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Hospital Waste Segregator using TensorFlow Object Detection Algorithm

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Abstract - Improper handling of hospital waste, leads to various health issues. Present method for segregation of hospital waste is done by manually which may cause health problems such as skin diseases, cancer and infection. Hence proper handling of hazardous waste is necessary, it need to focus on to sustainable healthcare waste material management plans. Solution for this problem is "smart automatic hospital waste segregation". To automate the waste segregation first we need to detect the waste type like bottles, gloves, masks, needles, etc for this system uses application of deep learning, system uses TensorFlow algorithm for detection and classification of hospital waste, system also uses Arduno UNO based system for further segregation of classified waste and through the waste into particular bin. The main purpose is to develop a system which includes hospital waste object detection, classification and automatic segregation, smart intelligent garbage alert system for a proper garbage management.

Key Words: TensorFlow, Garbage Alert, Automatic Segregation.

1. INTRODUCTION

Hospital waste classification and its segregation is one of the primary problem irrespective of the case of developed or developing country. The available method for segregating the the hospital waste is done by manually, which may leads to spread a waste, The main issue in the waste management is that the Hospital waste is collected manually by rag pickers, improper handling of Hazardous waste like used masks, cotton, gloves, plastic bottles, and sharp needles may cause infectious diseases like skin diseases, cancer etc. Another problem is garbage bin at public places gets overflowed well in advance before the commencement of the next cleaning process. It in turn leads to various hazards such as bad odor & ugliness to that place which may be the root cause for spread of various diseases.

To avoid all such hazardous scenario and maintain public cleanliness and health this work is mounted on a automatic waste segregation system. The main purpose of the work is to develop a smart intelligent waste segregation system to avoid manual effort and for a proper garbage management. This system proposes a smart alert system for garbage clearance by giving an alert signal to the municipal web server for instant cleaning of dustbin.

This process is aided by the ultrasonic sensor which is interfaced with Arduno to check the level of garbage filled in the dustbin and sends the alert to the municipal web server once if garbage is filled. An Android application is developed and linked to a web server to intimate the alerts from the microcontroller to the urban office and to perform the remote monitoring of the cleaning process, done by the workers, thereby reducing the manual process of monitoring and verification.

II. LITERATURE REVIEW

[1] Garbage waste segregation using Deep learning techniques- Sai Susanth G, Jenila Livingstone L M, Agnel Livingston L. G. X (RIACT-2020: IOP conf. series: Material Science and Engineering)

In this work, author suggested and efficient way to segregate Hospital waste (garbage) which consists of cardboard, glass, metal, gloves, plastic, trash using deep learning methods and using images more than 400 Plus images for each type of waste. Different models of CNN is used for detection of images models such as ResNet50, DenseNet 169, VGG 16 and AlexNet trained on ImageNet are used to extract features from objects image. Methodology consists of preprocessing of image data augmentation, pre-trained CNN Network and feature extraction after that classifier is used to get a final output. Accuracy by using AlexNet is 83.7, highest accuracy got by using DenseNet 169 that is 92.6% for initial Test-set and 94.9% for accuracy after scrapping.

[2] Application of Deep Learning For Object Detection(I C C I D S 2018) - Ajeet Ram Pathak, Manjusha Pandey, Siddhartha Routaroy

Author gives a overview of many useful applications like robotics, automatic driving system, video surveillance in the domain of computer vision. All these application uses image classification localization and detection using different methods or algorithms in computer vision. This work describes the role of machine learning techniques based on CNN (convolutional neural network) which can be used for detection of objects. Frameworks in deep learning and different services used for object detection are also discussed.

Authors aim to assess deep learning techniques based on convolutional neural network (CNN) for object detection. The beauty of convolutional neural networks is that they do not rely on manually created feature extractors or filters. Rather, they train per se from raw pixel level up to final object categories.

[3] Object recognition and Detection with deep learning for autonomous driving applications- Aysegul Ucar ,Yakup Demir and Cuneyt Guzelis – Simulation: Transactions of the Society for Modeling and Simulation International 93(9)

In this work, Author proposed a hybrid system using both the CNN and the SVM for object recognition and pedestrian detection. In a real environment, the appearance of objects Comparison of single CNN-SVM and the proposed Local Multiple Convolutional Neural Network-Support Vector Machine (LM-CNN-SVM) on the Caltech benchmark pedestrian dataset. Proposed Local Multiple Convolutional Neural Network-Support Vector Machine (LM-CNN-SVM) model and other state-of-the-art models on the Caltech pedestrian dataset. Method Average miss rate (%) ConvNet56 77.20 HIKSVM57 73.39 HOG-SVM6 66 JointDeep58 39.3 SDN59 37.8 MT-DPM + Context60 37.64 DNNSliding61 32.4 DeepCascade62 31.11 Katamari63 22.0 Proposed LM-CNN-SVM-2 30.0 HIKSVM: Histogram Intersection Kernel Support Vector Machine; HOG-SVM: Histogram of Gradient Support Vector Machine; SDN: CNN model including multiple switchable layers; DNNSliding: CNN model applying a sliding window to the image. 766 Simulation: Transactions of the Society for Modeling and Simulation International 93(9) varies due to the variations in light conditions, partial occlusion, the presence of shadows, and surrounding background clutters. In autonomous vehicle applications, this may cause wrong object recognition and object detection, which can lead to dangerous events. We presented a LMCNN-SVM system to handle these challenges in this paper. In our system, we used a pre-trained AlexNet architecture and a new CNN architecture including nine layers. We divided whole images into patches and employed the CNN to extract their discriminative features. Then we applied PCA to the features obtained from the CNN in order to deco-relate and reduce them. Finally, we imported them to the input of the SVM classifiers to increase the generalization ability of the system and, finally, effectively fused the images by using a majority voting rule.

[4] Automatic Health Care Waste Segregation and Disposal System Dr.K.Gayathri Devi, Dr.K.Yasoda , Dr.M.Dhivya, Mr.B.Kishore

Proposed system is application of feature extraction using Gray Level Co-occurence Matrix (GLCM). Dr.K.Gayathri Devi, Dr.K.Yasoda , Dr.M.Dhivya, Mr.B.Kishore designed a system To automate the segregation of the biomedical waste that is generated in the hospital, an automated waste segregator is proposed. GLCM is used for detection of medical waste, disposal system uses conveyor belt to move trash with the help of external motor. The waste will be passed to the sensing unit and Classifier unit. This is implemented with different steps like capturing of input image, pre-processing of that images, Median filtering, contrast enhancement and segmentation. After the completion of these steps, output will be assessed using different feature extracted from Gray Level Co-occurence Matrix (GLCM). After the segregation process it will be automated to the waste bin.

The bin is monitored by a IR sensor, a Water sensor, a gas sensor and an ultrasonic sensor to identify the level of waste. The medical waste segregation is done automatically in order to avoid diseases that spreading in hospitals and to reduce the manual process.

[5] Research on Daily Objects Detection Based on Deep Neural Network - Sheng Ding, Kun Zhao

Proposed system gives application of Deep Neural Network with help of deep learning algorithm. According to Author's Detection of Daily objects are done based on deep learning is faster and more accurate. The main research work is i)Collect a small data set ii) Gather a small data set of daily objects iii) Apply TensorFlow framework to build model for detection of objects. iv) Use this dataset for training of model are upgraded by fine-tuning the model parameters.

Proposed method consists of different functional block like CNN feature, Extraction, RPN, Rol pooling, Regression and classification. Experiments by the authers is done on various models like faster_rcnn_resnet_101 (accuracy = 69.5%), faster_rcnn_resnet_152(72.3%), R-FCN _resnet_101(69.8%), Finetune faster_rcnn_resnet_101(70.1%). This trained model further can be use in different applications like in mobile platform, Nao robot platform or in other smart devices, Hence this model is used to achieve accurate daily objects detection.

III. PROPOSED WORK

1. To design a sensing unit with Ultrasonic sensor and Camera which are used to detect the object and capture an image.
2. To prepare a datasets for each type of hospital waste.
3. To train and test the model with the help of datasets.
4. To apply deep learning algorithm, to detect and classify waste categories like cotton, bottles, syringes, masks, papers and others. The detection and classification of waste is based on TensorFlow algorithm.
5. To segregate the classified waste using Conveyor belt and dc motors.
6. To design disposal unit, segregated waste objects are automated to the Disposal Unit consisting of Arduino, relay, buzzer, GSM, UART and motors.

7. To design display and monitoring unit, waste bin is monitored by a IR sensor, a Water sensor, a gas sensor and an ultrasonic sensor to identify the status. In addition to the above, there are three motors to deposit the waste based on the classification of waste.
8. To interface all above mentioned unit and to automate the segregation process of Hospital waste using Raspberry Pi and python coding.
9. To reduced manual effort and avoid infectious diseases.

IV. BLOCK DIAGRAM

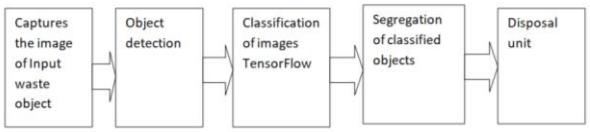

Fig: Block diagram of proposed system

First functional block of proposed system consists of camera to capture the images of hospital waste, before that one infrared sensor is placed to detect input objects. Sensor detects the input waste object and gives signal to enable camera, camera captures the image of object and pc having Object detection software that is TensosFlow, Tensorflow object detection algorithm detects the type of objects, here we used four types of objects Plastic bottles, syringes, mask and gloves. To evaluate the performance of proposed work, this work uses design of simulation model, For Hospital waste Object Detection we are using TensorFlow object detection API to train model and using Faster R-CNN algorithm for implementation.

Set of images taken from Google are taken for datasets to train the model. Here we used more than 400 images for each category of objects. These datasets are further used to train and test the model. After the detection and classification of waste type signal is sent to ardeuno kit which further gives command to start the particular dc motor to further movement of conveyor belt to segregate defined type of waste, system starts dc motor 1 to enable conveyor belt for plastic bottle, dc motor 2 for syringes, dc motor 3 for mask and dc motor 4 for other waste material, by using Conveyor belt through the each type of waste into a particular defined bin.

DISPOSAL UNIT

Result of image classification is given to the hardware of Disposal unit to segregate the waste. Unit includes four containers (bin), ultrasonic sensor, buzzer which is used at the top of each bin to indicate the level of waste material in the bin. Buzzer alarm is connected for giving indication that waste bin is filled.GSM is used to give the message to cleaning authority that bin is filled with waste material ,after getting the message the cleaning authority will empty that particular bin.

V. METHODOLOGY

1: The input image of Hospital waste object captured by the camera
2: The sensing and Classifier unit process the image and classifies the Hospital waste.
3: The waste type is detected by the unit using TensorFlow algorithm.
4: If the system detected the waste as plastic bottle, dc motor 1 will run and it falls to its respective bin.
5: If the system detected the waste as mask, dc motor 2 will run and it falls to its respective bin.
6: If the system detects the waste other than plastic bottle and mask, dc motor 3 will run and it falls to its respective bin.
7: After the segregation process the system will be stopped.

Training of model for Object Detection

In any deep learning algorithm, formation of dataset using lots of image is plays an important role in training and testing model. Dataset plays a vital role since the deep learning convolutional neural network needs a lot of training, testing and validation samples of images. To design the system for object detection of biomedical objects images with varied background were captured which having high clarity. We have taken more than 500 images for each type of object for training and testing purpose.

Dataset must be consists more than 550 images for better result for each type of biomedical waste, after getting these datasets we have to convert that image file into a .xml file. Next stage is to convert file into .csv file. Datasets then distributed into two groups that is for training and testing, so generation of train .csv file and test.scv file is required .now it's time to generate train.record file and test.record file out of which train.record is further used for training the model ,we are using python language for training our model here miniconda version is used. Evaluating model compares the data i.e., trained and tested data and gives the result for getting object location. Hence this way object detection takes place.

Scope

This proposed work provides a solution for different problem like manual segregation, high cost, more required time, also provides automation process to the healthcare industries to detect and classify the medical waste objects by deep learning to further segregation of biomedical waste .This work segregates the biomedical waste like, needles, glucose drip bottles, masks, gloves, cotton, plastic papers and bandages. Proposed work captures the image of biomedical waste using camera, by comparing trained image and actual image system detects the type of waste.

The proposed system enabled with a pre-trained Convolutional Neural Network model (CNN) developed using Python libraries. The processor unit coded in python, python is a high level programming language, needed to process images in real time. The camera in sensing unit captures an image in real time. CNN model is used to identify the objects with boxes and category index. This proposed system is useful to detect and classify the biomedical waste object using python libraries to train model and CNN algorithm for implementation.

VI. CONCLUSION

Training of model for Detection and classification of biomedical waste objects takes place efficiently by using deep learning algorithm, for this here TensorFlow object detection model is used. TensorFlow is very effective, easy, more accurate technique of deep learning for real time object detection. Faster R-CNN algorithm is very fast and having more accuracy for building machine learning object detection model. Training and testing code is in python. This model further can be used as ready to use software to automate the biomedical waste segregator. Training of model required more than 500 images of each objects for efficient classification.

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