BACKGROUND REMOVAL OF VIDEO IN REALTIME

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ABSTRACT

Background removal for video is a computer-vision based system to remove the background from a video with ease. Creating a professional background when at home, i.e., not in a very professional environment, can be a tedious task. Not everyone has time to learn editing and the technicalities involved in having an entire setup for creating a sophisticated background and it is not practical that normal people buy green screens or blue screens just for their everyday formal meets. Our goal is to create a quick and easy solution to that by removing background in real time while also maintaining the quality of the call, having the additional benefit of adding custom backgrounds and enabling users to add effects like adjust lighting, contrast etc., we are combining all 4-5 steps in 1 single step. SelfieSegmentation module of Mediapipe helps us achieve this. The Selfie Segmentation API creates an output mask from an input image. The mask will be the same size as the input image by default. A float integer with a range of [0.0, 1.0] is assigned to each pixel of the mask. The higher the confidence that the pixel depicts a person, and vice versa, the closer the number is to 1.0.

KEYWORDS

Categories and Subject Descriptors: G.4 [Mathematics of Computing]: Mathematical Software - User Interfaces; H5.2 [Information Interfaces and Presentation]: User Interfaces - User-centered design; Interaction styles; Theory and methods.

Background Removal, Online Meetings, Professional Background, Streaming.

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1. INTRODUCTION

This pandemic has made it clear that virtual meets are here to stay. They are the new normal. But often virtual meetups from home fail to create the professional atmosphere due to backgrounds in the video. The professionalism required can be achieved by proper background in videos and minimal disturbances. Unnecessary and visually unpleasing objects need to be removed. This can be achieved by background removal, changing background color and adding virtual backgrounds. Background removal can help avoid the cumbersome task of arranging a good backdrop in some cases even eliminates the use of green screens which are used by many youtubers. It helps add to the overall aesthetics and pleasantness of video conferences or even live streams.

The technique of mimicking human intelligence in robots programmed to think and behave like humans is known as artificial intelligence (AI). Computer vision is a branch of artificial intelligence (AI) that allows computers and systems to extract useful information from digital photos, videos, and other visual inputs and act or make recommendations based on that data. A computer vision technique called object detection is used to locate and identify objects in pictures and movies. Using this type of identification and localization, object detection can be used to count the items in a scene, locate and track them precisely, and accurately label them.

Image segmentation is the technique of dividing a digital image into numerous pieces for use in digital image processing and computer vision (sets of pixels, sometimes known as image objects). Various portions of a movie can be discovered using object detection and image segmentation, and different adjustments can be performed to each of the components. We'll use these ideas to remove the backdrop from a video using AI.

Open Broadcaster Software (OBS) helps you set your scene as a virtual camera to which we will be feeding our video directly in real time using pyvirtualcam and mediapipe. We'll use Google Meet to recognize OBS as a video source and output it as a virtual camera, resulting in enhanced quality of video calls.

2. REVIEW OF LITERATURE

2.1 PRESENT SYSTEM

The apps that currently provide such a feature for removing the background of a video in real time tends to worsen the quality of the video and do not provide us with smooth edges of the main object which is not ideal for a professional use. Also, the process to remove or change the background in these apps consists of various steps to be followed, sometimes we are even required to cut the video call and rejoin with a changed background. Through our project we have tried to overcome these problems by providing a system which removes the background while maintaining a proper quality of the video with fps greater than 30. And we also provide an easy way to change the backgrounds by just clicking a button on the keyboard.

Grzegorz Szwoch, in his paper presented, implementation of a background subtraction algorithm using the OpenCL platform. The algorithm works using a live stream of video frames from an on-line surveillance camera. A host machine and a parallel computing device are used to execute the processing. The research focuses on optimizing OpenCL algorithm implementation for GPU devices by taking into consideration specific GPU architecture aspects including memory access, data transfers, and work group structure. The technique is designed to work on any OpenCL-enabled device, including DSP and FPGA platforms. Several algorithm optimizations are presented and tested on a variety of devices with variable processing power. The work's major goal is to figure out which optimizations are required for on-line video processing in the surveillance system.

A relatively inexpensive background subtraction method is proposed by Hasup Lee et al., in their study employing background sets with im-age- and color-space reduction. Background sets are used to recognize objects from dynamic backdrops like waves, trees, and fountains. The image space is decreased to handle jittered and unstable frames, such as those from handheld mobile devices. The color space is shrunk to account for color noise, such as the scattered RGB values from a digital camera. To reduce expenses, a combination of color-space reduction and hash-table look-up operations is used. The results, when compared to other methods, suggest that the proposed technology is feasible: it may also be used in mobile or embedded environments.

S. Joudaki, et al., in their paper, they presented a comparison of numerous existing background subtraction methods, ranging from basic background subtraction to more complicated providential techniques. The purpose of this research is to provide an overview of the advantages and disadvantages of commonly utilized approaches. The approaches are compared based on how much memory they demand, how long they take to compute, and how well they handle different types of films. Finally, other criteria such as processing time and memory needs were used to compare the existing approaches. Baoxin Li, et al., in their paper they proposed a video background replacement algorithm, this is based on adaptive background modelling and background subtraction. It can be accomplished with a pre-recorded background scene image rather of a blue screen. Identifying statistical outliers in respect to a specific background is the challenge. A two- pass approach is utilized to modify initial segmentation based on statistics about a pixel's vicinity, which lowers false positives in the background area while raising detection rates for foreground objects. Experiments with real image sequences, as well as comparisons with other existing approaches, are shown to demonstrate the benefits of the proposed methodology.

S. Brutzer, et al., in their paper, presented one of the most important approaches for automatic video analysis, particularly in the field of video surveillance, is background subtraction. Despite their usefulness, reviews of recent background removal algorithms in relation to video surveillance challenges include several flaws. To address this problem, we must first identify the major obstacles to background subtraction in video surveillance. We then evaluate the performance of nine back-ground subtraction algorithms with post-processing depending on how well they over-come those challenges. As a result, a fresh evaluation data set is presented that includes shadow masks and precise ground truth annotations. This enables us to offer a thorough evaluation of the advantages and drawbacks of various background sub-traction techniques.

In their study, R. J. Qian et al., presented an algorithm for altering video backgrounds without a blue screen physically. Pre-recording a backdrop image of the scene free of any foreground objects is required for the operation. Based on the color difference between the pixels in an input frame and their corresponding pixels in the background image, the method computes a probability map that contains the likelihood for each pixel to be classified into the foreground or background. The probability map is further improved using anisotropic diffusion, which reduces classification mistakes without adding a lot of artefacts. The foreground pixels from the input frames are then feathered onto a brand- new background video or image based on the enhanced probability map to create the output video. The method requires only a little amount of CPU resources and is designed to work in real time. Experiment findings are also reported.

A. Ilyas, et al., in their paper, presented a Modified Codebook Model-Based Real Time Foreground-Background Segmentation. The initial step in object tracking is the essential process of segmenting the scene in real time into the foreground and background. beginning with the codebook approach. Authors suggested certain changes that show notable improvements in the majority of the typical and challenging conditions. For accessing, removing, matching, and adding codewords to the codebook as well as moving cached codewords into the codebook, they included frequency options. They also suggest an evaluation procedure based on receiver operating characteristic (ROC) analysis, precision and recall methodology, to impartially compare various segmentation techniques. Authors suggested expressing the quality factor of a method as a single value based on a harmonic mean between two related features or a weighted Euclidean distance.

Rudolph C. Baron, et al., in their paper, presented a solution for managing a video conference. When establishing a video conference with a second person, a first participant can choose from among several stored virtual backgrounds and use that background. One or more characteristics of the first and/or second participant, one or more characteristics of the video conference, and/or similar considerations may be used to choose the virtual background. The virtual backgrounds can be used, for instance, to provide people outside of a company organization a desired perception, message, and/or the like while they communicate with its employees via video conferencing. The virtual background can incorporate static image data, live or recorded video feeds, static business entity web pages, and dynamic business entity web pages.

Jian sun, et al., Effective techniques and approaches in a video sequence isolate the focus from the background, according to their paper. In one instance, a system creates an accurate real-time backdrop cut of live video by reducing the background contrast while maintaining the contrast of the segmentation boundary itself. This method enhances the border between the foreground and background images. The live video may then combine the fragmented foreground with another background. An adaptive background color mixture model can be used by the system to distinguish foreground from background more effectively when there are changes in the backdrop, such as camera movement, lighting changes, and the movement of small objects in the background.

Juana E. Santoyo-Morales, et al., in their paper presented a Background sub-traction models based on a Gaussian mixture have been widely employed in a range of computer vision applications for detecting moving objects. Background sub-traction modelling, on the other hand, remains a challenge, especially in video sequences with dramatic lighting changes and dynamic backdrops (complex backgrounds). The goal of this research is to make background subtraction models more resilient to complicated situations. The following enhancements were proposed as a result: Redefining the model distribution parameters (distribution weight, mean, and variance) involved in the detection of moving objects; enhancing pixel classification (background/foreground) and variable update mechanisms using a new time-space dependent learning rate parameter; and c) substituting a new space-time region-based model for the pixel-based model that is currently used in the literature.

According to Yiran Shen et al., background subtraction is a typical first step in many computer vision applications, including object localization and tracking. Its objective is to pick out the moving parts of a scene that match to the important things. Researchers in the field of computer vision have been working to increase the reliability and accuracy of such segmentations, but most of their techniques require a lot of computation, making them unsuitable for our target embedded camera platform, which has a much lower energy and processing capacity. In order to create a new background subtraction method that overcomes this issue while retaining an acceptable level of performance, authors added Compressive Sensing (CS) to the often-used Mixture of Gaussian. The results imply that their technique can significantly reduce the eventual time taking.

Semi-supervised video object segmentation should be considered, which is the process of creating precise and consistent pixel masks for objects in a video sequence based on ground truth annotations from the first frame, according to a suggestion made by Jonathan Luiten et al. To do this, they provided the PReMVOS algorithm (Proposal- generation, Refinement and Merging for Video Object Segmentation). The method separates the problem into two steps to specifically address the difficult issues related to segmenting multiple objects across a video sequence: first, generating a set of precise object segmentation mask proposals for each video frame; and second, choosing and merging these proposals into precise and object tracks that are pixel-wise and consistently timed inside a video sequence.

Thuc Trinh Le, et. al., demonstrated a method for removing items from videos. The technique simply requires a few input strokes on the first frame that roughly delineate the deleted objects. Authors claims that this is the first method which enables semi-automatic object removal from videos with intricate backgrounds. The following are the main phases in their system: Segmentation masks are improved after setup and then automatically distributed throughout the film. Video inpainting techniques are then used to fill in the gaps. Authors claim that their system can handle several, potentially intersecting objects, complex motions, and dynamic textures. As a result, a computational

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tool that can automate time-consuming manual tasks for editing high-quality videos has been developed.

Thanarat H. Chalidabhongse, et. al., in their paper, showed how to use color pictures to detect moving items in a static background scene with shading and shadows. They created a reliable and efficient background subtraction method that can deal with both local and global lighting variations, such as shadows and highlights. The approach is based on a proposed computational color model that distinguishes between the brightness and chromaticity components. This technology has been used to create real-world image sequences of both indoor and outdoor locations. The results, which demonstrate the system's performance, are also provided, as well as several speed-up techniques used in their implementation.

Yannick Benezeth, et. al., in their paper, presented comparison of different state-of-the- art background subtraction approaches is presented. On several movies containing ground truth, there have been developed and tested methods ranging from straightforward background subtraction with global thresholding to more complex statistical algorithms. The purpose is to lay a solid analytic foundation on which to highlight the benefits and drawbacks of the most extensively used motion detection methods. The approaches are compared in terms of their ability to handle various types of videos, memory requirements, and computing effort. A Markovian prior, along with several postprocessing operators, are also considered. Most of the films are from modern benchmark collections and highlight a range of issues, including low SNR, background motion in many dimensions, and camera jitter.

Yi Murphey, et. al., in their paper, describes their work on image content-based indexing and retrieval, which is an important technique in digital image libraries. Image features used for indexing and retrieval in most extant image content-based approaches are global, meaning they are computed over the full image. Background features can readily be mistaken for object features, which is the fundamental drawback of retrieval techniques based on global picture features. Users typically refer to the color of a particular object or objects of interest in an image while searching for photos using color attributes. The technique described in this article uses color clusters to analyze image backgrounds. After being identified, the background regions are deleted from the image indexing process, so they won't interfere with it anymore. Three main calculation processes make up the algorithm: fuzzy clustering, color picture segmentation, and background.

Zhao Fei Li, et. al., in their paper, presented background noise removal is a key stage in the picture processing and analysis process. Researchers use a variety of techniques to remove background noise from images. For instance, grey threshold techniques are frequently used to eliminate noises that have a strong contrast to the object of interest. However, there are a lot of noises in the grey scale that don't change as the interesting objects do. These noises cannot be reduced using the grey level-based noise removal technique, but the contour feature is excellent at doing so. The contour feature-based image background removal approach depends on the contour model. The contour characteristic of the interest items is modelled using a revolutionary method proposed in this study. A unique background noise with the same grey level as the background noise is completely eradicated using this method.

Thuc Trinh Le, et. al., demonstrated a method for eliminating objects from videos in their study. A few strokes in at least one frame are all that are needed for the technique to roughly delimit the items to be eliminated. These undeveloped masks are then polished and automatically broadcast throughout the video. The corresponding areas are synthesized again using video inpainting methods. Authors claim that their system is capable of navigating several, perhaps crossing objects, intricate motions, and dynamic textures. As a result, a computational tool has been created for editing high-quality videos that can take the place of laborious human work.

3. PROPOSED TECHNIQUE

The main objective of the proposed technique is to create a simpler process of removing background from a live or saved video, to simplify the process of creating an aesthetic background. Our project

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allows the user to completely remove the background or put a different background and be able to switch between multiple backgrounds or colors.

The main objective of our project is to eliminate the need to physically change the arrangement of room for a better and professional background. Thus, providing users an easy way of applying or changing backgrounds while they are in some online meet or live streams while maintaining the quality of the video.

3.1 Flow of Proposed Technique

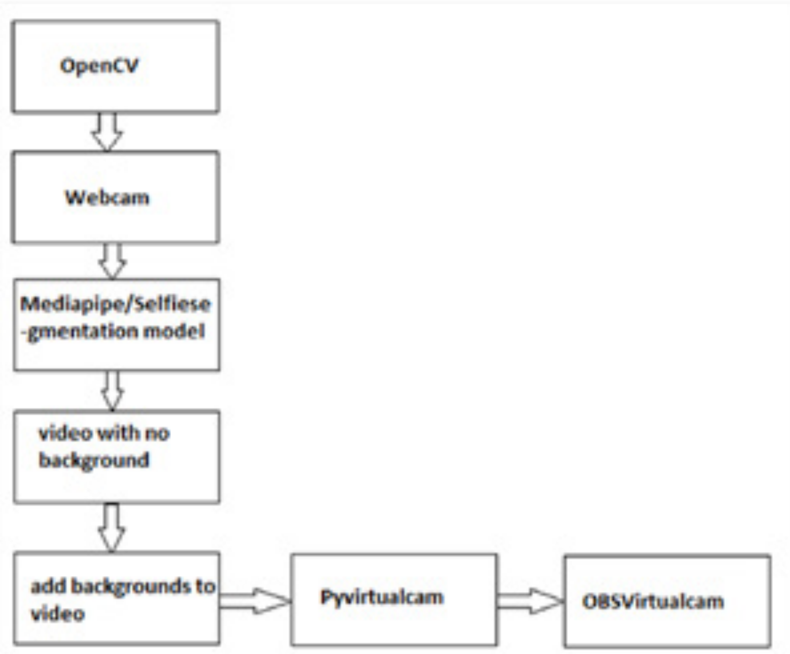

Fig. 1. Flowchart of the proposed system.

Fig. 1 shows the flow of the proposed system, starting with the accessing of the live video from webcam to the removal/changing of background and feeding the output to applications like google meet using OBS Virtual Camera.

3.2. IMPLEMENTATION

Our goal was to remove the background in real-time and with FPS more than 30.

3.2.1. STARTING THE WEBCAM

We should be able to access the webcam by simply running the code so that the videoi.e., real time video can be directly taken as input. A computer vision library is called OpenCV (Open-Source Computer Vision). with a variety of image and video manipulation tools. The OpenCV library can be used to manipulate films in a variety of ways. To capture a video, you'll need a *VideoCapture* object. The index of the device or the video file's name is stored in *VideoCapture*. The device index is just a number that identifies which of the camera device is being used.

Syntax: *capt = cv2.VideoCapture(0)*

Now a pop-up window will open if we have a webcam. We have set the frame size to 640X 480. Therefore, background-replacing images should be 640 x 480, which is the same size as the frame.

Creating a dataset for background images Make a folder called 'BackgroundImages' inside the project directory. You can download and store any image, or any number of images, in this directory.

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3.2.2. BACKGROUND REMOVAL

We have used the *SelfieSegmentationModule* from *cvzone* package which uses OpenCV and *Mediapipe* libraries at its core and makes AI operations on videos and images very easy. *SelfieSegmentation* is a technique for removing the frame's background and replacing it with photos from our directory. It is based on MobileNetV3 but has been tweaked to be more efficient. It uses a 256x256x3 (HWC) tensor as input and outputs a 256x256x1 tensor as the segmentation mask. Before feeding it into the ML models, *MediaPipe SelfieSegmentation* automatically resizes the input image to the necessary tensor dimension. We use the webcam for input and frame width should be set to 640 x

480. Then we utilize the *cvzone* to execute *SelfiSegmentation*(), which carries out object identification, image segmentation, and ultimately background removal. The output frames can show the frames per second (fps) using the FPS() method.

Syntax: seg = SelfiSegmentation() Setfps = cvzone.FPS()

SelfieSegmentation() converts the image into RGB and sends it to the SelfieSegmentation model to process and then it checks if the image is colored; if yes it changes the color of the background and if not, it then changes the color of the image. As a result, we can see the background successfully removed.

3.2.3. STORE BACKGROUND IMAGES IN A LIST

Then, after creating a list of every image in the *BackgroundImages* folder, we iterate through it, reading each one and adding it to an empty list. At the beginning, the index is set at zero.

3.2.4. REPLACE BACKGROUND WITH DESIRED BACKGROUND

The frames are read from the camera using a while loop, and the background is then removed from the frames using the *seg.removeBG()* method and replaced with images from the directory. The camera's image *frame (img),* the directory's collection of photos, and with an index of image (*imgList[indexImg]*), are all passed to the seg.*removeBG()* function along with the threshold. To improve the edges, we additionally modify the threshold setting.

3.2.5. FUNCTIONALITY TO CHANGE BACKGROUND USING KEYBOARD SHORTCUTS

Using *cvzone.stackImages*, we stack the images and retrieve the output of the frames or background-replaced image. Then, by means of a straightforward if statement, we assign keys to change the background. The principle is to sequentially remove the indexes according to the key that was pressed to display the image for the resulting index. This lets you change the backgrounds quickly.

3.2.6. SEND THE FRAMES TO OBS VIRTUAL CAMERA

We then send the resulting frames to OBS Virtual Camera using *Pyvirtualcam().* It sends frames to a virtual camera from Python. The OBS virtual camera is detected by various platforms, and we have our very own background removal with whichever backgrounds, or no backgrounds, as required.

4. RESULTS AND DISCUSSIONS

With our proposed implementation, we successfully removed the background and add any other desired background in real time with FPS more than 30.

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Fig. 2. Removal of background in real time.

Fig. 2. shows that the left half of the image has normal real-time video with backgroundand the right side has video with no background with FPS 34.

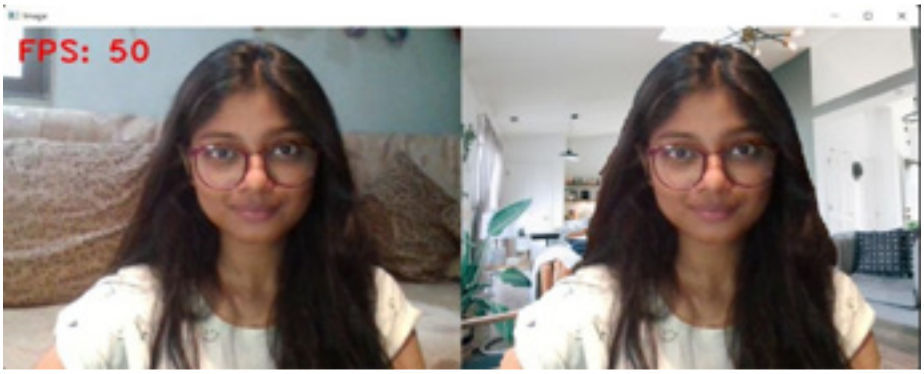

Fig. 3. Background changed in real time successfully with FPS = 50.

Fig. 3. shows that left side of the image has normal real-time video, and the right side hasvideo with desired background with FPS 50.

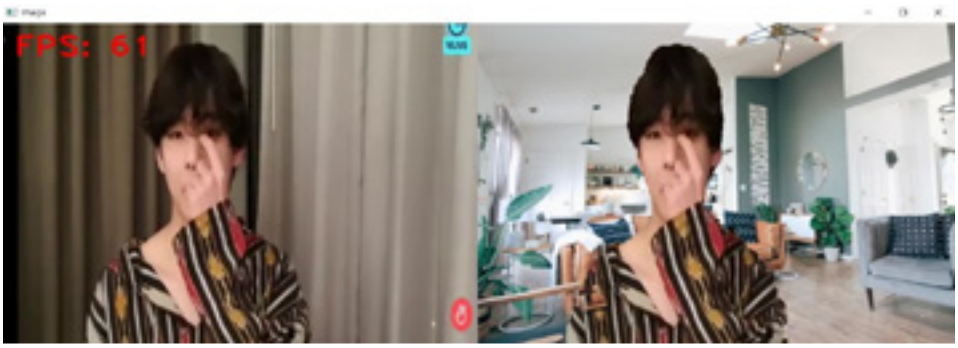

Fig. 4. Background changed of pre-recorded video successfully with FPS= 61.

Fig. 4. shows that left side of the image has normal pre-recorded video, and the right sidehas the video with desired background with FPS 61.

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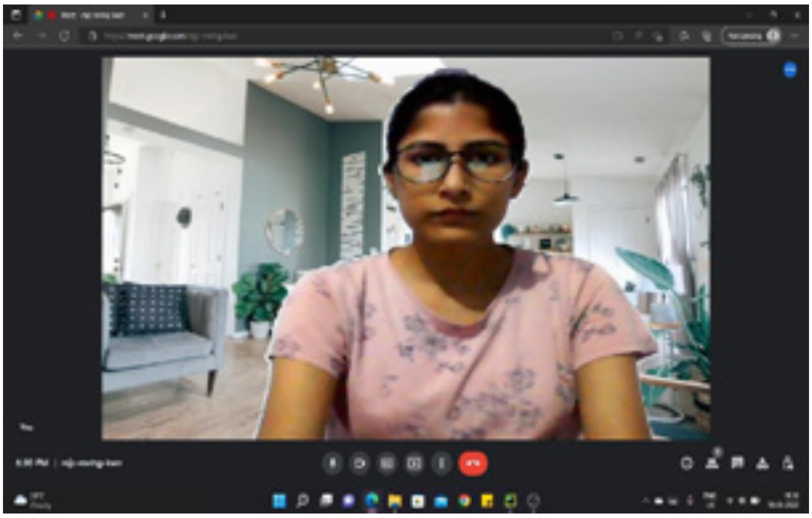

Fig. 5. Background changed in real time successfully on Google Meet.

Fig. 5. shows that we were able to change the background of our live video in a Google meet.

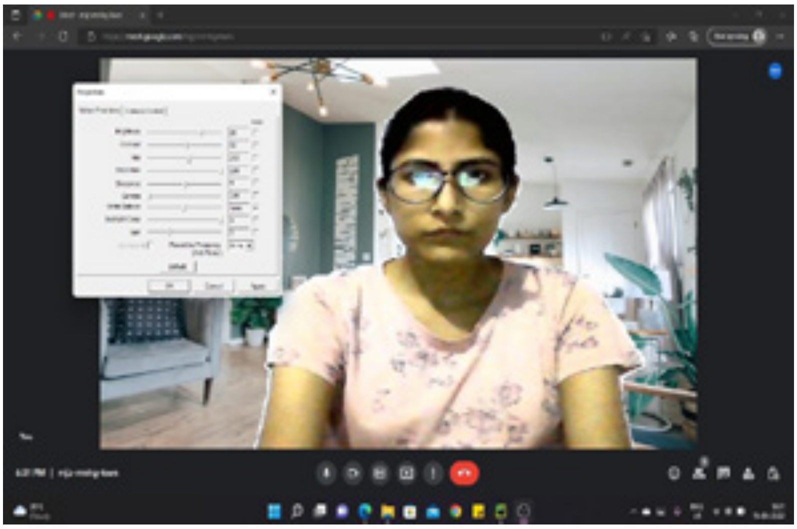

Fig. 6. Background changed in real time successfully and able to configure in Google Meet.

Fig. 6. shows that we were able to change the background of our live video as well as configure the features such as brightness, contrast, saturation, etc. of our real time videoin a Google meet.

4. CONCLUSION

We have implemented a computer-vision based system to remove the background from a video in real-time which enabled creating a professional background when not in a very professional environment. Our goal was to create solution for removing background in real time while also maintaining the quality of the call, having the additional benefit of adding custom backgrounds and enabling users to add effects like adjust lighting, contrast etc. We used *SelfieSegmentation* module of *Mediapipe* in this implementation. Our results shows that our technique successfully removed backgrounds from live videos as well as prerecorded videos at frame rate between 30 and 60. We also changed background of videos in reals time and prerecorded videos seamlessly. Our implementation also worked very well on streaming platforms like Google Meet.

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