Smart Cloud Enabled E-Waste Management System

P. Jayarajan
ECE dept, SKCT
Coimbatore, India

S.Thenmozhi
ECE dept, SKCT
Coimbatore, India

R.Maheswar
ECE dept, SKCT
Coimbatore, India

S.Malathy
ECE dept, SKCT
Coimbatore,India

R.Udaiyakumar
ECE dept, SKCT
Coimbatore,India

Abstract - **Electronic waste (E-waste) comprises waste electronics/electrical goods that are useless. This includes computers, servers, monitors, and so on. E-waste contains toxic substances, such as lead and cadmium in circuit boards, lead oxide and cadmium in monitor (CRTs), mercury in switches which are highly hazardous. In this paper, we propose a monitoring system for e-waste dump yards through smart phones. This is an initiative to do things for the wide scope e-waste management. We use the morphological operations in image processing to determine the area covered by e-wastes, which can be monitored by the end user through the dedicated android application.**

Keywords: E-waste, image processing, area and android application

I. INTRODUCTION

In this digital era people become more dependent on electronic gadgets. All of our needs are being satisfied or achieved only with the help of electronic gadgets. Electronic gadgets which are made of numerous integrated circuit chips may cost lesser at times, but they are consuming large amounts of non-renewable resources. This is because the chips are made up of gold, lead, mercury, silicon, etc., which are of high valuable elements. Therefore it is definitely useful to manage the e-wastes so that there are chances for reuse of these precious metals. The generation of e-wastes are now increasing at an alarming rate and the radiations from e-wastes can cause serious genetic disorders among the workers in the collection sites and also to people in surrounding regions.

India, a country of over 1.12 billion people, has witnessed sustained growth rate of over eight percent GDP8 in last few years. Although no definite official data exist on how much waste is generated in India or how much is disposed of, there are estimations based on independent studies conducted by the NGOs or government agencies [6]. According to the Comptroller and Auditor- General's (CAG) report, over 7.2 MT of industrial hazardous waste, 4 lakh tonnes of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, 48 MT of municipal waste are generated in the country annually.

An assessment conducted by the Manufacturers Association of Information Technology (MAIT) Indian hardware Trade Organization state that India produces almost 4, 00,000 tones of e-waste each year [5]. Out of the country's total e-waste only 5 percent is recycled and about 40 percent of obsolete and unused computers and electronic products decay in homes and warehouse. In 2007, India generate 3,80,000 tones of e-waste [3]. Only 3% of it recycled in authorized facilities. By 2012, the e-waste generation in the country is expected to cross the 8, 00,000 tones mark. Two billion PCs are expected to invade our homes and India's mobile subscriber base is expected to touch 450 million by 2015. Due to the absence of any proper disposal system followed in our country, enormous amount of e-waste has been generated in last 60 years. This has lead to the requirement of a proper disposal and recycling system so that the environmental pollution and health hazard is getting reduced. According to the report of UNEP, by 2020, the e-waste from old computer would grow by up to 500% from 2007 levels in India [3] while South Africa and China will witness a 200-400% rise in computer related waste. Due to growth in mobile phone sector in India, the e-waste from discarded phone will grow by eighteen times from 2007 levels. The status of e-waste in different states in India is given in Figure. 1.

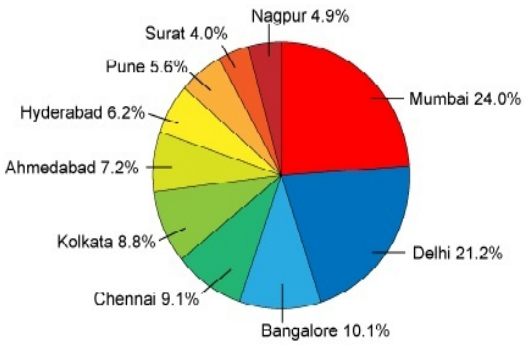

Figure 1: City wise e-wastes generation in India per year

The volume of e-waste is expected to increase by an impressive three to five percent per year as consumers demand more and more "smart" products [2]. About 90 percent of e-waste is end of-life house- hold appliances, IT and communication equipment and consumer electronics. According to earlier studies, Maharashtra, Tamil Nadu, Andhra Pradesh and Karnataka are some of the leading e-waste generating states in the country [5].

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II. EXISTING E-WASTE MANAGEMENT

The developing countries are facing huge challenges in the management of electronic waste (e-waste) which are either internally generated or imported illegally as 'used' goods in an attempt to bridge the so-called 'digital divide' [8]. The existing method for managing e-wastes is to manually collect e-wastes from the sources such as IT organisations, common people, etc. The other way is to segregate the e-waste from other wastes in garbage dump yards. This is done with hands of men at work [4]. As we know the hazards in handling e-wastes, manual segregation and destruction of e-wastes must not be allowed. The government has given some rules and regulations for e-waste management which are to be followed in order to be a legalised e-waste management organisation. Although there are several concerns for e-waste management there is no initiative for an automated technology for managing e-wastes. It's perhaps no surprise that many researchers have already concluded that intensive e-waste processing such as open burning is harmful to the environment and to human health [1].

The statistics provided above are determined for specific size and weight of those devices with the past records and forecasting to the future. Thus as time prolong the consumption of electronic gadgets and generation of e-wastes increase rapidly. A wide scope market is ahead in the future for e-wastes management firms all over the world. So in this project a system for monitoring the e-wastes disposal is developed to assist the management of e-wastes.

In this paper, we tried to develop a system for managing the e-wastes disposal and collection. The predominant way is to go with the sensors to detect the presence and severity of e-wastes. But we ended up in fixing the parameters appropriately to detect the e-wastes either directly determining the e-wastes or through the changes in atmosphere due to e-wastes in large scale. Hence we moved to image processing although it has certain limitations of its own kind.

III. PROPOSED SYSTEM

The proposed system performs the task of analysing an image captured from the e-waste dumping site and provides the area occupied by e-wastes. This is done by invoking a MATLAB [9] program through Task Scheduling and exporting the results of image processing with the date and time and the processed image to the android application target folder in the server system.

The three major sections in the proposed system are

- Field segment
- Server segment
- Network segment

A. Field segment

The field segment consists of several motes which are placed at the required spots in e-wastes dumping site. A mote consists of a wireless camera that has been interfaced to a WIFI router. This camera is deployed with one of the video adapters available in the server system. Upon triggering by Task Scheduling the MATLAB program will make the camera to capture the video stream at that moment.

Using getsnapshot() function a single frame is obtained from the camera. This single frame is used for image processing in server segment. Sometimes the wireless camera may be accessed by the IP address. The IP address is assigned to the IP wireless caners while configuring the router with it. In such cases, the image from that camera can be accessed by reading it with the URL.

B. Server segment

Server Segment is a server where the packets from the Wi-Fi routers of different field segments are received and processed to obtain the necessary information. It also deals with the query and command from the user and android application. This is just a PC that has the connectivity with the Wi-Fi routers and to the internet. The major image processing operations [7] performed in the proposed work are

- Acquiring the image
- Morphing the image
- Obtaining required region
- Calculating area
- Exporting the results

The server segment is the actual process where the core image processing work occurs. The MATLAB program is based on morphological operations to generate binary image from the original image. The generated binary image will have 1's in regions covered by e-wastes and 0's in other regions. Then the pixel density is calculated followed by calibration to give the area occupied by e-wastes in sq.cm. Using the file operation functions the area is moved as a result to a target folder in the system along with the date and time.

C. Network segment

Network Segment has the graphical user interface that facilitates the user to choose among the different field segments and also to access details for current and previous state from each mote.

There are several platforms for developing smart phone applications such as Windows Mobile, Symbian, iOS and Android. In the proposed system, the Android platform app is developed as most of the phones and handy devices support Android OS. Java programming language using the Android Software Development Kit (SDK) has been used for the development and implementation of the application. The SDK includes a complete set of development tools such as debugger, libraries, handset emulator with documentation, sample code and tutorials. Eclipse (running on Windows 7 development platform), which is the officially supported Integrated Development Environment (IDE) has been used

on in conjunction with the Android Development Tools (ADT) Plug-in to develop the application.

IV. APP DESCRIPTION

The purpose of the app is to access the 'DROPBOX' Figure 2,3 folder in the server system through synchronization with the server system dropbox account [10] and display the result as shown in Figure 4. Once the application is opened in a smart phone it will prompt the user to choose among two options.

They are as follows
UPLOAD:
This will allow the user to take images and upload it to the dropbox of server system.
DOWNLOAD:

This will allow the user to access the result files from the server system dropbox folder. Now the user will be asked to choose their desired browser to access dropbox login page, where user must enter the USER ID and PASSWORD of the server system dropbox account. Once the user logged in successfully, the files can be explored.

Figure 2: Android Application Home Page

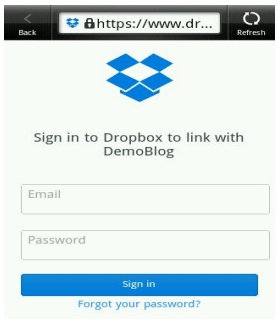

Figure 3: Dropbox Login Page

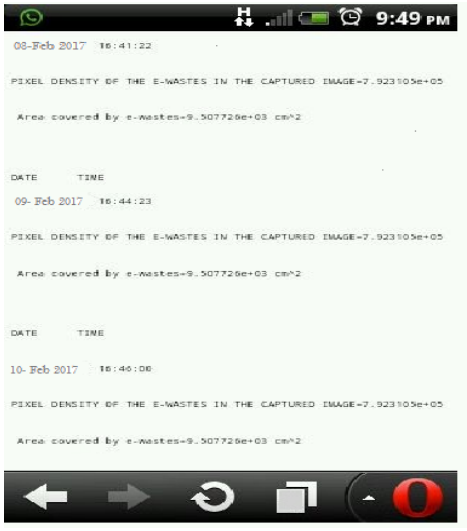

Figure 4: Result Text Document File

V. RESULTS AND DISCUSSION

In this section, the results obtained from image processing are presented with step by step progress in image processing Figure (5-14). The final results in the dropbox folder of the server system and in the smart phone are also presented in Figure 15.

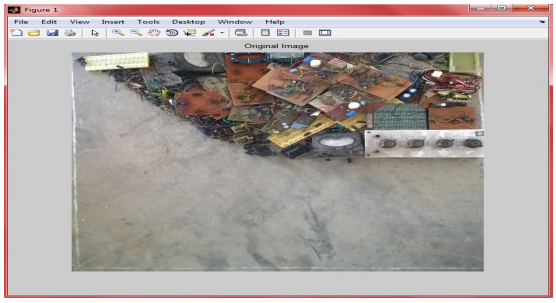

Figure 5: Image to be processed

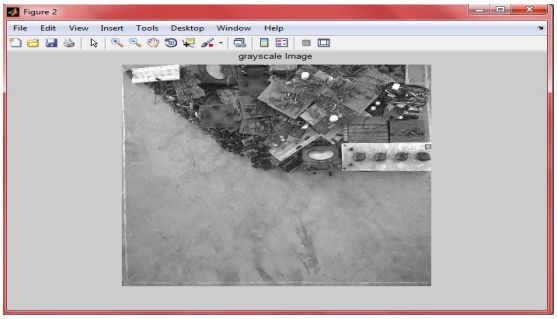

Figure 6: Gray Scale Image

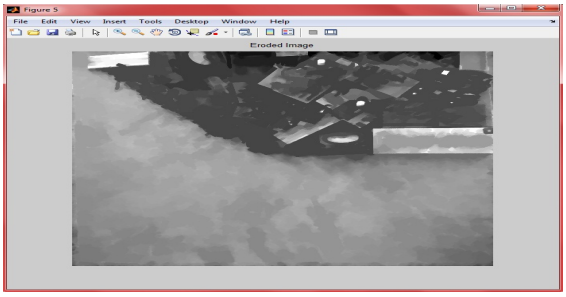

Figure 7: Eroded Image

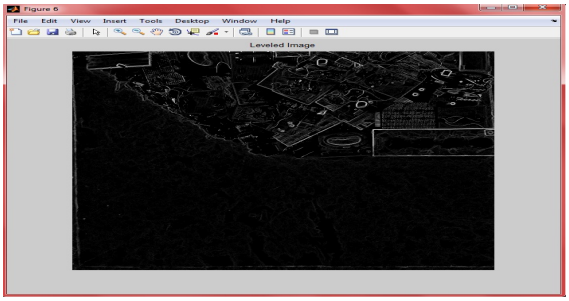

Figure 8: Levelled Image

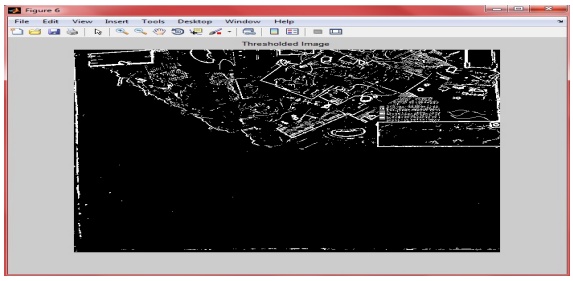

Figure 9: Threshold Image

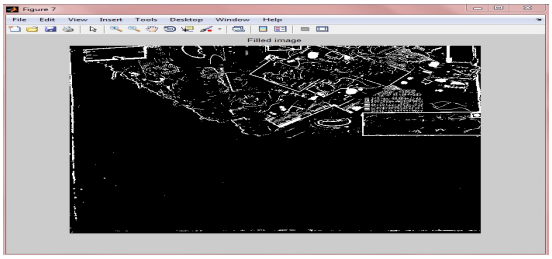

Figure 10: Filled Image

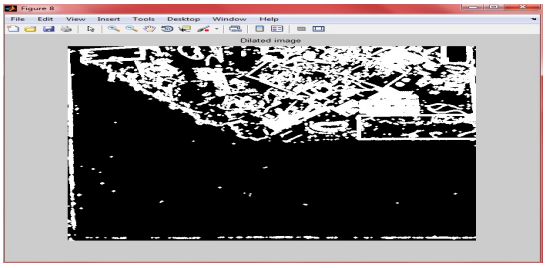

Figure 11: Dilated Image

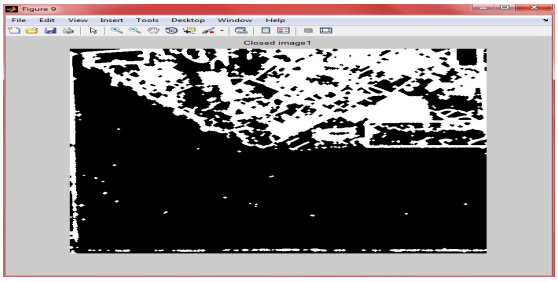

Figure 12: Closed Image

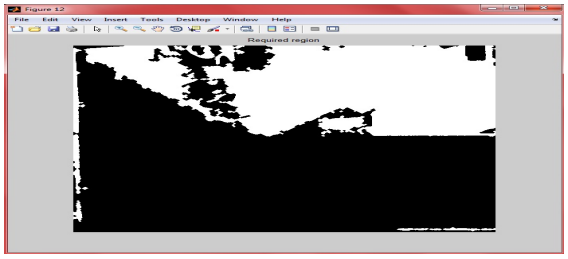

Figure 13: Required Region

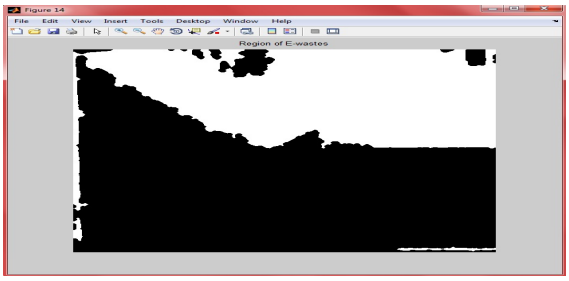

Figure 14: Region of e-wastes

A. *Results in dropbox folder*

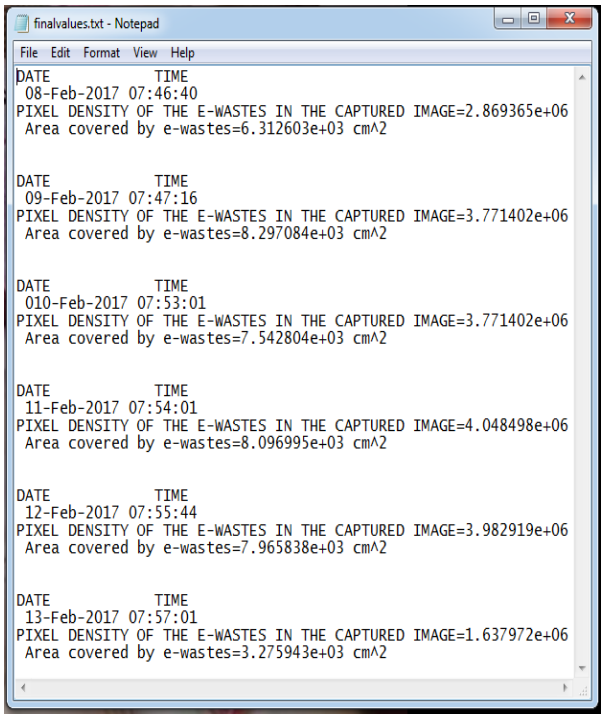

Figure 15: Results in Dropbox File

The captured images from the e-wastes disposal site are thus processed to calculate the area covered by e-wastes in the site. The results obtained from image processing are then exported to the dropbox folder of the server system along with the date and time for periodic monitoring of the disposal of e-wastes. This file can be accessed from the android application in the smart phone by using the same dropbox account as the server system.

B. *Result analysis*

In order to determine the working capability of the project we tested it with several images of known results. These testing images consist of the known amount of e-wastes which increases by 12.5% of the total area in each image. The following table shows the results observed for these testing images.

TABLE I. RESULTS OBSERVED FOR IMAGES WITH VARYING QUANTITY OF E-WASTES

Days	Actual area (cm^2)	No. of pixels covered by e-wastes	Calibration Factor
1	1250	975920	0.0013
2	2500	1212000	0.0021
3	3750	1638000	0.0023
4	5000	2423000	0.0021
5	6250	2869400	0.0022
6	7500	3771400	0.0020
7	8750	3982919	0.0022
8	10000	4048500	0.0024
Mean Calibration Factor = 0.0021			

Now using the above calibration factor we have determined the area covered by e-wastes in different images. It is observed that, the values obtained are not exactly correct with original values but with acceptable tolerance of errors. The area is calculated for all the above images and the following graph Figure 16 will show the increase in amount of e-wastes. To plot the graph it is assumed that in an e-waste dumping area the above used images are collected one on each day.

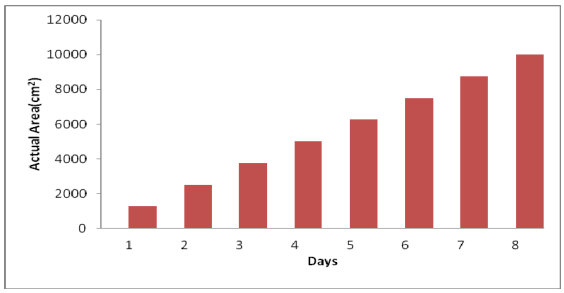

Figure 16: Day vs Area covered by e-wastes

From the above graph it is clear that the proposed system will provide the better approximation of the required information on a larger scale. Using this, the monitor of e-waste disposal can infer the severity of accumulation of e-wastes in a region. The monitor is provided with this information at hand through the smart phone. Hence the approximated results will also be useful to take the necessary steps to manage the e-wastes disposal in the site.

VI. CONCLUSION AND FUTURE WORK

A micro level careless mistake in monitoring making a macro level problem in today's technical world and the consumption of electronic gadgets will damn sure increase rapidly as long as life prevails on this planet. The generation of e-wastes hence cannot be brought under control but its harmful effects can be reduced with proper e-waste management systems. But the controllers may find problems in monitoring because of their distance from the fields. Our attempt is to provide such a prototype and it will provide instant and acute data and using that information we can give proper and timely solution to this issue. Remote sensing of hazardous waste using hyper spectral image processing technique is considered as our future work.

ACKNOWLEDGEMENT

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