

SYSTEM AND METHOD FOR REAL-TIME PARTICIPATORY DATA COLLECTION

TECHNICAL FIELD

5 The present invention relates to a system and method for real-time participatory data collection using sensor data embedded in photos captured from mobile devices and integrated external sensors.

BACKGROUND OF THE INVENTION

10 There has been an initiative to harmonize and integrate databases and information systems for the development of real time statistics to create an effective and efficient management of information for policymaking. In the Philippines, for example, the Interagency Committee on Statistical Information Management and Dissemination (IAC-SIMD) serves as a venue for discussion and resolution of issues relating to the improvement of statistical
15 information management and dissemination. For 2018 to 2023, the Philippine Statistics Authority (PSA) and Department of Information and Communications Technology (DICT) initiated to craft the Statistical Development Program for SIMD. Most of the Philippine data come from the PSA and other government agencies. Traditional databases and registry records are still the main data source in the country.

20 The Department of Science and Technology – Advanced Science and Technology Institute (DOST-ASTI) developed its own mechanism to generate weather and environmental data. In 2017, DOST-ASTI was able to deploy around 2000 weather stations all throughout the country and generated data for the purpose of contributing to the agricultural research,

development, and education for an increased agricultural productivity in the country. Also, the DOST-ASTI implemented the Philippine Earth Data Resource and Observation (PEDRO) Center Project to establish a Ground Receiving Station (GRS) that downloads image data from DIWATA-1 satellite. The PEDRO Center expanded its connection to various satellites for better earth surface data collection. Through these satellites, the PEDRO Center gathers wide range of data for different purposes.

However, given all the sources of data available in the country, there's yet insufficiency of available real-time machine-generated data to perform data analytics that can be an aid to foster economic growth, improve efficiency and coverage of public services, curate data for research purposes, etc. due to lack of available Internet of Things (IoT) system and infrastructure. Furthermore, building and constructing systems, gadgets, and electronics that can sense the environment and other relevant data are costly and strenuous to implement.

Thus, there is a need to develop and utilize mobile and web applications to carve out a niche for a potential big data generation platform and to deal with the challenges on the availability of data sources in the country for research and other purposes, by making use of available sensor data from smartphones and external sensor devices.

U.S. Pat. No. US9977782B2 discloses a method, and device for creating an environment and sharing an experience using a plurality of mobile devices having a conventional camera and a depth camera employed near a point of interest. Random crowdsourced images, depth information, and associated metadata are captured near said point of interest wherein the images include depth camera information. A wireless network communicates with the mobile devices to accept the images, depth information, and metadata to build and store a 3D model of the point of interest. Users connect to this experience platform

to view the 3D model from a user selected location and orientation and to participate in experiences with, for example, a social network.

U.S. Pat. No US9912772B2 discloses a system for automatic transmission of communications between a mobile device and a social networking system is regulated based on the communication mode of the mobile device. A mobile device communication mode switch allows a user of the mobile device to operate the mobile device in one of the two or more communication modes. Communications are transmitted between the mobile device and the social networking environment based on the communication mode of the mobile device.

10 SUMMARY OF THE INVENTION

It is an object of the invention to provide a system and method for real-time data collection using smart phones and external sensor devices. A mobile device captures an image and connects to a plurality of external sensor devices. The mobile device then collects internal sensor data and external sensor data and embeds the collected sensor data in the image header of the captured image. Before uploading to a computer application, (e.g., a mobile or web application) image layout enhancement may be performed by blending the embedded sensor with the captured image in accordance with one or more predefined templates. The computer application catalogs the plurality of the uploaded images. These images are also accessible to other users. It also enables users to manage and interact with the uploaded images, which can be shared to other users.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a preferred embodiment of the system for real-time data collection using smart phones and external sensor devices.

FIG. 2 illustrates a flowchart of the preferred embodiment of method for real-time data collection using smart phones and external sensor devices.

FIG. 3 illustrates data from a smart phone and external sensor devices written in the EXIF of the captured photograph using the mobile or web application.

FIG. 4 illustrates a sample of an enhanced photo (with sensor data) generated using the mobile application.

5 FIG. 5 illustrates a sample of game challenges available to mobile or web application users.

DETAILED DESCRIPTION

The following are definitions of terms as used in the various examples of the present
10 invention.

The term “Generic Attribute Profile” or “GATT” as used herein refers to the way that two Bluetooth Low Energy devices transfer data back and forth using concepts called Services and Characteristics. It makes use of a generic data protocol called the Attribute Protocol (ATT), which is used to store Services, Characteristics and related data in a simple lookup table using
15 16-bit IDs for each entry in the table. A characteristic can be thought of as a type, analogous to a class while a service is a collection of characteristics.

The term “Exchangeable Image File Format” or “EXIF” as used herein refers to a standard that defines specific information related to an image or other media captured by a digital camera. It can store such important data as camera exposure, date/time the image was
20 captured, and even GPS location.

The phrase “blending sensor data with the image” as used herein refers to overlaying sensor data on the layout of the image to augment its properties and characteristics based on one or more predefined image layout templates. These templates allocate spaces for inserting or inputting sensor data to be displayed alongside the image. Thus, blending sensor data with
25 the image allows an at-a-glance overview of the collected sensor data from the captured image.

The IoT has a great prospect in the transportation, supply-chain, environmental, communication, health, and agricultural industries. Despite attempts to develop applications and IoT platforms to gather and collect real-time machine-generated data in the country, authorities face enormous challenges to improve the current systems to make the infrastructure capable of deploying IoT as a whole. In developing countries, people face a lot of problems to have access to communication technologies in terms of poverty, lack of Internet speed, low levels of expertise, and overall lack of infrastructure.

Thus, a solution is to build a cost-effective citizen science application and IoT platform that enables real-time participatory photo and sensor data collection using smartphones and external sensor devices. Photos and sensor data gathered will be used to draw out insights and generate new knowledge and technologies that can be used across sectors.

The present invention provides a method for real-time data collection using smart phones and external sensor devices comprising: capturing an image using a mobile device; connecting to a plurality of external sensor devices through the mobile device; collecting internal sensor data from the mobile device; collecting external sensor data from the connected plurality of external sensor devices; embedding the collected internal sensor data and external sensor data in the image header of the captured image; blending the embedded sensor data with the captured image in accordance with one or more predefined templates for image layout enhancement; uploading the captured image to computer application; cataloging a plurality of uploaded images, wherein the plurality of cataloged images are images by an at least one user; and enabling the at least one user to manage and interact with the plurality of cataloged images.

The present invention also provides a system for real-time data collection using smart phones and external sensor devices comprising: a mobile device, a computer application, and a plurality of external sensor devices for collecting external sensor data. The mobile device is configured to execute the following: connecting to the plurality of external sensor devices;

capturing an image; collecting internal sensor data; embedding the collected internal sensor data and external sensor data in the image header of the captured image; blending the embedded sensor data with the captured image in accordance with one or more predefined templates for image layout enhancement; and uploading the captured image to the computer application.

- 5 Lastly, the computer application is configured to catalog a plurality of uploaded images (i.e., images uploaded by an at least one user) and enable the at least one user to manage and interact with the plurality of cataloged images.

FIG. 1 illustrates a preferred embodiment of the system of the present invention. An image is captured using a mobile device 100. The mobile application 102 connects and interacts
10 to an external sensor device 104 using Bluetooth low energy (BLE) technology. External sensor device 104 can be connected to a smartphone or any mobile device 100 as a plugin, attachment, or accessory. External sensor data are transferred to the mobile device 100 through the GATT profile. The GATT profile is a general specification for sending and receiving short pieces of data known as attributes over a BLE link.

15 Sensor data from the mobile device 100 is collected and collated in the mobile application 102. The data is then processed and embedded to the captured image. The image is then uploaded to the data server 106, web server 108, and application server 110 via a research network 112. The application server 110 processes all transaction and encryption of password during login. The data server 106 stores data and captured images from the mobile application.
20 The web server 108 handles Hypertext Transfer Protocol (HTTP) requests.

Data will be managed and maintained via an Application Programming Interface (API) 114. An API gateway 116 handles requests for web services that can be used to generate models, apply diagnostic analytics, or predictive/prescriptive capabilities.

FIG. 2 illustrates a flowchart of the preferred embodiment of the method of the present invention. An image is captured using a smartphone or mobile device (step 200), which connects with the plurality of external sensor devices (step 202). Internal and external sensor data are then collected by the mobile device and the plurality of external sensor devices (steps 204 and 206). Examples of external sensor data are ambient temperature, Infrared (IR) temperature, luminance, humidity, pressure, and movement (orientation and acceleration).

After the internal sensor data and external sensor data are collated, these sensor data are embedded or written as metadata of the captured image (step 208). This is done by setting EXIF tags using the collated data and saved in the image header. Using the collated data from the external sensors and mobile device, the captured image and its layout can be enhanced by blending the sensor data based on one or more predefined layout templates (step 210). Here, sensor data is fused or blended with an image to augment its properties and characteristics using predefined templates and image processing techniques. Enhanced and formatted images are saved in the local device's repository or gallery. The image together with the collated data can then be uploaded to the mobile or web application and becomes a contribution (step 212). The uploaded image and its associated sensor data are cataloged along with the other images uploaded by other users (step 214). Users can manage personal contributions through a gallery and keep track of all favorite contributions through a collection studio or gallery. Users can also interact with other contributors, search, or filter contributions according to tags/categories, notes, and contributors, and arrange contributions according to relevance, popularity, and time uploaded through the mobile or web application (step 216).

FIG. 3 illustrates sensor data from the mobile device 300 and external sensor device 302 written in the EXIF of the captured photograph using the mobile or web application. Sensor data collected from the mobile device upon image capture are as follows:

- a) Raw photo or image 304;
- b) Image Details 306: Timestamp, Size, Image Resolution, Path, Title;
- c) Location 308: Latitude, Longitude;
- d) Camera Settings 310: Model, Flash, Aperture, ISO, Exposure Time, Focal Length,
5 White Balance;
- e) Environmental Sensor Data 312: Luminance, Temperature, Sound, Humidity,
Pressure;
- f) Motion Sensor Data 314: Acceleration, Rotational Motion, Uncalibrated Rotational
Motion, Gravity, Proximity, Magnetic Field, Uncalibrated Magnetic Field;
- 10 g) Mobile Network Information 316: List of Available Mobile Network in the Device,
Mobile Network Name, Signal Strength, Service State, Network Type;
- h) Wi-Fi Network Information 318: List of Available Wi-Fi Network in the Area, List
of SSID Names; and
- i) Battery Information 320: Battery Level, Temperature, Status, Charging Time.

15 FIG.4 illustrates a sample of an enhanced photo (with sensor data) generated using the
mobile application. Image layout can be enhanced by means of the sensor data 400 captured
using the mobile device and external sensor device. Sensor data 400 is fused or blended with
an image to enhance the layout using predefined templates 402. Images enhanced using the
template 402 are saved in the mobile device's repository or gallery. Users can share and attach
20 the enhanced photo to other photo sharing platforms and applications. In some aspects of the
present invention, users can add new templates and modify the existing predefined templates
through the computer application.

FIG. 5 illustrates a sample of game challenges available to mobile or web application users. A set of activities, processes, and challenges 500 will be available in the application to enjoin users to contribute useful data and photos to the community by using or applying the characteristics of game elements. Every completed challenge and useful data contribution will be incentivized given a corresponding reward 502. A leaderboard 504 will be visible to the community to recognize significant contributors to the community.

In a preferred embodiment of the present invention, the web application can be used to explore and visualize data. Users can mine, search, and filter data for visualization, further analysis, and utilization. Contributions can be viewed through a map from any web browser using mobile and web applications. Reports and summary of sensor data can be accessed through the dashboard. Users can view a synopsis of all sensors and sensor data, contributors, and photograph contributions. Users can also view relevant contributions per location and explore data around the globe through a map. Contributions in the map can be viewed according to the category of contributors—enthusiast, student, or researcher.

In another preferred embodiment of the present invention, a facility to create and manage challenges will be available so users will be enjoined to contribute data. The administrator can add a challenge, define game requirements and guidelines, and keep track of the leaderboard and reward claims.

In another preferred embodiment of the present invention, a user can manage his/her own contribution, interact with other user's photo and data by tagging a specific contribution as favorite, and view all the sensor data embedded in a shared contribution using the mobile or web application.

In another preferred embodiment of the present invention, an API endpoint will be available to authorized users for research and data analytics purposes. Methods and techniques

such as data analytics, AI and machine learning, computer vision, blockchain, and other software technologies can be applied to the data requested via the API gateway.

Claims

1. A method for real-time data collection comprising:
 - a. capturing an image using a mobile device;
 - 5 b. connecting to a plurality of external sensor devices through the mobile device;
 - c. collecting internal sensor data from the mobile device;
 - d. collecting external sensor data from the connected plurality of external sensor devices;
 - e. embedding the collected internal sensor data and external sensor data in the image
 - 10 header of the captured image;
 - f. blending the embedded sensor data with the captured image in accordance with one or more predefined templates for image layout enhancement;
 - g. uploading the captured image to a computer application;
 - h. cataloging a plurality of uploaded images, wherein the plurality of cataloged images
 - 15 are images by an at least one user; and
 - i. enabling the at least one user to manage and interact with the plurality of cataloged images.
2. The method in claim 1, wherein the means of collecting external sensor data from the connected plurality of external sensor devices is defined by a GATT profile.
- 20 3. The method in claim 1, wherein the step of uploading the captured image is incentivized through gamification.
4. The method in claim 1 further comprising providing data analytics and data visualization by the computer application.
5. A system for real-time data collection comprising:
 - 25 a. a plurality of external sensor devices for collecting external sensor data;

- b. a mobile device configured for:
 - i. connecting to the plurality of external sensor devices;
 - ii. capturing an image;
 - iii. collecting internal sensor data;
 - 5 iv. embedding the collected internal sensor data and external sensor data in the image header of the captured image;
 - v. blending the embedded sensor data with the captured image in accordance with one or more predefined templates for image layout enhancement; and
 - vi. uploading the captured image to a computer application; and
- 10 c. the computer application configured for:
 - i. cataloging a plurality of uploaded images, wherein the plurality of cataloged images are images by an at least one user; and
 - ii. enabling the at least one user to manage and interact with the plurality of cataloged images.
- 15 6. The system in claim 5 further comprising a GATT profile for defining the means of collecting external sensor data from the connected plurality of external sensor devices.
- 7. The system in claim 5, wherein the computer application is further configured for incentivizing through gamification the step of uploading the captured image.
- 8. The system in claim 5, wherein the computer application further provides data analytics
- 20 and data visualization.