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Design and Development of Human Identification and Obstacle Detection System for Blind using Machine Learning.

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ABSTRACT

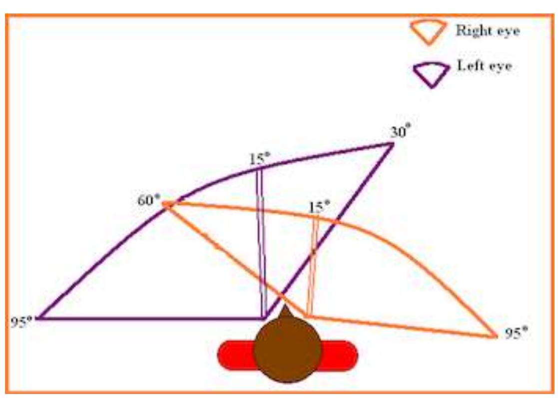
According to the World Health Organization (WHO), there are millions of visually impaired people in the world, either completely or partially, and they face numerous challenges in detecting obstacles and identifying persons around them. Not only has information technology evolved rapidly, but the spatial cognition theory for blind and visually impaired (BVI) people has also made great strides, which has opened up a new opportunity. As a result, this prototype develops the concept of supplying them with a simple and cost-effective solution via artificial vision. Thisproject has proposed a novel framework by utilizing AI, which makes the framework more straightforward to use specifically for the individuals with visual impedances and to help the society.we developed an intelligent system for visually impaired people using a Machine learning (ML) algorithm, i.e., convolutional neural network (CNN) architecture,to recognize the human and scene objects or obstacles automatically in real-time.The proposed system is able to properly recognize humans in complex environments with multiple moving targets, thus providing to the user a complete set of information, namely presence, position and nature of the available targets. Furthermore, a voice message alerts the blind person about the obstacle or known or unknown person. The proposed work aims to create a user-friendly technology for communication of physically liable people which fulfils the basic amenities of the especially abled persons aiming easy-to-use interface, convenience, portability and cost effectiveness. As a result, the proposed approach enables blind users to manage unaware indoor and outdoor locations.

Keyword: detecting obstacles, convolutional neural network (CNN), blind person

INTRODUCTION

Vision Impairment Types

The way in which vision impairments are classified differs across countries. The World Health Organization (the WHO) classifies visual impairment based on two factors: the visual acuity, or the clarity of vision, and the visual fields, which is the area from which you are able to perceive visual information, while your eyes are in a stationary position and you are looking straight at an object.



The Snellen Chart is used to test visual acuity. Your visual acuity is calculated using two numbers. The first number is the distance between the person reading the chart and the chart. The second number is the distance that a person with normal vision would have to stand from an object to see what you did at 20 feet. For example, a visual acuity of 20/80 means that you can read the chart from 20 feet away as well as a person who could read the chart from 80 feet away. In other words, what a person with normal vision would see from 80 feet away, you can't see until you move closer to only 20 feet away. This image shows the crossover between the eyes in order to create the visual fields.

Three Types of Vision Impairments

The types of vision impairments are low visual acuity, blindness, and legal blindness (which varies for each country):

- Low visual acuity, also known as moderate visual impairment, is a visual acuity between 20/70 and 20/400 with your best corrected vision, or a visual field of no more than 20 degrees
- Blindness is a visual acuity of 20/400 or worse with your best corrected vision, or a visual field of no more than 10 degrees
- Legal blindness in the United States is a visual acuity of 20/200 or worse with your best corrected vision or a visual field of no more than 20 degrees.

Being blind or visually impaired doesn't mean you automatically lose the independence of getting to and from places whenever you please. Several techniques and methods can help people get around safely regardless of their amount of vision.

1.2 Problem Identified

The biggest challenge for a blind person, especially the one with the complete loss of vision, is to navigate around places. Obviously, blind people roam easily around their house without any help because they know the position of everything in the house. People living with and visiting blind people must make sure not to move things around without informing or asking the blind person.Commercial places can be made easily accessible for the blinds with tactile tiles. But unfortunately, this is not done in most of the places. This creates a big problem for blind people who might want to visit the place.

Firstly, there has traditionally been an overwhelming emphasis on ICT tasks such as reading or using a computer, rather than helping those with vision loss better interpret real-world scenes. Portability and convenience remain a second major problem and, even though many such issues have been significantly mitigated by the emergence of the smartphone over the past ten years, blind people have long been crying out for solutions that are more seamlessly integrated and wearable.The most valuable thing for a disabled person is gaining independence. A blind person can lead an independent life with some specifically designed adaptive things for them. There are lots of adaptive equipment that can enable a blind person to live their life independently but they are not easily available in the local shops or markets.Assistive technology to help those who are blind or severely sight impaired has, for several decades, been dogged by a number of critical issues.Over the past few years, there has been increasing interest in AI powered smart glasses.Artificial intelligence & machine learning can be deployed to create products for enhanced productivity among the differently-abled.

Literature review

1. A Hybrid Algorithm for Face Detection to Avoid Racial Inequity Due to Dark Skin

There has been significant development in the facial recognition technology during past few decades. This technology has been widely used by different organizations and governments for defence, security, and surveillance projects. Furthermore, it has now been incorporated into our daily usages, such as consumer applications, personal data protection, or cyber-security, particularly while using smartphones. Most of these systems work very efficient, however, there are some challenges related to the accuracy of results of facial recognition systems when tested on images of people with dark skin. This article highlights the variation in accuracy of existing facial recognition algorithms when applied to dark-skinned people. Furthermore, as a principal contribution it presents a hybrid algorithm based on Gaussian and Explicit rule model that improves the accuracy for face-detection for dark skinned people. The results showed that Gaussian and Explicit Rule hybrid algorithm optimally improved the face detection rate for people with dark skin.

2. Exposing Fake Faces Through Deep Neural Networks Combining Content and Trace Feature Extractors

With the breakthrough of computer vision and deep learning, there has been a surge of realistic looking fake face media manipulated by AI such as DeepFake or Face2Face that manipulate facial identities or expressions. The fake faces were mostly created for fun, but abuse has caused social unrest. For example, some celebrities have become victims of fake pornography made by DeepFake. There are also growing concerns about fake political speech videos created by Face2Face. To maintain individual privacy as well as social, political, and international security, it is imperative to develop models that detect fake faces in media. This article proposes a hybrid face forensics framework based on a convolutional neural network combining the two forensics approaches to enhance the manipulation detection performance. To validate the proposed framework is used a public Face2Face dataset and a custom DeepFake dataset collected. Thus, the extracted features are specialized to represent various contents in a face. The latter feature extractor is based on the local relationship between neighbouring pixels, by first applying the multi-channel constrained convolution.

3. Object Detection in Thermal Spectrum for Advanced Driver-Assistance Systems (ADAS)

Thermal cameras can be used for object detection in both day and night-time environmental conditions.Since it is invariant to illumination changes, occlusions, and shadows it provides improved situational awareness. Moreover, by integrating with AI-based imaging pipelines and can design intelligent thermal perception systems to detect multiple objects of different classes. Such systems can be beneficial for advanced driver assistance systems (ADAS) & environment monitoring methods. Vehicular perception systems havebecome an emerging consumer technology application and the evolution of this technology over time aims to provide extended safety benefits and reliable means of transportation. Various key technologies are directly associated with intelligent vehicular systems which includes, sensor fusion for real-time data logging, and object/ obstacle detection and tracking system using machine learning algorithms. This will empower the drivers to monitor the external environment, detecting external objects, and predict events that the driver needs to be aware of thus providing a deeper understanding of the entire road surroundings. Moreover, a new model ensemble-based inference engine is proposed using the combination of two best-trained models to further improve the accuracy metrics on test data.

Proposed System

The proposed system of the project is to design and fabricate a Smart Electronic Glass that designed to make recognizing faces and objects easier for visually impaired people.

Face Recognition and Object detection is a computer technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class (such as humans, buildings, or cars) in digital images and videos. Face Recognition and Object detection is one of those fields that have witnessed great success.It is used in many areas like face detection (used by Facebook to recognize people), tumour detection (used in medical fields), etc. Ever since the inception of deep learning in computer vision, tasks like object detection have become comparatively easier and efficient.

The deep learning models provide better accuracy, less time consumption, less complexity, overall better performance than the earlier computer vision approaches. Deep learning provided outstanding results over the traditional computer vision methods for object detection, leading to the wide use of deep learning models.

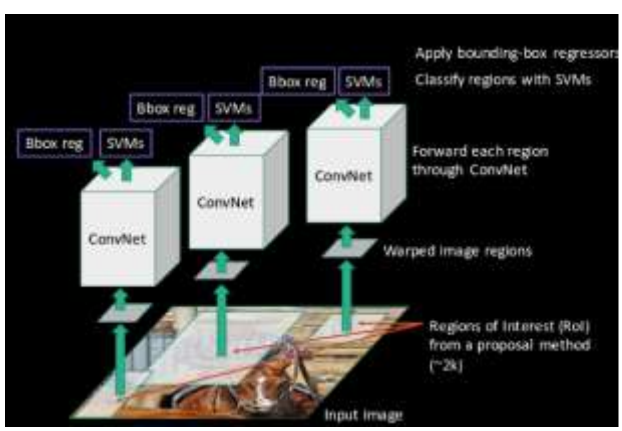
One of the best performing object detections (deep learning) algorithms include:

1. RCNN (Region-based Convolution Neural Network)

2. Fast RCNN

3. Faster RCNN

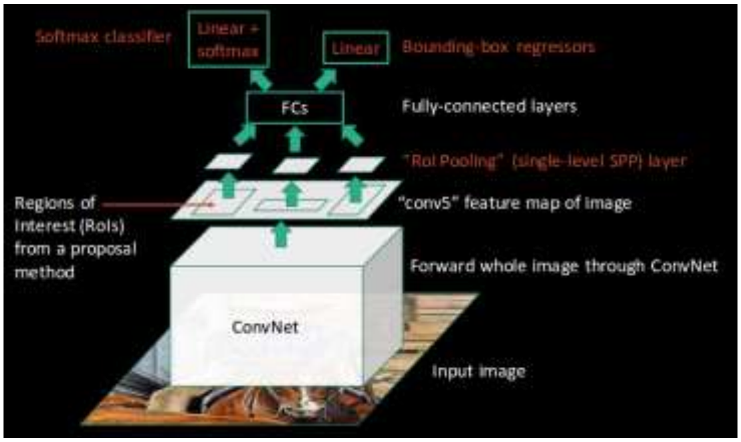
R-CNN extracts a bunch of regions from the given image using selective search, and then checks if any of these boxes contains an object. We first extract these regions, and for each region, CNN is used to extract specific features. Finally, these features are then used to detect objects. Unfortunately, R-CNN becomes rather slow due to these multiple steps involved in the process.



R-CNN

Fast R-CNN, on the other hand, passes the entire image to ConvNet which generates regions of interest (instead of passing the extracted regions from the image). Also, instead of using three different models (as we saw in R-CNN), it uses a single model which extracts features from the regions, classifies them into different classes, and returns the bounding boxes.

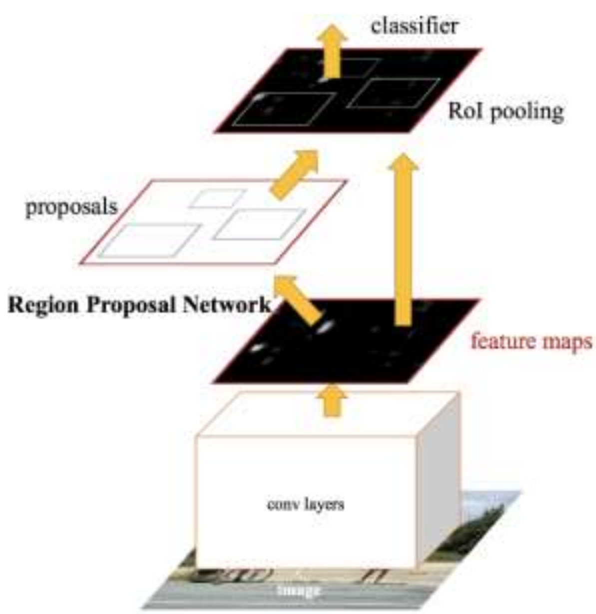
All these steps are done simultaneously, thus making it execute faster as compared to R-CNN. Fast R-CNN is, however, not fast enough when applied on a large dataset as it also uses selective search for extracting the regions.



Fast R-CNN

Faster R-CNN fixes the problem of selective search by replacing it with Region Proposal Network (RPN). We first extract feature maps from the input image using ConvNet and then pass those maps through a RPN which returns object proposals. Finally, these maps are classified and the bounding boxes are predicted.

The Faster R-CNN model uses the region proposal network (RPN) instead of the traditional selection search method to generate proposals, the feature map of the original image is shared to generate the proposals and perform the object detection. These two innovations improve the quality of proposals and significantly reduce the number of proposals. The implementation of the RPN network is scanning each point on the feature map by a lowdimensional convolution layer, predicting multiple proposals for each feature point on the feature map, and then through two full connection layers to get the probability of whether there exists the object in proposals or not and the border regression of the proposals. Faster R-CNN model detection process is divided into the following six steps, and the detection process shown in below figure:



Faster R-CNN

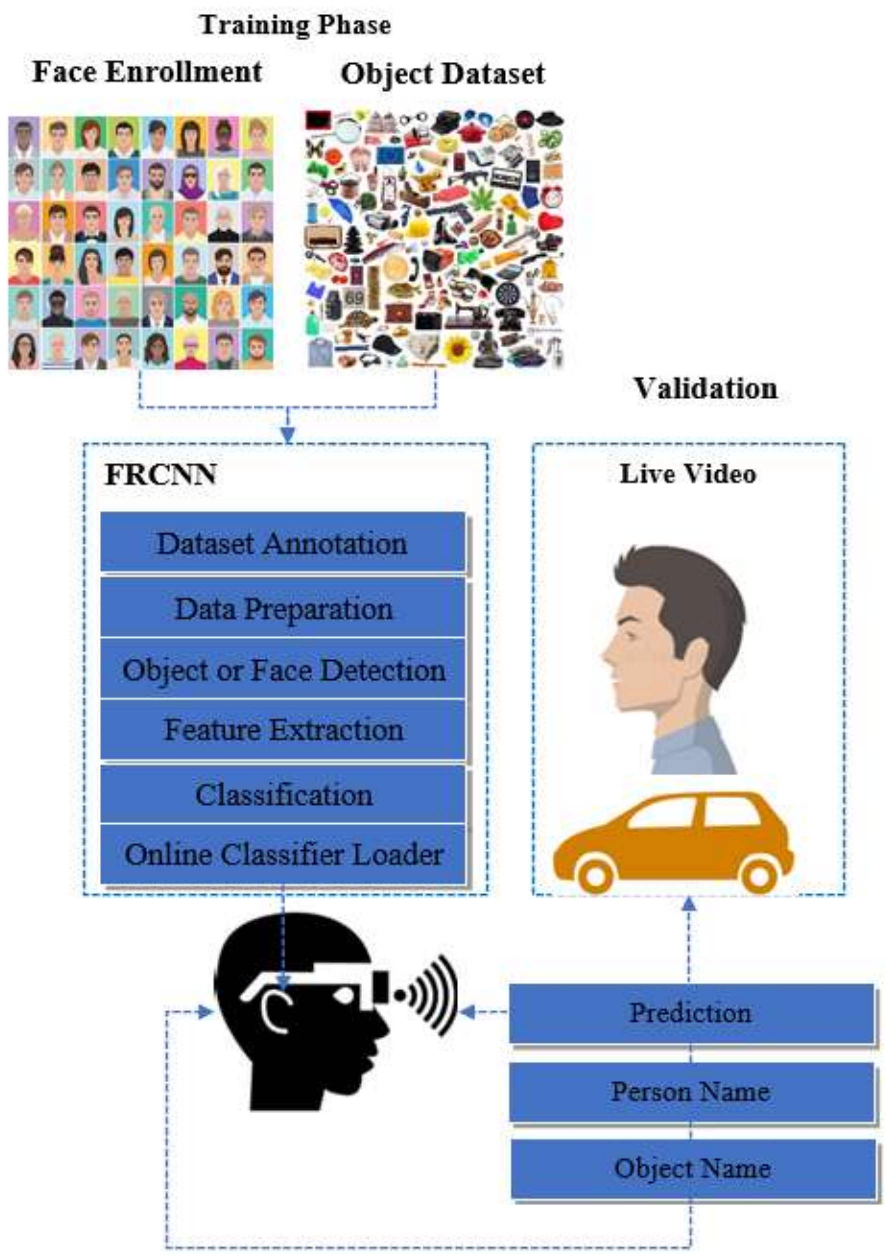
Summarized below the steps followed by a Faster R-CNN algorithm to detect objects in an image:

1. Take an input image and pass it to the ConvNet which returns feature maps for the image
2. Apply Region Proposal Network (RPN) on these feature maps and get object proposals
3. Apply ROI pooling layer to bring down all the proposals to the same size
4. Finally, pass these proposals to a fully connected layer in order to classify any predict the bounding boxes for the image.

Concept Flow

Obstacle Detection

4.2 System Architecture



CONCLUSION

The device presented here is a smart glass that incorporates the functionality of a machine vision and obstacle detection and recognition sensor. It can be conveniently advertised and made accessible to the visually disabled population. It would also help to deter future injuries. Smart devices can be transported comfortably and the system camera can be used to track objects and face from the surrounding environment and display in audio format. Each model represents a specific task or mode. The user can have the desired task run independently from the other tasks. The system design, working mechanism and principles were discussed along with some experiment results. Let the visually impaired people can interact more closely with the people around them, without fear of being blurred and uncertain. Although it is still a prototype, our system represents a promising avenue for future research aimed at enhancing the spatial awareness of visually impaired people traveling in unfamiliar environments.

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