Garbage Waste Classification Using Supervised Deep Learning Techniques

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ABSTRACT

The management of solid waste in large urban environments has become a complex problem due to increasing amount of waste generated every day by citizens and companies. Current Computer Vision and Deep Learning techniques can help in the automatic detection and classification of waste types for further recycling tasks. Numerous data-driven methods for solving the problem are investigated in a realistic setting where most of the events are not actual emptying. Machine learning is an area with a huge potential for the transformation of many areas of life and science including industrial informatics. The investigated methods include the existing manually engineered model and its modification as well as conventional machines learning algorithms. This paper presents the use of automated machine learning for solving a practical problem of a real-life Smart Waste Management system.

KEYWORDS: Deep Learning Techniques, Solid Waste, Classification, Management

1. INTRODUCTION

Recent enforcement of law by the Indian government for the welfare of sanitation workers has raised the need for an automated system in waste management. The existing garbage disposal system in India consists of unclassified waste collected from homes which are then segregated at a station manually. This segregation of solid waste done by manual labour can bring about many health hazards for the waste sorters in addition to being less efficient, time consuming and not completely feasible due to their large amount. Waste may be generated during the extraction or processing of raw materials, consumption of final products and human activities. They can thus be classified as industrial waste, clinical waste and domestic waste. Improper disposal of garbage has many hazards affecting all forms of life leading to contamination of air, water and soil and also causes dangerous diseases to human beings. The existing garbage disposal system in India requires manual labour for segregation of its waste. With a population of 1.252 billion people in India, relying solely on the segregation done manually is not healthy. It leads to an unhealthy environment as well as can bring about many hazards for the labourers. Our objective is to bring about an automated process to the existing laborious method where the process is faster, cleaner and does not affect the ecosystem. The biodegradable products must be put to decompose and the rest, recycled. Resources must be saved and they must not be extinguished. A Smart Waste Management system implementing elements of Internet of Things is an enabling technology addressing the challenges of the waste transportation optimisation. It will allow each recycling container reporting its filling
level. The advanced functionality of such a system will enable predicting the expected emptying time of a recycling container, i.e., the time when the container’s filling level will achieve a certain critical value. Filling level predictions will allow avoiding redundant transportation without violating the overfilling requirement. However, the quality of filling level predictions will determine the efficiency of a Smart Waste Management system. There are several technical challenges for achieving a high-quality prediction. Our analysis of an operating Smart Waste Management system revealed that one of these challenges is a problem of an accurate detection of a container being emptied using the measurements from a sensor mounted on top of a container.

2. RELATED WORKS

The prevailing garbage disposal system in India consists of unorganized waste collected from habitats which are then segregated at a station. The segregation is done by manual labour which has many health mishaps for the laborers and is time consuming and also requires financial share to the workers. Uncontrolled dumping of waste on outskirts of towns and cities has created overflowing landfills which are not only impossible to reclaim because of the disorder manner of dumping but also has acute environmental implication in terms of ground water pollution and contribution to Global warming. This has been found to reduce the average life span of the manual segregators. A new concept uses a hardware component that can sort waste at the initial stage thus making waste management more powerful and fruitful. The designed system sorts waste into three different categories, namely metal, dry and the wet waste. A simple 8051 microcontroller forms the heart of the system. It controls the working and timing of all the sub sections so as to sort the waste into the three primary categories. The main disadvantage in the existing system is that, segregation of the waste consumes time. Size of the waste must be less than or equal to the dimension of the funnel i.e. 20cm X 20cm. E-waste, Sanitary waste and medical waste cannot be segregated by the proposed system as there are certain rules and regulations specified by government to be followed for their segregation. It also uses complex hardware components for segregating the garbage. Deep learning is an arising field of Machine learning which is still in its research and mainly aims in bringing machine learning even more nearer to one of its focuses: Artificial Intelligence. Machine learning concentrates on tasks such as recognising the images, converting speech to text, recognition of speech and visual object, drug discovery, face detection and recognition, weather forecast etc. Deep learning techniques are used more in these applications where adaptive learning is done. Deep learning can do cognitive learning such as learning the features, characteristics and attributes with the help of good algorithms which can learn by itself and deep architecture. The family of deep learning has been increasing which includes neural networks, various unsupervised and supervised learning algorithms for recognising feature such as Deep Belief Network, Deep convolutional Neural Network and Recurrent Neural Network and models which represent the probability of the hierarchy. Deep Structured Learning which is also termed as Deep Learning or Hierarchical Learning has risen as one of the fastest growing areas of the methodology is applied to a problem within an area of waste management, which is one of the biggest challenges imposed by the rapid growth of the urban population. For example, in Europe each person is expected to yearly produce six tonnes of waste of materials used in the daily life. An efficient strategy for facing the challenge of the waste management should address several directions including building
a structured process for the waste disposal and maximising the recycling of the waste. When implementing these steps economic and environmental aspects should be taken into account. Waste transportation greatly affects both aspects and its optimisation can significantly increase the positive effects. At the same time, there is a clear requirement that in order to keep recycling stations clean they should be emptied at a right time. It is non-trivial to fulfil this requirement in a scenario with several hundreds of recycling stations (each with several containers) that are spread over a large geographical area.

Machine Learning which focuses on trying to mimic all the tasks that a normal human brain can perform. Deep learning allows processing of multiple layers through the computational models in order to learn data representations with abstraction of many layers. Deep learning uses the back-propagation algorithm to discover complex structures in huge data sets and represents how a machine should vary its inner parameters that are used to determine the representation of each layer from the depiction of previous layer. Deep architecture has networks with multiple layers and the adjacent layers are in some way connected with each other. It is mainly used in solving the problems of representation and classification through constant learning. Perceptron which has some weight combines all the known features for recognising the objects.

Mobile Nets are based on a streamlined architecture that uses depth-wise separable convolutions to build light weight deep neural networks. Mobile Net is a stack of the separable convolution modules which are composed of depth wise conv and conv1x1 (pointwise conv). The separable conv independently performs convolution in spatial and channel domains. This factorization of convolution significantly reduces the computational cost from HWNK²M to HWNK² (depth wise) + HWNM (conv1x1), HWN(K² + M) in total. In general, M>>(K²) (e.g. K=3 and M ≥ 32), the reduction rate is roughly 1/8–1/9.

In artificial neural networks, the activation function of a node defines the output of that node given an input or set of inputs. Activation Functions – Several different types of activation functions are used in Deep Learning. They introduce non-linear properties to our Network. use in the
hidden layer as well as at the output layer of the network. rectified linear unit, and is a type of activation function which the most commonly used activation function in neural networks, especially in CNNs. Allowing models to learn faster and perform better. The relu algorithm has advantages in time efficiency for training and testing. Adam method is used for the optimization process to update the weight on the Convolutional Neural Network. Adam is an adaptive learning rate optimization algorithm that’s been designed specifically for training deep neural networks. Adam combines the best properties of the AdaGrad and RMSProp algorithms to provide an optimization. This method has efficient computation (memory and time), invariant to gradient scaling and suitable when applied to large data or parameters.

4. RESULTS AND DISCUSSION
The results of the proposed works are given below. Table.1.1 depicts the accuracy of CNN model obtained during process of training and testing.

<table>
<thead>
<tr>
<th>Slot</th>
<th>Accuracy</th>
</tr>
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<tbody>
<tr>
<td>First time</td>
<td>63%</td>
</tr>
<tr>
<td>Second time</td>
<td>70%</td>
</tr>
<tr>
<td>Third time</td>
<td>73%</td>
</tr>
<tr>
<td>Fourth time</td>
<td>72%</td>
</tr>
<tr>
<td>Fifth time</td>
<td>75%</td>
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<tr>
<td>final result</td>
<td>79%</td>
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5. CONCLUSION
Keeping our environment clean and ecofriendly so that our next generation lives a disease-free life is a priority. This project aims to support that thought. Cities are becoming increasingly aware of the problems related to conventional methods of waste collection. The existing garbage disposal system in India requires manual labor for segregation of its waste. Currently there is no effective system for segregation of various types of wastes at a household level. The purpose of our project is to make a simple,
low cost and user-friendly segregation system for urban households to waste management process more effective in India. The Automatic waste management system is a step forward to the existing system to make the manual segregation of wastes easier. The developed system would pioneer the work for solid waste management process in the field of Artificial Intelligence. When properly trained, the system is highly efficient. The deep learning algorithm used here has better performance with comparatively less computation time.

REFERENCES


