uses feature points to comprehend the physical world. SLAM gives AR apps the ability to instantaneously track the environment, recognise 3D objects and settings, and overlay interactive digital augmentations.

4 Experiments and Results

4.1 Requirements for Software and Hardware

The following hardware is needed for augmented reality:

- battery power
- Bluetooth and WiFi connectivity, a 3D view

field of vision, internal storage, and internal OS and Web Browser inputs and outputs (button, eye tracking, accelerometer)

- microphone
- adequate capacity
- display power
- visual following

The following software is needed for augmented reality:

The use of AR software requires a variety of hardware, including tablets, phones, headsets, and more. These integrating devices have sensors and digital projectors, so they need the right software to project digitally created items into the actual world.

The user to leverage API linkages to other databases and websites to display information. on-board operating system and user interface to support the programme web Browser creation.

4.2 Understanding the difference between 360 degree and 3D photography

Viewers can experience a location, an event, or a product from a point of view different than their own by using 360 degree and 3D photography techniques. Both of them use geometric equations to display the image to the viewers, and they both capture the spatial placement of an object within its surroundings, which are two significant similarities between them.

While there are some parallels between the two procedures, there are also significant variances that frequently cause confusion. For instance, while 3D photos often concentrate on catching a single object, 360° photos capture the complete scene.

When you look at a 360-degree photo on a computer or on a phone, you can actually move your device and gaze about in all directions within the image because it completely circles the scene. The use of 360-degree images is extremely popular right now and is used in many different contexts. A sequence of shots taken from various angles all around a single object are stitched together to create 360° images. They are frequently referred to as panoramas, which are made up of many pictures stitched together to form one whole picture. Hayden Smith [13] states that omnidirectional camera’s (or 360-degree camera’s) are defined by an entire field of view. They are particularly adept at covering a large visual field such as a panoramic video.

A technique called 3D photography gives the appearance of depth to an image. By taking two slightly different pictures of the same object, it functions. Additionally, to producing 3D photos, it can also produce 3D panoramas.

Using 3D imaging, it is possible to visualise how a room, object, or service will appear and feel before it is really created. It is sometimes referred to as CG animation, 3D graphics, 3D rendering, 3D modelling, and 3D rendering.
Hence in recreating the scene we will be using 3D imaging.

Many different uses exist for 3D photos. They can be used, for instance, to illustrate the spatial and visual details of products and how they relate to one another. Games can also make advantage of 3D imagery. Both the gaming industry and computer games employ them. Just like that CSI can also employ them.

4.3 Challenges of building 3D content for Augmented reality

Perfect digital twins of the real environment must be modelled in 3D. The most common sort of content for AR is made up of these pieces, which, when combined with other rendering components (such as animation, audio, and physics), give an additional immersive layer to the user's experience.

The somewhat difficult process of making such realistic visual elements is hidden from the user. Their creation can transition from a meticulous manual procedure and the reuse of computer-aided data to a process based on photogrammetry.

Size restrictions, file formats, and the overall application size are just a few of the many specifications that developers must comprehend in order to create fantastic augmented reality experiences. Significant industrial hurdles also result from a lack of industry standards for AR content and a shortage of competent workers.

4.4 Building 3D Assets: 3D Model vs. 3D Scanning

Building 3D assets for augmented reality can be done by 3D modelling and 3D scanning, respectively.

Computer graphics are used in 3D modelling to provide a 3D representation of any surface or object. Since everything is handled by the computer, this technology is advantageous when used to duplicate actual objects since "it does not require personal interaction with the original." As a result, 3D modelling is perfect for constructing virtual versions of things, settings, and people that don't actually exist (think of Pokémon and other fantastical augmented reality games).

Real-world scenes and objects are the starting point for 3D scanning when creating AR assets. By employing this technique, the model is not created by the content producers using a programme from scratch. As an alternative, they can scan the object using photogrammetry or a 3D scanner technology.

The primary distinction between the two is how the object's data is captured. While photogrammetry uses photographs taken using standard smartphones, smart glasses, or tablets to map an item, scanning needs specialised equipment with depth sensors.

Since no specialised tools are needed, it makes photogrammetry more available to the larger developer community for producing AR content. However, 3D scanners are more dependable.

A point cloud that can be used in the AR experience can be extracted using one of two methods.

In the end, you can choose between 3D modelling and 3D scanning by evaluating how accessible the actual thing to scan is. If the chosen AR object target is not available, 3D modelling should be used instead.

Bostanci [7] in his paper has suggested method involved extracting keyframes from a video taken at the crime scene, and using these keyframes, sets of 3D point clouds corresponding to various areas of the scene were produced. After all the pieces were synchronised, the crime scene was finally collected as a single 3D point cloud. Results reveal that the method described in the paper can be simply used to create an accurate 3D model of the environment.

4.5 Augmented Reality and IoT in the Age of 5G

AR applications even help address the challenges that arise when companies collect large quantities of data from IoT devices and sensors. If the volume of data collected during CSI is too high, investigators may not actually be able to mine it in ways that provide tangible benefits. But AR allows investigators to visualize the data, which can speed up their ability to understand it and take action.

The increased speed of data processing through a combination of AR and IoT will also be enhanced by faster network connectivity [15]. It's one of the reasons why there is so much excitement for broader 5G adoption, as though 4G continues to be the most common cellular connectivity for IoT, 5G's promise of lower latency could mean even better support for AR in IoT.

5 Implementations

If crime is new then the existing scene is scanned using 3D scanners and 3D imageries of the scenes are obtained which would be processed into a portal room. If the case is unsolved and is older, then the scenes are recreated using 3D models and an animated augmented portal will be created and it would be like as follows in fig.2:

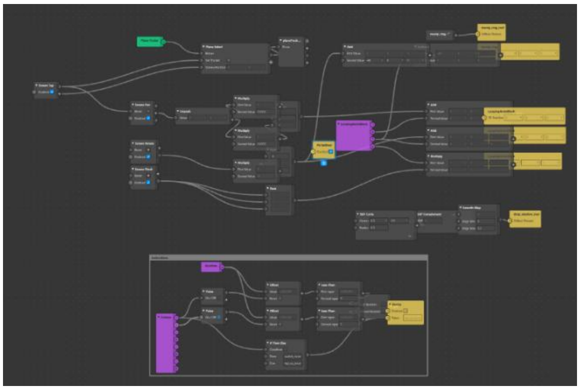

fig 2.1: creation of portal

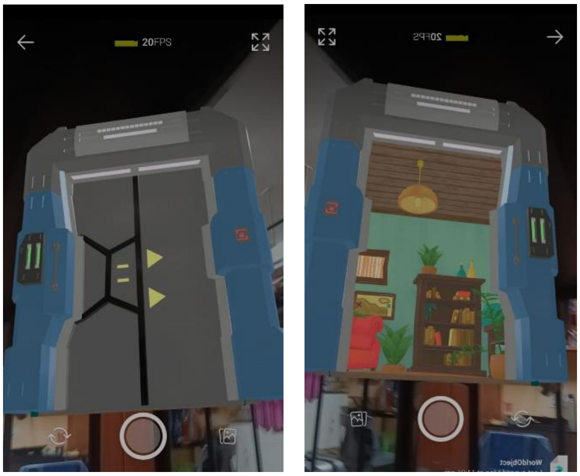

fig 2.2: portal implementation

6 Acknowledgements

Prof. Dr. Niramala M, our helpful advisor, deserves a special thank you for overseeing and counselling us throughout the development of our dissertation and project.

7 Conclusions

Our proposal explores the implementation of an augmented reality-based solution for crime scene investigation and recreation. It will incorporate emerging technologies such as Iot, 5G etc., and combines them in a single solution to aid in crime fighting and investigation.

8 Inferences

Last year, there were 2,09,519 cases total under the Indian Penal Code, of which 1,53,562 were still unresolved. The authorities are still working to identify the culprits and bring justice to the victims' lives by apprehending the offenders. We are hoping that the proposal we made will help investigators find the offenders and stop evidence fabrication. Three-dimensional augmented reality technology can transform the scene's actual portrayal, giving even crimes committed more than ten years ago a genuine appearance. It will make you feel as though you are actually at the original crime scene. This recreated crime scene will be more helpful and might assist trigger someone's memories in addition to the sketches of the culprit, thousands of incentives, and more than 10,000 tips. We can only hope that this notion will serve as a new informational resource that might eventually provide the impacted with justice.

"1000 criminals can escape, but one innocent person shouldn't be punished," the saying goes. Let's hope that justice will be done fairly now that this technology has been developed.

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10 Presentation Video Link:

https://1drv.ms/v/s!AsamJhHY4OWZkiuwOFKwiZawBvvt

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