A Framework for Developing Social Awareness of the Effect of Plastic Waste on the Environment

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***Abstract*—Plastic is cheap and incredibly versatile with properties that make it ideal for many applications. Meanwhile, plastic can take anywhere from 20 to 500 years to decompose, depending on the material and structure. It is hard to find any other materials that can replace plastic in short findings. The study proposes 4-steps of action for a loop of plastic waste collection by raising social awareness of the hazardous plastic waste to the environment. An experimental portal has been set up for collecting the images of the 4-steps of action labeled with a designed schema of metadata. Social awareness of environmental concerns is experimentally conducted through the 4-steps of action. The resulting labeled image bank is designed effectively retrieving to raise environmental consciousness regarding the use of plastic.**

Keywords—plastic waste collection, social awareness, file uploader, metadata, steramlit

I. INTRODUCTION

Plastic is indispensably used in our modern life, but its widespread use has a high potential in impairing human life sustainability. The production and disposal of plastic goods generate several greenhouse gases and hazardous waste. Plastic and the chemicals it emits are building up on land and in oceans, lakes, canals, rivers, ice, and air, and the resulting damage to human and ecological health is currently poorly understood. In our modern life, plastic is everywhere, from single-use bags, bottles, and packages to car parts, pipes, and kitchenware. It cannot be abandoned in the natural environment which may cause irreversible changes to nature. It is reported by OECD that globally, only 9% of plastic waste is recycled while 22% is mismanaged. It is miserable to mention here that "other non-OECD Asia" countries which include Thailand have a 45% of waste management categorized into the category of mismanaged and uncollected litter, which is the third highest group in the OECD definition [1].

Plastic waste that ends up in landfills leads to the generation of toxic compounds both in the form of gas and leachate, which are environmentally hazardous [2], such as benzene, ethylbenzenes, toluene, trimethyl benzenes, xylenes, and BPA (endocrine disrupting compound) [3, 4, 5]. The hazardous effects of plastic waste on the environment are either in a direct manner or indirect manner. The physical harms caused to marine or terrestrial animals due to ingestion of plastic or entanglement in plastic waste are the direct effect of plastic waste, whereas the indirect effect of plastic waste on the environment is caused as a result of ecosystem alteration (due to debris cleanup) and species invasion (various invasive species move along with the plastic waste from one locality to the other locality) [6].

Hence, it is important that people should be aware of the consequences of plastic usage so that an attempt would be made to minimize the generation of plastic waste. The loop of plastic waste collection is designed stepwise in 4-steps of action (Before, Pickup, Shoot, and After).

The remainder of the paper is organized as follows. Section II raises awareness of social actions on environmental concerns. Section III explains the design issues of the *FileUploader* and metadata. Section IV describes the usage of *FileUploader*. Section V gives the conclusion messages of the efforts.

II. SOCIAL AWARENESS FOR ENVIRONMENTAL CONCERNS

Plastic waste is considered the most hazardous to the environment among the total solid waste generated worldwide. There is a critical need to reduce/reuse/recycle the generated plastic waste. They are durable, strong, lightweight, water resistant, and relatively easy and inexpensive to manufacture. In most cases, it is cheaper to manufacture a new product than to recycle it. Plastic has various potential properties, and it is very difficult to find the best alternative source to replace it [7].

There are several organizations around the world working hard to propagate awareness among the people at the mass level about the problems generated due to the usage of plastic and recommending the minimal use of plastic and/or also suggesting to use of other items as alternatives to plastic. In this study, an attempt is made to discuss the possible ways to conduct an awareness campaign in different parts of the world to realize the disturbance of the plastic waste making to the environment, and practically to experience the environment when the plastic waste is getting rid of. The purpose is to minimize abandoned plastic waste in the natural environment after use.

Practically, the proposal designs a loop of plastic waste collection in 4-steps of action to make people aware of the

environmental recovery after ending plastic waste in the environment. They are:

1. Before:
   Coming across the dirty environment.
2. Pickup:
   Applying an appropriate tool to pick up the plastic waste, and/or preventing leakage into the environment.
3. Shoot:
   Throwing the plastic waste into a proper bin.
4. After:
   Returning to the expected normal environment

Fig. 1 shows an example of a series of images in 4-steps of action.

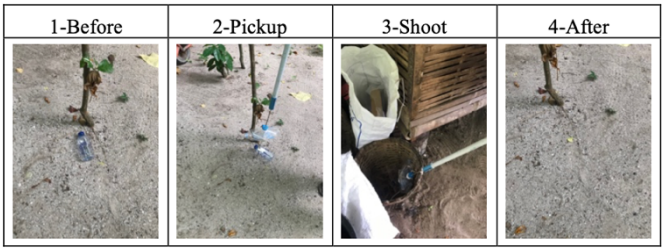

Fig. 1. An example of a series of images in 4-steps of action

To conclude the loop of plastic waste collection, it is important to raise awareness and inspire participation in sustainable practices and clean-up.

III. Design of the FileUploader and Metadata

The portal of *FileUploader* (experimentally hosted at https://upload-m04.vizdata.tech) is developed to facilitate the environmental plastic waste situation sharing. Members are allowed to post a series of images showing the contribution in 4-steps of actions in plastic waste collection, and the images are labeled according to the designed metadata schema. The collected images will be created as an image bank for understanding the effects of plastic waste on the environment. Members participate in the *FileUploader* to make contributions to image bank creation as well as to experience social awareness of the effects of plastic waste on the environment. Several technological tools can be experimented in the process such as a smart bin that recognizes the type of waste and measures the collected amount in any arbitrary location.

A. Framework of FileUploader

Members may make their contribution online connected through the Internet. A centralized image bank in the Google Cloud Storage (GCS) accumulates both raw image files and a thumbnail version of the image files. The thumbnail image files are automatically generated during the uploading process for referring view when needed in browsing.

Fig. 2 shows the processes in *FileUploader*. The web portal of *FileUploader* is hosted in a cloud server. The interfacing framework of *Streamlit* [1] is introduced to manipulate the dynamically updated data visualizations. *Streamlit* is all Python and an open-source app framework for Machine Learning and Data Science teams. It lets you turn data scripts into shareable web apps in minutes

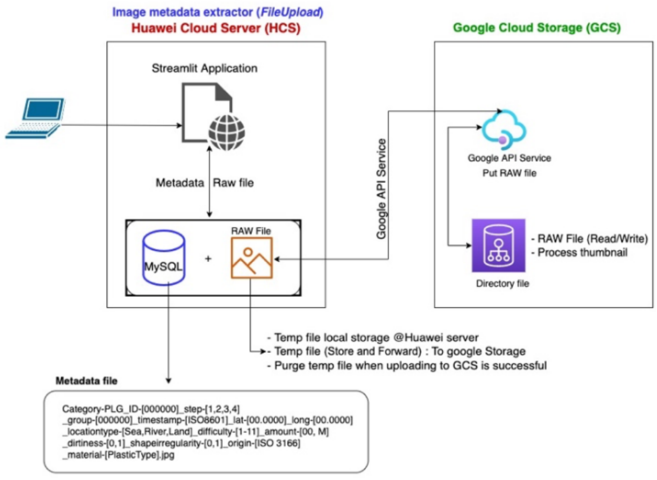

Fig. 2. Processes in *FileUploader*

After deciding the 4-steps of plastic waste collection to share, a member takes a photo of the garbage full image with a lovely background of the environment to post for the step-1. There are no specific clues for location selection. Since the purpose of the program is to encourage social awareness of the effects of plastic waste on environmental pollution, the scene of plastic waste littered in the natural environment is potentially producing a high-risk situation. The appropriate manipulation for waste management in such a situation is highly taken care of. All executable four steps for photo taking are preferred to complete the full loop of actions.

The necessary metadata as described in Subsection B. especially the information in the segment of **[Obligatory]** must be filled in. Some controlled information, such as image ID, and group ID for the step-1 photo, are automatically assigned by the system. To facilitate the member in filling in the metadata, the retrievable information, such as timestamp and location, from the photo EXIF data are intentionally extracted. Photos taken on an iPhone or Android have extra metadata called EXIF data. This includes information like the date when the photo was taken and the camera lens model. Because smartphones have GPS, the photos normally also have latitude and longitude information associated with it. It is recommended to turn on location services and GPS before the program participation. In the case of the iPhone setting, the following is the step to turn on the location services for GPS-enabled photos.

```
Settings > Privacy > Location Services > Camera
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The information in segments of **[Optional]** and **[Garbage information]** are the desired information to elaborate on the detailed condition of the garbage collection process, such as the difficulty of garbage pick up, and the physical state of the garbage, such as the amount, dirtiness, shape-irregularity, origin

[1] https://streamlit.io

and the material of the garbage. Some information such as amount, dirtiness, shape-irregularity, and material, can be heavily relied on in the detection and recognition process of the tools when the collected samples are sufficient for training a model.

The image raw file and its metadata are separately stored in the Huawei Cloud Server (HCS). The metadata is stored in the MySQL database having an external link to the image raw file. The image raw file is temporally stored in HCS until it is successfully uploaded to GCS. The image thumbnail file of the uploaded image raw file is then automatically generated to be managed in the GCS.

As a result, the collection of image raw files and their corresponding thumbnail files is managed under the metadata in the MySQL database. The Google API service is prepared for image file collection downloading together with its metadata in JSON file format. *FileUploader* performs as a metadata formatter for image file collection management which facilitates both file uploading and downloading.

B. Schema of Metadata

Image file metadata is designed to describe the information features of the image. Both dimensions of minimality and informativity are considered to minimize the member burden in the filling process and still maintain sufficient information features for model development.

The schema is structured in three segments, that is **[Obligatory]**, **[Optional],** and **[Garbage information]**. The metadata is assigned in a set of attributes and values, where the value can be a string or an integer. To maintain its compatibility, the values are referred to as the widely used open standards.

In the segment of **[Obligatory]**, the sets of attributes and values are indispensable to identify the image in the loop of the garbage collection process. Except for the system-controlled value of image ID which is automatically assigned, the member needs to fill in the proper values. The value of the timestamp can be extracted from the photo EXIF data if exists. If not, the member can select from the calendar form pulldown menu. The value of the timestamp is expressed in the format of the ISO8601 standard.

In the segment of **[Optional]**, the sets of attributes and values are optional. They are supportive information for identifying the location and generating the candidate list of images for grouping the 4-steps loop of action. By default, the series of actions of the 4-steps must be taken place nearby. The value of difficulty is reserved for estimating the rate of member effort in the loop of garbage collection.

In the segment of **[Garbage information]**, the sets of attribute and value are also optional. The amount shows the seriousness of the problem when the situation is abandoned in the natural environment. The dirtiness and the shape-irregularity are the key information to estimate time duration of the ignorance, in addition to member's effort in managing the garbage. The origin and material information can be extracted from the manufacturing place and product label of the plastic waste. They are reserved to estimate the source of problem. The current targeted harmful types of plastic are seven common basic types of plastic as shown in Fig. 3. Normally, the types of plastic are indicated in the product label which may be filled in by the member from reading the label or automatically recognized by a trained model equipped with an equipment such as a smart bin.

Fig. 3. The Basics On 7 Common Types of Plastic[2]

The total sets of attribute and value are elaborated in the following list together with their possible values and value types.

[Obligatory]

Category-[str]:
type of garbage i.e. PLG=Plastic Garbage

ID-[int]:
image ID in 6 digits i.e. 000000

step-[int]:
step of garbage collection i.e. 1=Before, 2=Pickup, 3=Shoot, 4=After

group-[int]:
group ID of the collection which is the image ID of step-1 of the group

timestamp-[int]:
timestamp of the image expressed in ISO8601
i.e. 20170213T133300Z

[Optional]

lat-[int]:
latitude in decimal degree system
https://www.wikihow.com/Write-Latitude-and-Longitude
i.e. 8.0825552

long-[int]:
longitude in decimal degree system
https://www.wikihow.com/Write-Latitude-and-Longitude
i.e. 98.7423982

locationtype-[str]:
garbage found environment i.e. Sea, River, Land

[2] https://plasticoceans.org/7-types-of-plastic

difficulty-[int]:
level of difficulty, from easy (1) to hard (11) i.e. 1= with g- box in campus, 11= garbage at the cliff

[Garbage information]
indicating the amount, dirtiness, shape irregularity, origin, and material

amount-[int]:
number of pieces or 'M' for Many

dirtiness-[int]:
degree of dirtiness i.e. 0=Clean, 1=Dirty

shapeirregularity-[int]:
degree of shape irregularity i.e. 0=Normal, 1=Irregular

origin-[str]:
origin of the waste expressed in ISO 3166 international standard https://www.iban.com/country-codes i.e. JP=Japan, TH=Thailand, CN=China, KR=Korea

material-[str]:
plastic material referring to https://plasticoceans.org/7-types-of-plastic i.e. PET, HDPE, PVC, LDPE, PP, PS, OTHER

The undefined value attributes are intentionally left blank in the MySQL database. However, when generated to link to the raw image file, the attribute name is a placeholder in the filename.

Fig. 4 shows the prototype of the file name generated from metadata. The sets of attribute and value are delimited by an underscore character '_', and the attribute and value are delimited by a hyphen character '-'. Values indicated in the brackets '[' and ']' are value types defined in the above list. The undefined value attributes are intentionally left blank after the hyphen character '-'.

Category-PLG_ID-[000000]_step-[1,2,3,4]_group-[000000]_timestamp-[ISO8601]_lat-[00.0000]_long-[00.0000]_locationtype-[Sea,River,Land]_difficulty-[1-11]_amount-[00,M]_dirtiness-[0,1]_shapeirregularity-[0,1]_origin-[ISO 3166]_material-[PlasticType].jpg

Fig. 4. Prototype of file name generated from metadata

IV. USING OF *FILEUPLOADER*

The portal of *FileUploader* is experimentally hosted at https://upload-m04.vizdata.tech. Currently, the member accounts are limitedly created for a closed user group (CUG) who intentionally participate in the program.

Page-1 in Fig. 5 is the opening page after the member login. There are two main menus for whether to "Upload File" or "List File". The selected menu is highlighted in green.

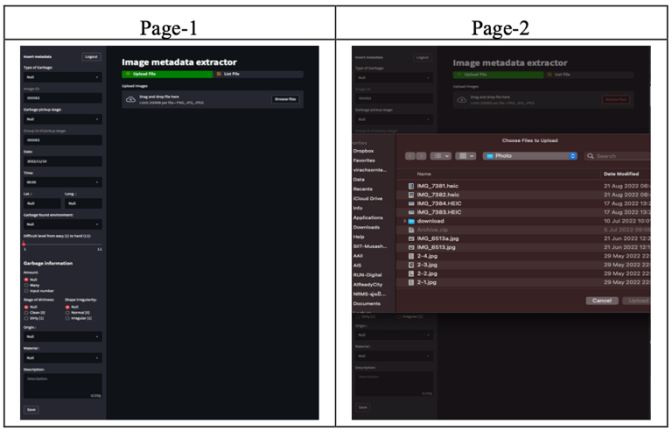

Fig. 5. Image file upload

Page-2 in Fig. 5, the Finder pops up for image file selection when "Browse files" is clicked. Currently, .jpg, .png and .heic files are accepted.

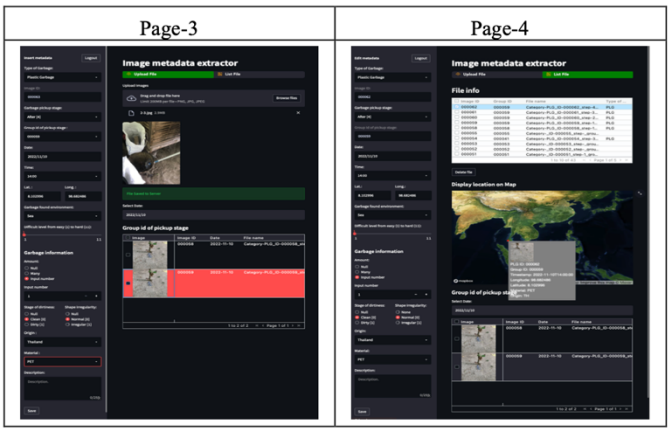

Fig. 6. Metadata and file browsing manipulation pages

Page-3 in Fig. 6 displays the uploaded file and metadata template after the determined file is successfully uploaded. Now, it is time to fill in the metadata. The template for the metadata is provided according to the Schema of Metadata defined in Subsection B. The member confirms on the display the uploaded image file and then fills in the necessary values of the image file. A special treatment is applied to the image defined in step-1, and the image ID is automatically used to create a new group ID for the loop of 4-steps. If the image is defined to other steps than step-1, the group ID of the pickup stage will show the list of candidates of the uploaded step-1 photos in the order of which the closest timestamp and location are.

When everything is confirmed, do not miss clicking on the "Save" button. Now, the image file and metadata are uploaded safely and ready for browsing and downloading.

Page-4 in Fig. 6 shows the mode of file browsing, editing, and downloading when the "List File" button is clicked. The "File info" table shows the list of uploaded image files with their metadata. All fields can be sorted by clicking on the column name, or searched by clicking on the right 3-bars of the column and filling in the keyword of the value names. The Boolean operation of the keywords is also applicable.

Pop up window for file summary information is also available when overlaying the mouse pointer on the red button indicating the location of the image file on the map.

Editing the metadata of the uploaded file can be done one at a time by selecting a file by clicking on the front box of the file. Except for the system-controlled information, any metadata values can be directly edited. After clicking on the "Save" button, the new information will be reflected on the next visit.

For deleting and downloading the selected files from the GCS and HCS, it can be done by selecting the files by clicking on the front box of each file and clicking on the "Delete file" or "Download file" buttons.

V. Conclusion

The practical 4-steps of action for the loop of the plastic waste collection have been proposed to facilitate raising social awareness of plastic waste pollution effects on the environment. The corresponding schema of metadata is designed for building an image bank to facilitate image retrieving to raise environmental consciousness regarding the use of plastic. An experimental portal is set up to serve the image file collection of the 4-steps. To conclude the loop of plastic waste collection, it is important to raise awareness and inspire participation in sustainable practices and clean-up. As a result, the proposed framework will work as a platform for making awareness by encouraging members to collect the images and go through the metadata labeling process. In future work, the framework will be implemented with an activity participation program openly and facilitated by image classification specifically based on the targeted tasks which can be plastic waste awareness, environmental protection, disaster evacuation site instruction, or even the must-see tourist spot or dive site recommendation.

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