RO026

Helping the Visually Impaired Navigate at Bus Stops

Research Plan

1. Rationale

Singapore aims for a public transport system that is inclusive to all, however, the visually impaired (VI) often face difficulties in using the public transport system. Advances in computer vision technology could potentially address this issue.

This project aims to create an all-in-one system to help the VI determine what bus is arriving at the bus stop using object detection, optical character recognition and text to speech techniques.

Research Question(s)

- What types of networks to use?
    - What are the limitations of each one?
    - How feasible are they to train and run (detection at real time speed)?
- How does one train and use these networks?
    - What can be automated via existing technologies?
    - What needs to be done from scratch?
- How effective will this solution be?
    - Will it be able to capture the buses each time?
    - Will it be user friendly enough to be used by the VI?

2. Hypothesis

We hypothesize that using modern machine learning techniques, we will be able to create a cohesive system that is able to detect the bus number of oncoming buses and relay this information to the visually impaired.

3. Engineering goal(s)

We aim to create a system that will take in a stream of images and determine the presence of buses in them and read off the bus number if a bus is present and then relay this information to the user in the form of audio.

4. Expected Outcome(s)

We hope that the developed system will be user friendly and accurate that the VI are able to reliably use it in their daily commutes. We also hope that it will prove the effectiveness of this approach towards enabling the VI to commute more independently and ganer the interest of bigger firms such as Microsoft and Google.

5. Procedures

We collect data by taking the perspective of the VI and filming the buses as they come and go at different bus stops at different times of the day. These videos are extracted into individual frames. We train an object detection network with this data and get it to identify the bus number location. We then use an OCR algorithm or neural network to extract the bus number from the location of the bus number specified by the object detection algorithm.

6. Risk and Safety

- Do not stand too close to the road while collecting data
- Ensure to not over spend credits on Azure or AWS if we use those cloud platforms

7. Methods for Data Analysis

Data Preparation

- Formatting and labelling the raw data
- Splitting the data for training, testing and validation

Training Phase

- Analysis of the performance of the neural networks
    - Accuracy
    - Recall
    - Precision

8. Bibliography from your literature review

1. "Azure for Students – Free Account Credit | Microsoft Azure." Microsoft, https://azure.microsoft.com/en-us/free/students/. Accessed December 15, 2020.
2. “Seeing AI | Talking camera app for those with a visual impairment." Microsoft, https://www.microsoft.com/en-us/ai/seeing-ai. Accessed December 15, 2020.

3. Vincent, James. "Google releases Lookout app that identifies objects for the visually impaired." The Verge, March 13, 2019, https://www.theverge.com/2019/3/13/18263426/google-lookout-ai-visually-impaired-blind-app-assistance. Accessed December 15, 2020.
4. "YOLO: Real-Time Object Detection." Pjreddie, https://pjreddie.com/darknet/yolo/. Accessed December 15, 2020.
5. "Using Tesseract OCR with Python." PyImageSearch, https://www.pyimagesearch.com/2017/07/10/using-tesseract-ocr-python/. Accessed December 15, 2020.

Abstract

The Land Transport Authority's (LTA) "Land Transport Master Plan 2040", outlines the aim of "Transport for All" as LTA plans to reduce the barriers of transport that different groups of commuters face when taking public transport. A group that faces large amounts of difficulty taking public transport is the Visually Impaired (VI). We aim to reduce the barriers to public transport that the VI face by developing an all-in-one system that the VI can use to know what buses are coming when at bus stops. This system uses a custom object detection model together with optical character recognition (OCR) techniques from the cloud platform Azure to recognize if there is a bus coming towards the bus stop and what the bus number of the bus is. This information is then relayed via text-to-speech techniques to the VI to internalize. We successfully collected training data, trained the custom object detection neural network and constructed the system which was tested on several videos of buses at bus stops and determined to be working relatively well.

Report

1 Introduction

Singapore, being a small and dense city state, strongly relies on the use of public transport to reduce the impact of congestion and pollution that comes from rampant use of private transport. Thus, Singapore utilises many strategies to curb private vehicle usage, such as the Certificate of Entitlement and the Electronic Road Pricing system.

However, the other part to reduce private vehicle usage is to increase the ease of the alternative, public transport. While the Land Transport Authority has indeed increased the standards of public transport in Singapore over the years, groups of people such as those facing mobility issues or sensory issues are often neglected.

Enabling these neglected groups not only increases the appeal of Singapore's public transport system, but also serves to increase the cohesiveness and unity of Singapore as it sends a strong message that no one is left, behind as Singapore advances into the future.

Of these neglected groups, a large portion is made up by the VI. A study by the Singapore Eye Research Institute in 2015 found that diabetic retinopathy has to date resulted in visual impairment of more than 26100 Singaporeans[1]. Apart from diabetic retinopathy, there are many other causes of visual impairment, such as glaucoma and cataract. A risk factor of some of these ailments is age[2], which makes transport for the VI even more relevant to Singapore given that Singapore is suffering from an ageing population.

The VI face difficulties in transportation due to the lack of information available to them. In the case of bus transportation, this is with regards to where to stand (unable to find the first bollard), where the bus is, or what bus is currently at the bus stop. Furthermore, through interviews with several VI, it is found that many visually-sighted people often do know or care about the difficulties of the VI when asked for help, thus making seeking help rather difficult for the VI. Additionally, seeking help frequently leads the VI to feel less independent and erodes their self-confidence. Thus, there is a need to leverage on new technologies to create an innovative solution that enables the VI to take in more information about their surroundings and take public transport more independently.

In this paper, we attempt to build an all-in-one system that leverages on the cloud platforms to analyse a feed of images taken from a camera (which will be worn by the VI), identify buses and bus numbers on the buses and relay this information via text-to-speech back to the VI.

We chose to rely on cloud computing rather than doing the machine learning locally for 2 main reasons. Firstly, doing the machine learning on the cloud enables the predictions to be done on the cloud, reducing the need to heavy amounts of resources while still being able to make fast predictions. Secondly, relying on machine learning algorithms on the cloud

platforms mean that we are always using the most up-to-date and well-trained neural networks out there. The cloud platform we have chosen to work with is Microsoft Azure[3] due to its seemingly simpler workflow and student sponsorship program[4].

1.1 Related Work

The concept of using artificial intelligence to help the VI with "seeing" is not something new, a very impressive product current in market is Microsoft's "Seeing AI[5]" that uses machine learning to describe what a VI person is seeing and relaying that information to the VI. Google also has a similar product: "Lookout[6]".

However, both these options are currently very generic and are not tailored to use in identification of bus numbers, especially at a large distance, as they are optimised for closer ranged objects such as people or supermarket products. Furthermore, Lookout is only available on Google's Pixel smartphones, thus making it rather inaccessible for those without such devices.

As such, there is a need to work on applying such machine learning technologies on bus transportation. Perhaps, with validation that this technique works, big name companies such as Microsoft and Google will attempt to fit this technology into their existing products so that the VI have a single combined platform where they are able to use AI to help them perceive the world.

2 Materials and Methods

Equipment needed:

1. A 64-bit computer running Linux
2. A camera, the higher the solution, the better the results
3. Speakers or earpieces to hear the output sound

Prerequisite Software:

1. Python 3.7+[7]
2. Numpy (Python Module)[8]
3. Matplotlib (Python Module)[9]
4. Azure Cognitive Services Speech SDK (Python Module)
5. Jupyter Notebook[10]
6. FFmpeg (Linux Package)[11]

Other Prerequisites

1. Microsoft Azure subscription

2.1 Overview of System Logic

Our system performs 4 main processes. First it activates the camera to take a picture and store it as an image. After which, this image is imported into python and sent to Azure servers through a POST request to an Azure Custom Vision[12] prediction application program interface (API). The API returns the coordinates of its predicted bounding boxes for the bus numbers. We then check if there exists a bounding box which Custom Vision has a high confidence of. If so, we proceed to crop the image to the coordinates of the bounding box and use the Azure Recognize Text API[13] to extract the bus number from the image. If the API is able to find a valid number within the image, this is sent the Azure "Text-to-Speech" API[14] which will write to an audio file to be played.

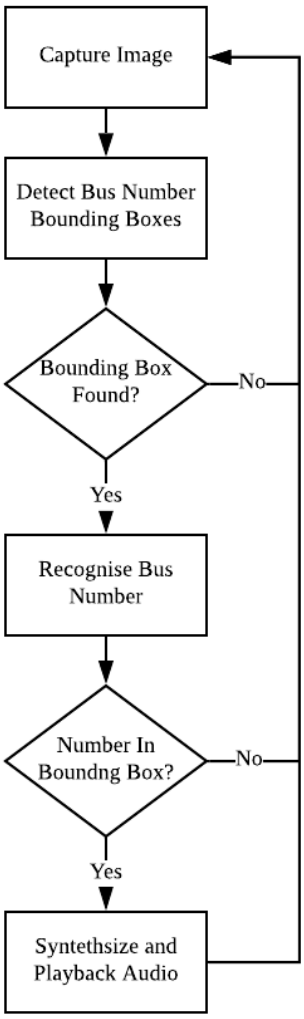


Figure 2.1.0: Logical Flow Diagram of System

2.2 Azure Custom Vision Set-Up

Although Azure has a pre-trained computer vision neural network[15] that detects common objects in images (including buses), this network is only able to identify the entire bus but not the actual location of the bus number on the bus. Thus, using it would result in less accurate responses from the OCR section later on.

As such, there is a need to train a custom computer vision neural network to fit our task. Azure provides a convenient platform for this in the form of Azure Custom Vision.

Figure 2.2.0: Bus Detection with Pre-Trained Computer Vision Network on Azure

2.2.1 Data Gathering

A large amount of quality data is important to generate an accurate neural network. Although there are many datasets for vehicles available, most of them are either not based in Singapore or from the wrong angle. For the network to learn properly, the buses need to be the same as those it will be tested on (i.e. Singapore buses), furthermore, it must be from the perspective of a human standing at a bus stop and watching the on-coming vehicles.

With the above constraints, the only reasonable way to attain data would be to manually film videos of buses coming from the perspective of someone standing at a bus stop. Additionally, to reflect real life scenarios more closely, a tripod was not used as the neural network would have to take into account variations in the orientation, position and stability of the camera in relation to the buses that were coming.

After the videos were filmed, a bash script that used FFmpeg was written to extract every 10^{th} frame of the videos.

2.2.2 Data Augmentation

While in many cases, data augmentation such as image inversion or rotations can be used to help generate more data, for this project, the test images are guaranteed to be upright and the bus is always going to be on the left of the bus stop as the VI will be facing the oncoming traffic and Singapore is a left driving country. As such, there was no benefits and potentially worsened results if we performed such data augmentation.

2.2.3 Data Labelling

To reduce the difficulty of the object detection problem, we opted to only use one class "bus_number" in our object detection model. The bounding box for the images were drawn with the built-in labelling tool from Custom Vision's web interface. They were drawn across the top of the front of each bus as shown in the image below.

Figure 2.2.1: Labelling Bus Numbers on Custom Vision's Web Interface

[Destination] [Bus Number]

Figure 2.2.2: Destination and Bus Number within the labelled bounding boxes

Choosing to label the bounding boxes around only the bus numbers and destinations as opposed to labelling the entire bus helped to ensure that only these sections of the bus were later cropped and sent to the OCR network. Sending the entire bus would reduce the network's focus on the actual bus numbers and false bus numbers could be generated as a result as the OCR network finds other numbers in the image (such as car license plate numbers).

Additionally, we chose to include the destination in the bounding boxes for the images as well to give the algorithm an easier time to find the bus number. This is because the destination is always found adjacent to the bus number. Thus we theorised that the neural network could learn to search for 2 orange sections adjacent to each other. This would be easier than finding the bus number on its own, which would also have the complication of the neural network choosing to put a bounding box around the destination as opposed to the bus number as they look visually similar and in a similar location on training images.

2.2.3 Training the Neural Network

While this is often the most tedious part of machine learning projects, the use of Azure Custom Vision greatly simplified the process it automated the splitting of the labelled images and the training loop for their neural network. Furthermore, the training was done on Azure servers and thus could utilise their more powerful graphics processing units (GPUs). Training thus only took about 10 compute minutes to complete.

Performance of the neural network can be seen under section 3: Results.

2.2.4 Incorporating Custom Vision Network into System

After the training is done, the neural network can be accessed via a POST request to the API end-point for Custom Vision Prediction. The image is sent in binary as the request body. The response will contain JavaScript Object Notation (JSON) data on the position of the different bounding boxes and the confidence score.

For each image, we assume there is only at most 1 bus within the image, and identify the bounding box within the response with the highest confidence score. If this confidence score is higher than a threshold (we set ours to be 20%), then there is considered to be a bus in the image and the bounding box coordinates are subsequently used to crop the image, else the image is discarded.

2.3.0 Data Preparation for OCR

After the location of the bus number on the bus is found out by Custom Vision, we use the Python Image Library to crop the image to be ready to send to the OCR algorithm.

We cropped the image to the right 50% of the predicted bounding box. This was to crop away the destination in order to ensure that the bus number fills up most of the space of the image.

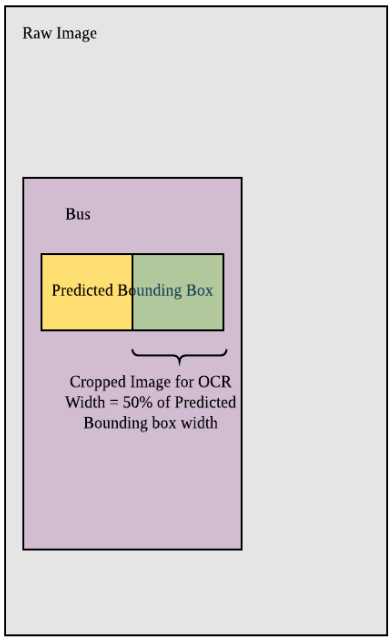


Figure 2.3.0: Illustration of Cropping Area for OCR

Furthermore, we performed 2 types of image resizing on the cropped image. Firstly, we pad white space to increase the image size to at least 50px by 50px to meet Azure's API requirement. Secondly, we resize overly tall images to 50 pixels tall and shrink the width appropriately to preserve the aspect ratio. This sounds counterintuitive as the decrease in resolution typically leads to worse OCR performance. However, as the bus number is formed from individual lights on the front panel of the bus, in high resolution close up shots, the lights could appear separated, leading to the OCR being unable to detect the number.

Figure 2.3.1: Bus number Before Lowering Resolution (note the distinctly visible grey strips)

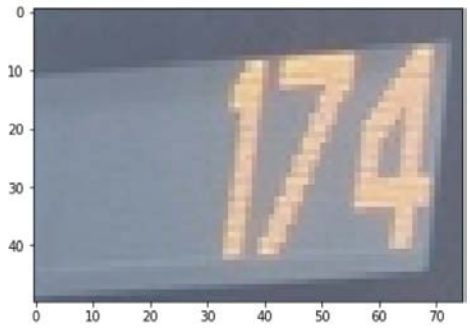


Fig 2.3.2: Bus Number After Resolution Reduction (less visible grey strips)

2.3.1 Performing the OCR

Performing the actual OCR was relatively easy as we used used the pre-trained Azure Cognitive Services "Recognise Text API". This was chosen instead of the "OCR API" and "Read API" on Azure as OCR API was based on an older recognition model and Read API is optimised for text heavy images such as documents which does not fit our OCR needs.

Similar to the Custom Vision API, a POST request is sent and the response contains the different text values. To ensure that we get only the bus number and not any remains of the destination, we search the response by words and pick the first word that begins with a number.

2.4.0 Text-to-Speech Synthesis

To inform the VI about the upcoming bus, we need to convey the information through audio. Again, we rely on Azure's Cognitive Services which has a text-to-speech synthesising API. We synthesize the sentence "Bus {bus number} is coming now!" and write it to an audio file which is then played.

3 Results

Table 3.0: Configuration and Performance of Custom Vision Model

No. of Labelled Images	386
No. of Negative Images	572
Training Time	~10 Minutes
Precision	100.0%
Recall	93.5%
mAP	96.1%

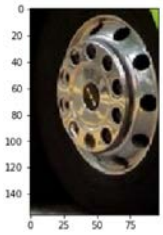
Table 3.1: Testing of Overall System

Number of Videos Tested	6
Number of Successful Tests	5

Table 3.2: Example of Successful Attempt

Raw Image	
Bounding Box	
Cropped Image	
Bus Number	298

Table 3.3: Example of Unsuccessful Attempt

Raw Image	
Bounding Box	

4 Discussion

Overall, the network works relatively well for images taken at the correct angle and from the right distance.

The overall good performance of the system is likely due to the lack of variety amongst Singapore public buses. There are only a handful of bus designs, thus with enough data, our Custom Vision Neural Network is able to quickly learn how to identify which parts of the bus to look for to attain the bus number.

However, once the angle for the images changes (refer to table 3.3), the network has difficulty finding the bus number. That being said, this is not a big issue as the system is intended to be used from only the bus stop angle (refer to table 3.2)

5 Limitations and Future Work

While doing this project, we were faced with 2 major constraints, time and computational resources.

Machine learning in its current state requires a large amount of data is needed for good results, however, the process of collecting data is tiring and tedious, thus were only able to collect about 1000 images for this project. By collecting more images of different buses and bus models, we may be able to improve the network's performance.

Furthermore, we lacked access to dedicated hardware (discrete GPUS) to train models locally. Thus it was not feasible to train large networks such as YOLOv3[16] or SSDMobileNet[17]. As such, we decided that it would be most ideal to leverage Azure's Custom Vision for our project.

Additionally, our current system is still only able to work from a computer with a webcam and we have yet to make it available as a mobile application which will be the main way the VI would have access to the system.

Although we have attained a successfully working system to detect bus numbers for the VI at bus stops, there is room to improve. With better selected and customised neural network architecture and data, we may be able to improve its accuracy. Apart from just detecting bus numbers, this could be improved to tell the user where to stand to wait for the bus or where to face to allow the VI a more comprehensive solution to reduce the barrier of bus transportation. Furthermore, it could be improved by incorporating it into a Bluetooth wearable such as a pair of spectacles that contain a camera as this would be more convenient for the VI to use while on the go.

6 Conclusion

In this project, we created a system to detect the bus number of oncoming buses and relay that information to the VI through audio means.

References

[1] "Singapore's Eye Health." Snec, https://www.snec.com.sg/giving/singapores-eye-health. Accessed January 06, 2020.

[2] "Risk Factors for Visual Impairment." PORTAL MyHEALTH, http://www.myhealth.gov.my/en/risk-factors-for-visual-impairment/. Accessed January 06, 2020.

[3] "Microsoft Azure Cloud Products, Services, Solutions | Microsoft Azure." Microsoft, https://azure.microsoft.com/en-us/. Accessed January 06, 2020.

[4] "Azure for Students – Free Account Credit | Microsoft Azure." Microsoft, https://azure.microsoft.com/en-us/free/students/. Accessed January 06, 2020.

[5] "Seeing AI | Talking camera app for those with a visual impairment." Microsoft, https://www.microsoft.com/en-us/ai/seeing-ai. Accessed January 06, 2020.

[6] Vincent, James. "Google releases Lookout app that identifies objects for the visually impaired." The Verge, March 13, 2019, https://www.theverge.com/2019/3/13/18263426/google-lookout-ai-visually-impaired-blind-app-assistance.

[7] "Welcome to Python.org." Python, December 20, 2019, https://www.python.org/. Accessed January 06, 2020.

[8] "NumPy — NumPy." Numpy, https://numpy.org/. Accessed January 06, 2020.

[9] "Matplotlib: Python plotting — Matplotlib 3.1.2 documentation." Matplotlib, https://matplotlib.org/. Accessed January 06, 2020.

[10] "Project Jupyter | Home." Jupyter, https://jupyter.org/. Accessed January 06, 2020.

[11] "FFmpeg." Ffmpeg, https://www.ffmpeg.org/. Accessed January 06, 2020.

[12] "Custom Vision." Home, https://www.customvision.ai/. Accessed January 06, 2020.

[13] "Printed, handwritten text recognition - Computer Vision." Azure Cognitive Services | Microsoft Docs, April 17, 2019, https://docs.microsoft.com/en-us/azure/cognitive-services/computer-vision/concept-recognizing-text. Accessed January 06, 2020.

[14] "Text to Speech | Microsoft Azure." Microsoft, https://azure.microsoft.com/en-us/services/cognitive-services/text-to-speech/. Accessed January 06, 2020.

[15] "Computer Vision | Microsoft Azure." Microsoft, https://azure.microsoft.com/en-us/services/cognitive-services/computer-vision/. Accessed January 06, 2020.

[16] "YOLO: Real-Time Object Detection." Pjreddie, https://pjreddie.com/darknet/yolo/. Accessed January 06, 2020.

[17] "Review: SSD — Single Shot Detector (Object Detection)." Towardsdatascience, https://towardsdatascience.com/review-ssd-single-shot-detector-object-detection-851a94607d11. Accessed January 06, 2020.

Appendix

System Main Script

```
#!/usr/bin/env python
# coding: utf-8

# # Identification of Bus Numbers from Images
#
# ### Steps
# 1. Find bounding box of bus numbers
# 2. Crop image to bounding box location
# 3. OCR on cropped image
# 4. Text to Speech to tell the visually impaired about the bus

# In[12]:


# Libaries
import requests, json, numpy as np, time
import azure.cognitiveservices.speech as speechsdk
from PIL import Image
from matplotlib.pyplot import imshow

get_ipython().run_line_magic('matplotlib', 'inline')

get_ipython().system('ls')


# ## Use Azure Custom Vision to Find Bounding Box of Image

# In[47]:


threshold = 0.2 #Threshold on what probability corresponds to a valid bounding box
test_image = "bus_ext_6.jpg"
custom_vision_api =
"https://southcentralus.api.cognitive.microsoft.com/customvision/v3.0/Prediction/b35dc00f-1a23-4f90-a2f1-c406952ff467/detect/iterations/Bus_Numbers_1/image"
```

```
prediction_key = "secret"

with open(test_image, 'rb') as image_file:
	custom_vision_response = requests.post(custom_vision_api, data=image_file,
headers={"Prediction-Key": prediction_key, "Content-Type": "application/octet-stream"} )

print("Custom Vision Response:", custom_vision_response.text)

json_response= json.loads(custom_vision_response.text)
bounding_boxes = json_response['predictions']


# In[48]:


# Extract Best Bounding Box with Probability > 0.5
max_probability = -1
for bounding_box in bounding_boxes:
	#print("Box:", bounding_box['probability'])
	max_probability = max(max_probability, bounding_box['probability'])

if max_probability < threshold:
	print("No Valid Bounding Boxes Found")
for i in bounding_boxes:
	if i['probability'] == max_probability:
	bounding_box = i
	print(bounding_box)


# In[49]:


bounding_box = bounding_box['boundingBox']
print("Bounding Box:", bounding_box)


# ## Use Python Image Libary to Crop Image at Bounding Box

# In[50]:


# Import Test Image into Python
raw_image = Image.open(test_image)
width, height = raw_image.size

# Set Points for Cropped Image to Bounding Box
left = width*bounding_box['left']
right = left + width*bounding_box['width']
top = height*bounding_box['top']
bottom = top + height*bounding_box['height']

# Crop Image
bus_num_image = raw_image.crop((left, top, right, bottom))
print("Image of Bus Number")
imshow(np.asarray(bus_num_image)) #Display the Image


# In[51]:
```

```
ocr_crop_percentage = 0.5
# Crop Away ocr_crop_percentage of Left Side for OCR Reasons
width, height = bus_num_image.size
left = width * ocr_crop_percentage
right = width
top = 0
bottom = height

ocr_image = bus_num_image.crop((left, top, right, bottom))

# Resize Image with Interpolation if height too big (somehow OCR on Azure doesn't work too well
with too sharp of bus numbers)
width, height = ocr_image.size
if height > 50:
       ocr_image = ocr_image.resize((int(width*50/height),50),Image.ANTIALIAS) # Ensure the
aspect ratio doesn't change
print("OCR Ready Image")
imshow(np.asarray(ocr_image)) #Display the Image

# Save OCR Ready Image
ocr_image_file = "ocr.png"
ocr_image.save(ocr_image_file)


# In[52]:


# Fits image into a square of at least 50x50 pixels by padding white space
def Reformat_Image(ImageFilePath):

       from PIL import Image
       image = Image.open(ImageFilePath, 'r')
       image_size = image.size
       width = image_size[0]
       height = image_size[1]

       if(width != height or (width < 50 and height < 50)):
       bigside = width if width > height else height
       if bigside < 50:
              bigside = 50

       background = Image.new('RGBA', (bigside, bigside), (255, 255, 255, 255))
       offset = (int(round(((bigside - width) / 2), 0)), int(round(((bigside - height) / 2),0)))

       background.paste(image, offset)
       background.save(ocr_image_file)
       print("Image has been resized !")
       print(background.size)

       else:
       print("Image is already a square, it has not been resized !")

Reformat_Image(ocr_image_file)


# ## OCR with Azure Cognitive Services
```

```
#
# Uses the Recognise Text API which operates asyncronously

# In[53]:


# Sending Image file to Recognise Text API
ocr_key = "secret"
ocr_api = "https://southcentralus.api.cognitive.microsoft.com/vision/v2.0/recognizeText"

#ocr_image_file= "helloworld.png"
params ={"mode": "Printed"}
with open(ocr_image_file, 'rb') as image_file:
       print("Sending", ocr_image_file)
       ocr_response = requests.post(ocr_api, data=image_file, headers={"Ocp-Apim-Subscription-
Key": ocr_key, "Content-Type": "application/octet-stream"}, params=params )
       print("Resource location", ocr_response.headers['Operation-Location'])
ocr_response


# In[54]:


# Request for the Result
request_result_api = ocr_response.headers['Operation-Location']

while True:
       ocr_status = requests.get(request_result_api, headers={"Ocp-Apim-Subscription-Key":
ocr_key})
       print("Response Text:", ocr_status.text)
       json_response= json.loads(ocr_status.text)
       if json_response['status'] == "Succeeded":
       print("OCR Finished")
       break
       else:
       time.sleep(0.5)


# In[55]:


# Extract Lines from Response
lines = json_response["recognitionResult"]["lines"]
if len(lines) == 0:
       print("No Text Identified...")

# Finding first word that begins with a number
predicted_number = ""
for line in lines:
       for word in line["words"]:
       #print(word["text"][0])
       if word["text"][0].isdigit():

              predicted_number = word["text"]
              break
if predicted_number == "":
       print("Failed to Get a Number...")
```

```
else:
	print("Predicted Bus Number:", predicted_number)


# ## Synthesise Speech to Output File

# In[56]:


speech_key, service_region = ocr_key, "southcentralus"
speech_config = speechsdk.SpeechConfig(subscription=speech_key, region=service_region)

audio_filename = "bus_number.wav"
audio_output = speechsdk.AudioOutputConfig(filename=audio_filename)

speech_synthesizer = speechsdk.SpeechSynthesizer(speech_config=speech_config,
audio_config=audio_output)

text = "Bus "+ predicted_number + " is comming now!"
result = speech_synthesizer.speak_text_async(text).get()

if result.reason == speechsdk.ResultReason.SynthesizingAudioCompleted:
	print("Speech synthesized to [{}] for text [{}]".format(audio_filename, text))
elif result.reason == speechsdk.ResultReason.Canceled:
	cancellation_details = result.cancellation_details
	print("Speech synthesis canceled: {}".format(cancellation_details.reason))
	if cancellation_details.reason == speechsdk.CancellationReason.Error:
	if cancellation_details.error_details:
		print("Error details: {}".format(cancellation_details.error_details))
```