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Pedestrian's Controlling on Zebra using Multi-Layer Image

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Abstract: *The improvement of road safety is considered as a top priority on the agendas of governments and transport policy making stakeholders worldwide, with the 'Vision zero' target being the pinnacle of the European Commission's road safety strategy. Increased attention has been given to pedestrians, since crashes involving this vulnerable user group, have a higher mortality rate. As a result, research focusing on the behaviour of pedestrians and on the application of Intelligent Transport Systems that will assist pedestrians, is of increased importance. This project attempts to predict pedestrian behaviour on crossings with a Countdown Signal Timer (CST), through the application of a machine learning algorithms. In the frame of the case study presented, an intersection in the simulated environment model, where countdown signal timers have been installed on the pedestrian traffic lights, is analyzed. For the needs of the analysis two models were implemented, a X-Convolutional Neural Network (X-CNN) and a Decision making. Results of both models indicated a satisfactory performance. In detail, the X-CNN model managed to estimate the pedestrians' crossing speed with a Mean Squared Error value. The accurate determination of pedestrians' crossing behaviour could not only underline the influence of countdown signal timers, but also highlight appropriate countermeasures that can make infrastructure safer for this user group to alert them on the speaker with appropriate messages.*

Keywords: Decision Making, Cross- Convolutional Neural Network (X-CNN), Machine Learning, Countdown Signal Timer (CST)

I. INTRODUCTION

The continuous development of technology over the years tends to fundamentally change modern people's reality. Nowadays smart cities, where technology has a vital role, are becoming not only a priority but also a necessity. The core of all societies are their citizens, who constitute the cornerstone around which all decisions are taken and every infrastructure is designed and organized in order to improve the providing quality for humans. The ultimate aim of modern cities is to provide a high quality of life for their inhabitants.

A significant criterion associated with the quality of people's life, is the sustainability of transportation systems and the conditions that exist in the different modes of transport. Several researchers have conducted a range of surveys related to transportation problems and provided services, aiming at the implementation of sustainable mobility. More specifically, they have investigated traffic congestion under a plethora of different conditions, operating conditions of public transport (e.g. quality of service, mode's occupancy according to its capacity), road crashes due to their alerting increase, and all the characteristics that form a transport system in general. Thus, researchers and people in charge, have applied a variety of technological tools, addressing corresponding problems in the most desirable and efficient way. These technological findings can be determinants for the transition to conditions of sustainable mobility.

In particular, many studies have been carried out in the transportation domain based on innovative techniques and state-of-the-art methods. One method of high importance and particular interest are the techniques of machine learning and more specifically the applications of Artificial Neural Networks (ANN). It is a form of artificial intelligence that has piqued the interest of many researchers, due to the extensive range of applications of these models and their malleability, as they are capable of adapting with ease in many different cases. A valid reason for selecting these

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models is the high accuracy rates they present in their predictions, making them a reliable forecasting tool. At the same time, an equally efficient machine learning technique, especially in classification problems, is Logistic Regression.

In this project, an attempt was made to investigate and examine the efficiency and contribution of Deep Learning models to transport problems, in terms of exploiting their predictive capacity, in the interests of appropriate design and improvement of transportation systems. More to the point, we applied a variety of deep learning models on a problem concerning the most vulnerable road users in urban areas, i.e., pedestrians. The scope of the research was to examine the crossing and kinematic behaviour of pedestrians in an intersection with a Countdown Signal Timer (CST). Apart from the purpose of eliciting useful information with respect to the classification of pedestrian's behaviour, the research aimed to extract promising findings for the improvement of the safety of roads for pedestrians.

II. LITERATURE SURVEY

The field this project is based on has been researched many times before; in order to get an overview of the previously done work, this chapter analyses some of those documents for each part of the project.

MariosFourkiotis [1], attempts to predict pedestrian behaviour on crossings with a Countdown Signal Timer (CST), through the application of two machine learning algorithms. In the frame of the case study presented, an intersection in the Kalamaria city of Thessaloniki, Greece, where countdown signal timers have been installed on the pedestrian traffic lights, is analysed. For the needs of the analysis two models were implemented, a Deep Neural Network (DNN) and a Logistic Regression model. Results of both models indicated a satisfactory performance. In detail, the DNN model managed to estimate the pedestrians' crossing speed with a Mean Squared Error value of 0.0647 (km/h)2, while the Logistic Regression model, which classified pedestrians based on their behaviour, achieved an accuracy of 97%. The accurate determination of pedestrians' crossing behaviour could not only underline the influence of countdown signal timers, but also highlight appropriate countermeasures that can make infrastructure safer for this user group. Findings of this research can prove beneficial for researchers, infrastructure operators and policy makers alike, in their effort to improve the safety level of pedestrians.

Hongjia Zhang [2], focuses on pedestrian intention recognition on the basis of pedestrian detection and tracking. A large number of natural crossing sequence data of pedestrians and vehicles are first collected by a laser scanner and HD camera, then 1980 effective crossing samples of pedestrians are selected. Influencing parameter sets of pedestrian crossing intention are then obtained through statistical analysis. Finally, long short-term memory network with attention mechanism (AT-LSTM) model is proposed. Compared with the support vector machine (SVM) model, results show that when the pedestrian crossing intention is recognized 0 s prior to crossing, the recognition accuracy of the AT-LSTM model for pedestrian crossing intention is 96.15%, which is 6.07% higher than that of SVM model; when the pedestrian crossing intention is recognized 0.6 s prior, the recognition accuracy of AT-LSTM model is 90.68%, which is 4.85% higher than that of the SVM model. The determination of pedestrian crossing intention parameter set and the more accurate recognition of pedestrian intention provided in this work provide a foundation for future fully automated driving vehicles

Fen He [3], explained deep learning and its difference with machine learning and then some research is done by various researchers around the use of deep learning techniques in the creation and development of smart cities and pedestrian identification in smart cities and Intelligent Transportation Systems (ITS). Finally, he examined smart transportation and listed the challenges in each of them. In general, according to the studies conducted, the most important challenges in identifying pedestrians on the street using the proposed technologies and methods, especially deep learning techniques, and some of the solutions that seem useful in solving these challenges.

Esteban Moreno [4], has presented a random forest classifier to predict pedestrian crossing intention at a busy inner-city intersection. Using pedestrian features such as position, velocity and heading, provided by a publicly available dataset, and derived features, the model was able to predict crossing and non-crossing intention within a 3-s time window and an accuracy of 0.98. Due to the nature of the dataset used, providing only information related to the trajectory of the tracked pedestrian, detailed features such as body pose or gaze direction that might potentially improve the model performance could not be extracted. In future, this could be improved by building a dataset recorded from a fixed sensor and extracting these features. The authors also conducted a comparison analysis between an RF and a NN showing that the RF outperformed the latter in terms of accuracy and training times.

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Sergio Mascetti [5], Presents Zebra Recognizer, a software module to recognize pedestrian crossings. The requirements of this module were derived from the experience in the development of ZebraX, an application that recognizes zebra crossings, computes the safe path to correctly align and provides audio feedback to guide the user with visual impairment or blindness. This paper shows that Zebra Recognizer can compute the quantified and accurate position of the zebra crossings without incurring into any false positive and with few false negatives. At the same time, Zebra Recognizer is efficient on mobile devices. We are currently working on the other two modules composing ZebraX. The Logic module has two main objectives: first, to keep the information about the stripes position updated by using dead reckoning techniques and, second, to compute a safe path to guide the user towards the crossing. Also, this module could implement a form of spatio -temporal reasoning to track the already recognized zebra crossings between consecutive frames. The Navy gator module interacts with the user and its main challenge is to provide effective audio feedback without distracting the user from the surrounding environment.

XUE-HUA WU [6], Describes a block-based Hough transform is proposed to recognize the zebra crossing in natural scene images. Overlapping blocks are laid on the region of interest (ROI) in each image. For each patch in the block, two processes are performed successively. First, pre-processing is adopted for edge detection, whereas the adaptive thresholding is used to minimize the effect of various shadows. Second, parallel lines detection is adapted to recognize the zebra crossing, whereas the Hough transform is used for straight lines detection. When all the blocks are processed, the angles of parallel lines are averaged to provide the direction of the zebra crossing, and the accumulative scores are synthesized to provide the position of the zebra crossing. The performance of the proposed method is evaluated by testing results based on numerous images.

III. METHODOLOGY

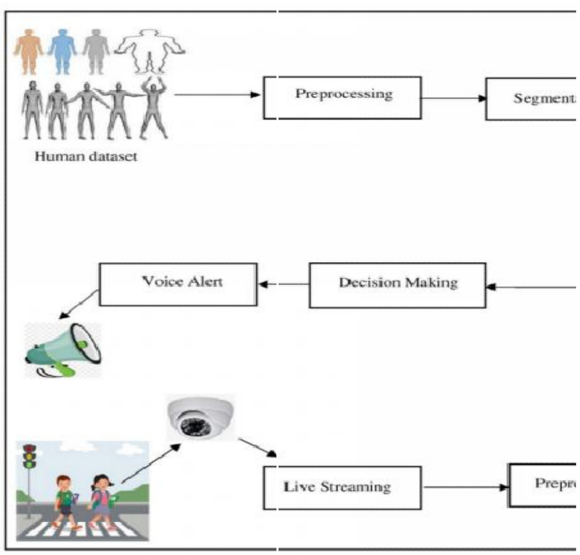

Fig. 1. Block Diagram

Module Description

Module A: Camera, Live image capture

- Instant Frame Collection
- Frame Processing
- Frame normalization
- Extracted Frames

Module B: Convolutional Neural Network

- Input layer initialization

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- Hidden Layer evaluation
- Output Layer estimation
- Trained data

Module C: Preprocessing & Image Normalization ROI Extraction

- Image resizing
- Pixel value normalization
- Image conversion
- Normalized and pre-processed image output

Module D: CNN & Decision Making

- Test Image data
- Model initialization
- If-then rules
- Voice alert to the pedestrians

Proposed Methodology with relevant Diagrams and Figures

DFT Level 0

The DFD 0 diagram for the data flow diagrams describes the flow of the approach. The DFD diagram provides the simplest flow where in the Live Streaming is provided and the pre-processing and decision making implemented and the Voice Alert generation is achieved.

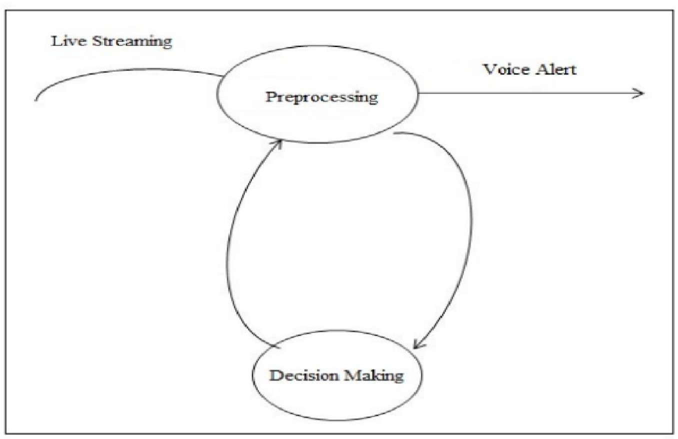

Fig. 2.DFT Level 0

DFT Level 1

The DFD 1 diagram provides even more details wherein the user provides the Live Streaming which is provided for Pre-processing which results in the pre-process list. The X-CNN is deployed through the segmentation by which trained data is achieved decision making is applied and the Voice Alert is achieved.

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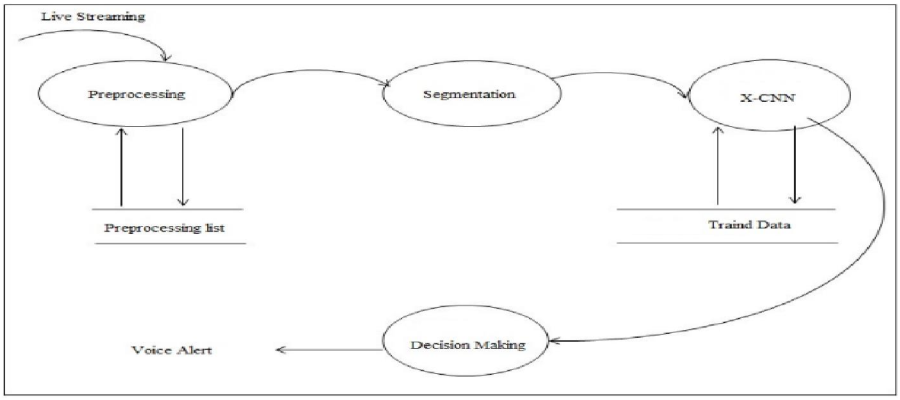

Fig. 3.DFT Level1

DFT Level 2

The DFD 2 diagram is the most detailed wherein the user provides the Live Streaming from which the Pre-processing and pre-process list is generated and Segmentation is utilized and labelling is performed. Then X-CNN is deployed through Segmentation and trained data is achieved then if-then rules is applied to do decision making which achieve voice alert.

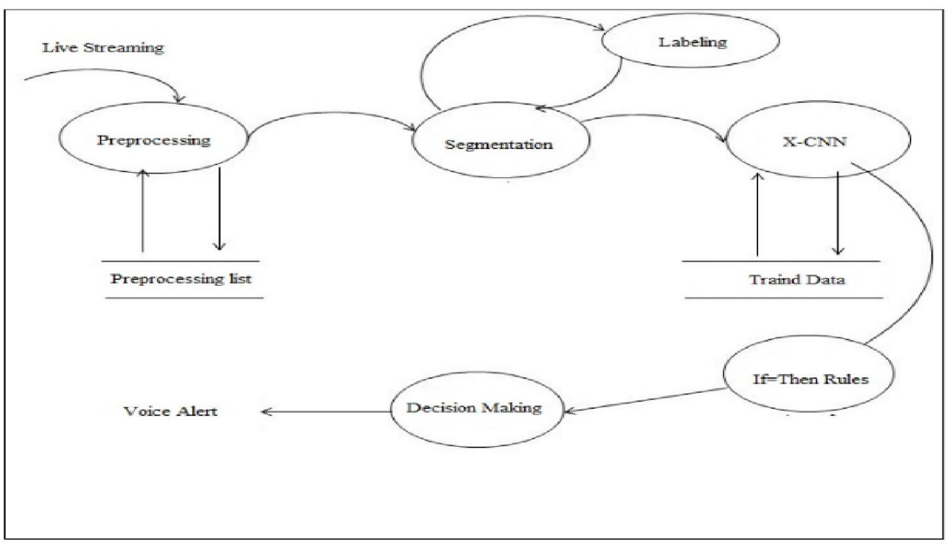

Fig. 4.DFT Level 2

Activity Diagram

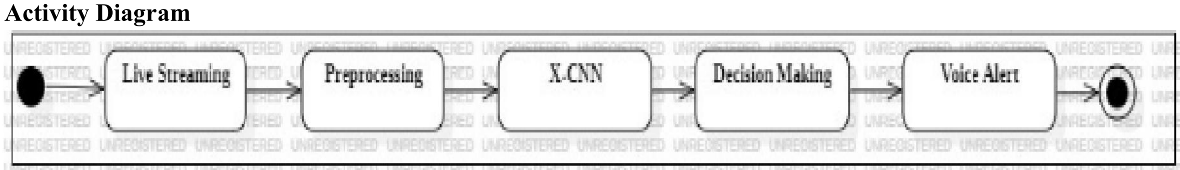

Fig. 5. Activity Diagram

The activity diagram lists the various activities that are performed in the proposed methodology, the start state is initiated and the user provides the Live Streaming, pre-processing, X-CNN, Decision Making which results in the Voice Alert.

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Usecase Diagram

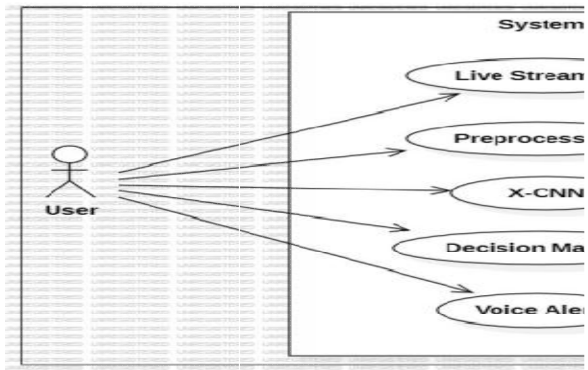

Fig. 6.Usecase Diagram

The Use case Diagram depicts the various use cases that are performed by the user in the proposed model. The use cases include, live streaming, pre-processing, X-CNN, decision making and finally the Voice Alert.

IV. CONCLUSION

The present research focused on the investigation of pedestrians' crossing behaviour at a signalised crossing, which utilised a CST device. More to the point, in the framework of the project, a X-CNN model was developed, which aimed at estimating the pedestrians' crossing speed, by taking into account several characteristics, such as gender, age, the indication of the CST device at several instances, etc. Additionally, an attempt was made to classify pedestrians according to their crossing behaviour, using a trained model, which exploited the input data of the X-CNN model, added with speed data. Results indicated a satisfactory performance from both models. In detail, the X-CNN model showed no overfitting or under fitting, something that signifies an efficient training process. Moreover, according to the MSE metric, which was used for the evaluation of the model's predictive capacity, the pedestrians' speed can be estimated with considerable accuracy.

ACKNOWLEDGMENT

It gives us great pleasure in presenting the paper on "PEDESTRIAN'S CONTROLLING ON ZEBRA CROSSING USING MULTI-LAYER IMAGE" We would like to take this opportunity to thank our guide, Prof. Wawale S. N., Professor, Department of Information Technology Engineering Department, Amrutnahini Polytechnic, Sangamner, for giving us all the help and guidance we needed. We are grateful to him for his kind support, and valuable suggestions were very helpful.

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