

Wearable Banknote Value Audio Interpreter Smart Glass for the Visually Impaired using Natural Language Processing

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Abstract

Knowing and understanding the value of a banknote in the real-world, to resolve the problems faced by the blind population of the nation, this is an approach to provide a simple yet innovative solution for them using the latest technology. This solution provides results to know the denomination of real currency notes present in front of the visually impaired or completely blind in audio format which is the best way of interpretation to the visually impaired. The solution is aimed at building a smartphone application that can visually detect, internally analyze using sophisticated algorithms and interpret the results through auditory perception. Since efficiency is always the main objective of any project the idea of implementing the solution in a product like blacked out spectacles that is used by almost 99% of the visually impaired population is also taken care of by using the latest technologies.

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1. Introduction

The population of the world that can be an asset involves all its living entities without the discrimination of abled or disabled in any means. We often fail to understand the difficulties faced by the commons with a disability who also has the same ability to exceed as that of every other normal individual.

Addressing one such scenario which was already in chaos where the visually impaired were unable to identify the currency denominations and were prone to cheating at almost every place visited by them in the day, this is one less expensive solution that can be a fortune for them by which they can get gain the trust back on them on not getting cheated and confidence on technology.

Another mass act that happened in India, that gave us the motive to this project was the '2016 Indian banknote demonetization', where every citizen of the country faced problems regarding the aggressive change in currency and introduction of higher denominations, the most affected

and prone to cheating were the daily laborers and the disabled. Accounting on one such affected mass, the disabled (visually), where a very high percentage of them have the ability to find out the denominations of the currency notes by analyzing the structure and size of the note which was their main paradigm and source of self-trust, it was affected and lost due to the introduction of same size of banknotes for all denominations that was printed post 2016.

Our research solution that uses the latest computing technologies that are based on facts and algorithms is a step towards bringing the trust back in such lives through technology who are facing issues else are a big asset to the economic development of the country.

2. Literature survey

Few years ago, LUKS-A2 Lab published a research paper regarding the basic image recognition detecting on an object using simple C++ library by which the amount of

computing power required to do such a tedious task was found very minimal., with the introduction and publication of such papers it gave birth to such tremendously new technologies to be implemented in large scale for the [1]. How quantum computing is gaining high importance in the field with the introduction of mic4ro computing service devices like Raspberry pi board and Arduino shows how the field is extensively passion about exploring. [2] The Raspberry pi Is edge computing device where all the computation task happens at the node end instead of flowing the data over the cloud, The detailed description and functioning of the Raspberry pi in the paper by the author is discussed and has been made maximum use of its features in the implementation of this project [4]. Several International governments have been working together in order to use these advanced technologies for more enhanced and accurate results for multi-dimensional analysis of the obtained results.

The paper [2], authors discuss about the low computational complexity, which is expected to give efficient results for high requirement of the data. The proposed idea, may not be able to differentiate between the genuine and counterfeit with complete accuracy but techniques involving ultraviolet spectra can be used to carry out the above procedure at a very highly scaled level.

The review [3], the advancement of technology has made it possible to come with new and fast methods to like Optical Character Recognition (OCR) in order to scan the serial number of the notes and classify them as real or fake based on the updated dataset which includes image acquisition and then extract the required features in order to categorize using various algorithms.

In the Modern era of computing, the methods started to become more wide in order to solve the problems which were complex in the olden times, In [4], attempt to combine many discrete procedures in order to build a complete model which is capable of performing more efficiently was attempted and authors discuss on those features which include – edge detecting, comparing images, segmentation, characteristic extraction, image processing[5]. The Sobel Operator [6], which is of most importance in banking sector which helps in gradient extraction. Sobel Operator and Sobel filter is used for computer vision, image processing and help in build emphasizing edges within the edge detection algorithm.

3. Problem definition

To address the issues faced by the visually impaired and blind in order to interpret the numbered value of the currency notes in any place under needful circumstances using OCR model implemented in a raspberry pi and the detected output is pipelined to a speech synthesizer in order to interpret it over the destined audio output device that helps the visually impaired to help a lot in the rapidly growing society.

4. Methodology

The project model which involves making the already present prescribed spectacles/blackout spectacles that are used by 99% of the visually impaired/blind population smarter by deploying an image recognition model in order to recognize the value on the banknote and convert it into auditory form which can be heard by the user, done using the custom algorithm on a Deep Learning Mode. Fig1. Clearly highlights the architecture of the model.

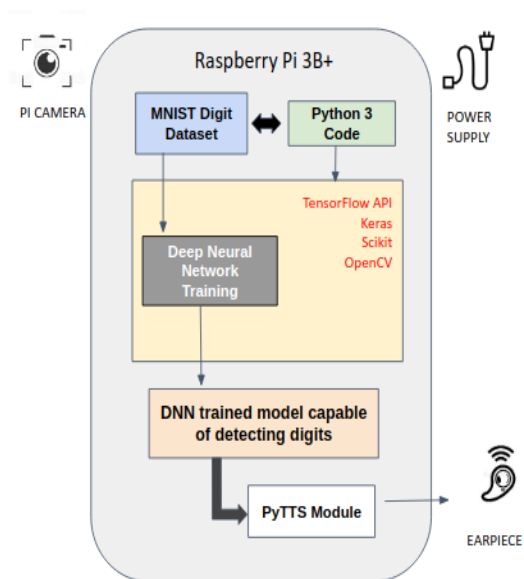


Figure 1: Architecture of the Wearable Smart Glasses

5. Algorithm Used

For more accurate and precise results we have built our own custom algorithm below which consists of the major steps for computation -

Step 1 – **Read the image** – This helps in scanning the image using the pi camera module which is further processed for detection.

Step 2 – **Converting to gray scale** – The scanned image is converted into gray scaled using scipy function call.

Step 3 – **Scale image range** – The scanned image in gray scale condition is converted into unit8 range [0, 255].

Step 4 – **Thresholding** – To obtain a accurate image in black and white, the image thresholding is done using Otsu method.

Step 5 – **Resize image** – the image is resized to a 28x28 pixel array. It is then flattened to a linear array of size 28x28

Step 6 – **Invert image** – MNIST DNN accepts images as 28x28 pixels, drawn as white on black background. So we have to invert the image.

Step 7 – **Feed the trained neural network** – The deep neural network weights and the image to be detected to the network, It takes 2-3 seconds to come up with a prediction.

Step 8 – **Text to Audio Conversion** - the predicted output is pipe lined into the pyTTS text to speech conversion tool in order to obtain the output in audio format.

6. Tools & Technology

Required

1. MNIST image data set is used comprised of 60,000 training examples formatted a 28x28 pixel monochrome images.

2. Hardware Requirements

- Raspberry pi 3b+ (onwards)
- Pi camera module
- Audio Interpreter.

3. Software Requirements

- **Python3** – primary coding language used.
- **TensorFlow v2.1** – for creating a structured network layer for the proposed algorithm.
- **Keras** – acts as wrapper for TensorFlow.
- **Scikit-learn** – to enable real time image processing.
- **OpenCV** – to enable computer vision for the hardware.

7. Experimental Results

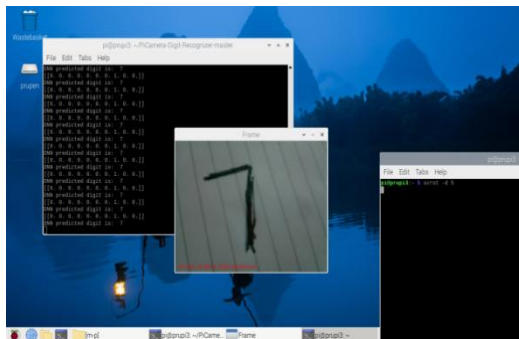


Figure 2: Detection using Custom built Deep Learning Algorithm



Figure 3: Real-time detection and output interpreted on earphone for the visually impaired

8. Conclusion

A smart wearable glass paired with a camera in order to recognize, detect and analyze the value of the currency that is intelligently programmed by Raspberry Pi Board with custom build Deep learning algorithm based on MNIST data set [fig2] and pyTTS module pipelining for the audio output [fig3].

9. Future Enhancement

In Upcoming days the model can be updated with the latest dataset for better accuracy, the connections between different modules can be minimized by using wireless communication devices between the detection module and audio output module.

Can be used for more Interesting application for guiding daily movements of visually impaired with more computational power since the algorithm has a robust background

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