Creative writing on applications of artificial intelligence

[Technology](#), [Artificial Intelligence](#)

Applications of Artificial Intelligence

An automatic car number-plate recognition system can be used successfully to identify the vehicles passing by a particular location and hence recognize their owners. In the given situation, this system needs to be used to identify vehicles entering and leaving a proposed congestion charge area in Southampton. This can be achieved with the help of a camera for taking images of the vehicle as it passes into the zone. Thereafter, using software those images can be processed and compared with the already existing records for identification and recognition.

For the identification process it is necessary to have an understanding of the patterns of the number-plates of the cars. The British number plates have a display made up of reflective materials. Its front and rear faces are painted in white and yellow respectively. These plates can be divided into four segments. The first part which is blue in color contains the EU country identifier. It is a two-lettered code and is characteristic of the particular country. The next two characters refer to the specific area code of the zone where the vehicle has been registered. Next, two numbers are embedded which depict the age or the last two numbers in the year of registration. Finally, the last three random letters differs from one vehicle to another such that every vehicle possesses a unique identity. All these regulations are applicable for the vehicles that were registered after the year 1973 (nationalnumbers. co. uk).

In the given situation, the captured images of vehicles can be suitably processed using the various techniques to obtain a clearer and more understandable version. Thereafter, this data needs to be compared with the

existing database. As mentioned above, the British number plate comprises of four disparate segments providing information about different aspects about its registration. Different search loops can be run for each of the four segments of the number-plate. However, searching needs to be carried out in a hierarchical fashion beginning with the comparison of country code and ending with recognizing the unique three-lettered code which forms the fourth segment. Therefore, four successive steps are required in the process. The search for the subsequent code shall begin only after a successful match for the previous code has been derived. Also, after each step the comparing database will become shorter eliminating the sets that went unmatched. Therefore, as the database reduces in size, the steps will become faster with time.

For the pre-processing of images obtained through the camera, connectionist solution serves a good application. The vehicles that pass through the Southampton's particular area under consideration may be driven at varying degrees of speeds. Also, we know that the area is heavily congested. Therefore, it is quite understandable that there is high probability of the images getting blurred or blocked by some other object that comes in between. Therefore, the images of the vehicles obtained with the help of a camera need to be processed before they can be sent for recognition. Images can be processed through low, medium or high level processing methods.

Low level processing involves the techniques of edge detection, line fitting, thresholding, image smoothing and image intensification. In the first technique of edge detection, when an image is captured its edges are

sharpened so as to enhance their visibility. Two-dimensional edge detection technique facilitates the recognition of the edges of the objects in a picture. Firstly, the difference in intensities of the local regions of an image are computed and recorded. The difference zones form the border between different objects or scene parts. The two most popular methods used for edge detection include the gradient and laplacian methods (owlnet. rice. edu). In the gradient edge-detection method, the maximum and minimum in the first derivate of the image are computed for detecting the edges in the image. This method uses three kinds of filters, namely Robert, Prewitt and Sobel. However, the laplacian method uses the Mars-Hildreth filtration technique (owlnet. rice. edu). This method detects edge of the image by noticing the zero-crossings found in the second-derivative of the image. The changes in intensity of the image found in the raw image are computed at varying scales and degrees. When this image gets filtered at an appropriate scale it gives the second-derivative of a Gaussian. It has been observed that these primary filters do not depend upon the orientation once the basic conditions get satisfied.

Intensity changes in an image can also be caused due to discontinuities in the surface structure, reflectance or illuminated boundaries which are spatially localized (rspb. royalsocietypublishing. org). These zero-crossings are not independent and there are certain rules devised for combining the zero-crossings of the image into a description of the image called the raw primal image (rspb. royalsocietypublishing. org).

There is a possibility of some noise disturbing the image quality. This noise can be considerably reduced with the help of the image smoothing

technique. Image smoothing is best used when random noise is present, either caused by poor image capture equipment or by over-compression of the image. The kinds of filter to be used for smoothing can be grouped into various categories such as Box Filter, Gaussian Filter, Median Filter and Bilateral Filter (docs. opencv. org).

The box filter is the simplest of all the image smoothing methods. Box filter smoothens the image by equally weighting a rectangular neighborhood of pixels. The output pixel has a value equal to the average or mean of all the pixels located around it (docs. opencv. org).

Gaussian filter is the most useful image smoothing technique. In this the output pixel (x, y) is weighted using the normal distribution method i. e. the local values carry posses weight. Here the sum obtained after each input point is convolved with the Gaussian kernel gives the output array (docs. opencv. org).

The median filter replaces a pixel value by the median of its neighbourhood. It runs through every element of the input i. e. the image in this case and will perform the replacement of pixels (docs. opencv. org).

The function of these filters is to smooth the image obtained for better understanding. However, at certain times they also dissolve away the edges of the image which deteriorates the quality of the image. The bilateral filter is responsible to avoid the dissolving of the image. Similar to the Gaussian filter, the bilateral filter also takes into consideration the weighted value assigned to the neighbouring pixels. At the same time, the bilateral component also takes into account the difference in intensities of the neighbouring pixels and the one under consideration (docs. opencv. org).

The image intensification method is used to enhance the intensity of the image's brightness. If an image is, for example, too dark to identify detail, a non-linear boost can be used. It boosts all intensities but special emphasis is laid on the lower intensities more than the higher ones. This process is known as Contrast Stretching. It is carried out using the expression shown below.

fx= x1y

Next, the Histogram Equalisation further facilitates in the image intensification process. The output image uses all intensity values and the same number of pixels is assigned to each gray level.

The line detection technique plays a very important function to compensate for the loss of information about the image when an object is partially hidden by some other object e. g. a house is partially hidden by a tree. In these cases edge detection does not prove to be very useful and hence line detection method needs to be applied.

In order to ascertain the flow of the edges and check if they would join if extended, the Hough Transform method is used. It uses the following expression.

A straight edge is given by the formula $y = mx + c$ where m is the slope and c is the y intercept. The method edge(x, y) is a function that returns 1 if there is an edge point at (x, y), 0 otherwise. Once the line segments have been found, the image can be split into the regions with similar patterns such as brightness.

Thresholding can be used to obtain binary images from the grey scale images. It chooses some pixels as foreground and the remainder as

background. The threshold value is chosen to highlight certain features. The grey-tone values that lie above or below the threshold become foreground pixels. The threshold values provide a useful measure to filter the desirable elements from the undesirable ones based upon a set of predefined criteria. The identification mechanism can be carried out with the help of two kinds of approaches which are symbolic solution and connectionist solution. The symbolic solution involves a combined effort of the various disciplines of cognitive science, artificial intelligence together with an efficient human-computer interface. Instead of numbers, the symbolic systems manipulate symbols (symsys. stanford. edu). Symbols depict crisp values and therefore statistical methods can be incorporated for symbolic method.

Connectionist solutions comprise of artificial neural networks. Neural network is a simplified representation of the brain done artificially so as to imitate its functioning mechanism. Human brain is composed of numerous neurons that carry the signals sent through external agencies and transport it to the brain, where these signals get processed into useful information. Similarly the neural networks involve several units that have the ability to measure the strength of their inter-connections (plato. stanford. edu).

Neural networks have been successfully applied in the areas of face recognition, speech recognition, detection of grammatical errors in simple sentences etc. The data obtained or the signal has an associated level of strength or weight that determines its character. This signal can represent either positive or negative value depending upon the nature of activation. This variation in strengths distinguishing one signal from another imparts a fuzzy character to it (plato. stanford. edu).

Neural network offer considerable flexibility and are capable of facing the real-time challenges. In such occasions where the inputs have certain defects or noise, this method offers the possibility to correct the input and impart it a usable form (plato. stanford. edu).

For a system where the images are perfectly clear, the traditional statistical method of searching and comparing the each data would serve the purpose. However, in a real-life situation where there are several possibilities of images getting blurred or any hurdle obstructing the process of capturing images. Even after several attempts of processing the image may not have perfect clarity to a degree such that its comparison with the database elements could be carried out with ease. In such a situation, the incorporation of fuzzy logic in the search-mechanism can enable enhanced search-ability. The subsequent quantization of the elements according to certain threshold values can ensure much higher degree of accuracy.

In a traditional method, the processes are designed according to the ideal situations without taking the other undesirable elements into consideration. However, artificial intelligence solutions offer various methods to rectify the errors that may crop up in real-time. Artificial intelligence improves the efficiency of the system remarkably as compared to the traditional method. Furthermore, artificial intelligence techniques reduce the need for external supervision to the minimum enhancing the ease of workflow.

Bibliography

' Connectionism,' Stanford encyclopedia of philosophy, viewed 24 April 2013

Hildreth, E and Marr, D 1980, ' Theory of Edge Detection,' The Royal Society,

viewed 26 April 2013 < http://rspb. royalsocietypublishing. org>

McCarthy, J 2007, ' Applications of AI,' What is Artificial Intelligence?, viewed 24 April 2013

Morelli, R, ' CPSC 352 -- Artificial Intelligence,' Introduction to computing, viewed 24 April 2013

' Number plates search,' Number plate formats explained; UK car registrations | National Numbers, viewed 26 April 2013

' Other methods of edge detection,' viewed 26 April 2013

' Smoothing images,' Image processing, viewed 26 April 2013

' Symbolic systems program,' Stanford University, viewed 24 April 2013

Yang, MH, Kriegman, DJ and Ahuja, N 2002, ' Detecting Faces in Images: A Survey,' IEEE transactions on pattern analysis and machine intelligence, vol. 24(1).