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To classify our images after applying the sobel operator, we have use an Artificial Neural Network (ANN) with three layers. The model supports inputs of size 128 * 128. The first layer has 16,384 neurons for input and is using ReLU activation function. The second layer which is the hidden layer of our model, has 8,174 neurons and also uses the ReLU activation function. The final layer which is the output layer has 36 neurons for the number of classes we need to recognize. We use the cross-entropy loss function because it works well with classification tasks, especially with high number of classes. We use the AdaGrad algorithm for optimization of the loss function. This is a variant of the Gradient Descent in which learning rates are adjusted during training. In our testing data, this gave us an accuracy of 98.77% as seen in Figure 8 this may be lower for other more general datasets and needs more testig with varied inputs.

The final component of our project is the openCV application which ties the other two parts together, allowing us to take input from real-time video and pass it through other two components. It will also tell the prediction to the user. This application has the most scope for work in the future. This component currently rescales the input, applies grayscale (though this part is not necessary since the sobel filter application can do it) and then saves the image. Then it calls sobel filter application to convert the image to csv output, this is data is given to the model which produces the final prediction.

There are many future avenues for exploration, several compelling directions emerge, aligning seamlessly with the trajectory of this project and its uses for use by general public. Firstly, we can devle deeper into the edge detection where we can upgrade from a simple sobel filter to canny edge detection. This algorithm works after sobel filter to further select only the most prominent edges. This will help in getting better accuracy when working on real-time input like video, because most modern cameras usually focus on the foreground effectively making edges of the focus (hands) more prominent. We can go further and add a way to remove the background from our input. This would required another suitable algorithm or model which can detect the background and remove it.

The neural network can be upgraded to a Convolution Neural Network (CNN). These networks are better suited for computer vision tasks than traditional Neural Network which we have used in this project. Increasing the quality of the dataset, with more varied images which the network can train on. It would also be ideal if these images could have more noise in the background so that we could train the model to only isolate the hands.

The frontend application needs the most work in the future, if this project is to be used for gesture detection in true-to-life setting. The current implementation relies on OpenCV, but we are not using all of the capabilities of the library. It was chosen since it was appropriate for the scope of this project, but switching to another library which is lighter and can allow us to work with camera directly will significantly improve performance. Alternatively, we could also use OpenCV to do more difficult tasks such as the canny edge detection mentioned before. This would make the use of such a large library appropriate. The fontend also needs to be more user friendly and intuitive to use.

In essence, the future holds boundless opportunities for advancing the field of sign language recognition through interdisciplinary collaboration, innovative technologies, and a steadfast commitment to excellence. By embracing these opportunities and staying attuned to emerging trends and challenges, we can continue to push the boundaries of what's achievable, driving innovation and shaping the future of computer vision.

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