IoT Based Smart Museum using Bluetooth Low Energy

K. Sornalatha
ME - Computer Science and Engineering
Department of Computer Science and Engineering
Prathyusha Engineering College
Tiruvallur, Tamilnadu, India.

V. R. Kavitha
Head of the Department
Department of Computer Science and Engineering
Prathyusha Engineering College
Tiruvallur, Tamilnadu, India.

Abstract— **In today's world everything is becoming smarter through the development of heterogeneous technologies. To match this smartness, our environment needs to become smarter through a technology that is we called Internet of Things. Nowadays, People are switched to follow our ancient culture. Museum is the one of a place where ancient culture and cultural heritage exist, hence it is considered to make a smart museum. To get the attention of visitor in museum it is being proposed as IoT based Smart Museum Environment which will automatically provide the information about artwork without any user intervention. IoT based smart museum relies on a wearable device(Raspberry PI) that will capture the user's movement, does the background subtraction algorithm to perform Image processing and it gets the localization information from a Bluetooth Low Energy (BLE) which is fixed in the museum. Hence, this wearable device will increase the performance of the whole system by sending only matched frame to cloud processing center. To start with all the artwork and related multimedia contents need to be uploaded to cloud. Finally, everyone can easily access the arts profile and history through smart phone by using the mobile application.**

Keywords— Smart Museum, Bluetooth Low Energy (BLE), Wearable Device.

I. Introduction

Cultural have always expected a basic part in individual lives. Especially a gallery in museum is an establishment that nurtures an accumulation of ancient rarities and different objects of masterful, social, authentic, or logical significance and some open historical centers make them accessible for open survey through displays that might be lasting or transitory. As indicated by the Washington Post, there are 35,000 exhibition halls in the only US. Historical centers like museum are these days a device for diversion such silver screens/theaters and exhibition halls and craftsmanship displays for the most part furnish with paper booklet or human aides. Visits at displays are every now and again saw as debilitating, in light of the way that it is hard for chronicled focus' attendants to get the thought of vacationers. In particular, it is difficult to portray early a visit for every one of the guests, since interests may change from individual to person. Subsequently, a keen gallery should be made for natural and modified chronicled focus visits.

Smart environment plans to fulfill the experience of people from each environment by supplanting the physical work, risky and tedious errands with wearable device. In this perspective, a basic duty can be given by the accompanying Internet of Things (IoT), which incorporates the expansion of the Internet to pretty much nothing and negligible exertion "things" that are thought to acknowledge smart environment with a particular true objective to give new administrations to the clients. IoT hopes to make a predominant world for people, where smart articles around us understand what we like, what we need and act in like way without unequivocal movements. To fulfill this target, the cutting edge world is earnestly fixated on accepting low-control and insignificant exertion embedded advancements in standard items, which end up being real smart object. Considering each one of these considerations, we propose a system prepared to address all the above-depicted issues. More in purpose of intrigue, the course of action showed in this paper engages wearable device, associating with an IoT-based smart environment, to go about exhibition hall guides, giving a real attractive cultural experience. The whole system transforms into a generator of occasions, which can be used to enhance the customer encounter. For example, exactly when a client is before a art, a few inconspicuous components, for instance, title, skilled worker, chronicled setting, and essential overview can be effectively and automatically given. The information can simply not to the overall artistic work furthermore to purposes of intrigue or to the entire room. For instance, particular faces or sub scenes of immense painting or frescoes can be recognized. The social substance could be sent freely to a specific client or made available through sight and sound dividers in the historical center room. The information assembled from the earth could moreover be used for the organization of the entire office by the Museum manager.

To give every one of these components, the client is outfitted with a wearable gadget ready to catch recordings and pictures. The wearable gadget satisfies two essential assignments: it unendingly tracks the customer by using a Bluetooth low Energy (BLE) system and recognizes the artwork in front of the user by using localization information. The consequence of this twofold are sent to the cloud's processing center and that is in control to give every one of the components of the framework. In particular, they 1) Provide

cultural contents to the visitors based on their age 2) communicate information with other users 3) interact with different technologies that controls the status of the environment

II.   Related Work

In the related works, there are a few works tending to the already said issues, yet none of them gives a versatile game plan that can deal with the extensive number of issues in one structure. One of the key elements of the proposition is spoken to by the indoor confinement mindful framework administrations, which right now is a vital and testing research theme. In [1] creators proposed the framework naturally deals with the home environment basing on clients characterized rules and on individual's developments. It permits to effectively portraying the home gadgets and in addition the administrations and UIs. In any case, inconsistence among the standards may occur in this design. A lightweight IoT gadget administration structure [2] gives continuous communication to keen home administrations. The keen electronic guide [3] for historical center utilizing AVR microcontroller and RFID innovation which has the ability giving vocal data to the guests of gallery with respect to every protest in the exhibition hall. This guide gives just sound data to the clients. In [4] creator proposed an abusing a few area based administrations and advancements keeping in mind the end goal to understand a keen multi-media direct framework. It makes fine arts ready to tweet and talk utilizing GPS and Wi-Fi amid clients visit. Vicinity calculation [5] is utilized to speak to and deal with the adroitness inside social spaces. To take care of the issue of indoor spread and to get the high precision, unique finger impression procedure and example coordinating calculation [6] were utilized. RFID per user and tag, and MAC Address method [7] are utilized to interface an exhibition hall's antique particular sight and sound records on the system to keen gadgets. In [8] creator proposes a got flag quality sign (RSSI) based Bluetooth Localization strategy. We can likewise utilize this BLE in particular brilliant environment to discover protest's positions. At last, A Location-Aware Access Control convention [9] is utilized for getting to regions of various get to focuses.

III.   System Architecture

An admin of a museum has the authorization to maintain the museum by keep track the list of all artwork, status etc.., and their history to give a pleasant environment. Firstly an admin of the museum uploads all the images of smart object present in museum hall as well as information content in multimedia format. While entering into the museum everyone provided with one wearable device which will be synchronized with users mobile. The wearable device is cable of doing two things.

1.   Localization Service

Several framework sections depend on the localization service. It involves three primary components: 1)

a base of remote smart object points that occasionally send location details 2) a service introduced on the wearable device that gathers the data of the smart object points to decide its area More especially, the network of wireless points consists of embedded devices equipped with BLE interface and placed in every rooms of the museum. The reason for selection of BLE is its low cost and low energy properties as compared to previous version of Bluetooth. Each devices of BLE environment send its Location Identification together with the transmission power esteem. The service running on the visitor's wearable device gathers area information from every points of territory and then   identifies the room in which the visitor is standing. To do so, it processes a proximity index d, for each area, using the corresponding value of the RSSI. The equation is as follows,

$$RSSI = - (10n\log_{10}d + A) \qquad (1)$$

Where, A - Received signal strength at 1 m, n - Signal propagation constant and d - Distance from the sender.

2.   Image Recognition

Before seeing an artwork, supportive preprocessing steps have to be made. A normal mental self view vision trademark is that the visitor with camera can have speedy head movement, for example when s/he is looking around for something. This prompts high darken in that part of the video progress, which achieves a low quality. Thusly, clearing darkened or blurred artwork from get ready can upgrade the quality and also shield the system from giving the visitor information s/he is definitely not enthusiasm on.

This is done breaking the measure of slop in the picture. An equation that preserves the blur and obscure degree in a frame f has been defined

$$Blur\ (f,\ \Theta_B) = \sum_I \sqrt{\nabla S_x^2(f) + \nabla S_y^2(f)} \qquad (2)$$

where $\nabla S_x(f)$ and $\nabla S_y(f)$ are the x and y components of gradient/slop in frame. A threshold Θ_B, learned by computing the average amount of slop in a sequence is used to discard frames with blurriness.

Fig. 1 shows the overall structure of the proposed system architecture. It is composed of the following three main modules.

A.   Updating Cloud Contents

The museum administrator has login credentials and can upload the arts of every rooms based on the Bluetooth low energy type. We can assign new BLE Id in a particular art works. we can classify room names like (Historical room, Technical rooms etc...) We can update the multimedia content for each artworks with particular room based on BLE id. For each art works the video, audio and the textual information content will be uploaded in a cloud. This interactive media depends on work of art substance and no size breaking point is settled for uploading video, sound, content documents. We can

upload up to n number of sizes. Media content updating depends on room name and after that BLE id. Restriction administration is finished by utilizing Bluetooth Low Energy. BLE is chiefly utilized for recognize the area by collaborating with close-by gadgets or web associated gadgets. Every room is infrastructure with Bluetooth 4.0 and each has identity number. Based on this number, the wearable gadget will recognize the user's position in a museum hall.
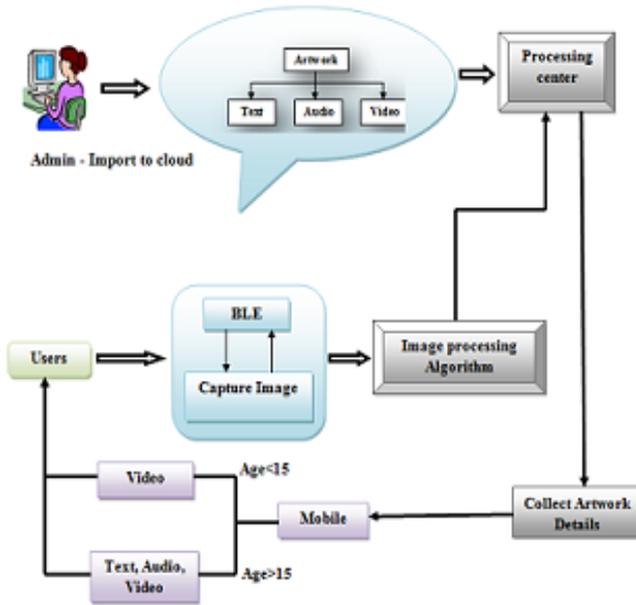

Fig 1 - The overall structure of the system

B. Image-processing

It is dispersed between the wearable gadget and the cloud's processing center. The principal we can identifies the present client's position and conveys it to the processing center. To aware android device, wearable device must pair with the user's mobile device through which users can get information about artworks. The information is also used locally to speed up the image-processing algorithm. It can rapidly examine the video outlines caught by the wearable gadget and distinguish the objective protest with high precision. We are utilizing background subtraction algorithm which recognizes moving articles from the segment of a video edge that varies fundamentally from a foundation display. An image's foreground is extracted for further processing. The output of the image processing is then sent to the cloud server.

C. Artwork content Delivery

It is the center of the business rationale. It gets to in the Cloud, get pictures from work of art and after that contrasting with specific art afterward cultural contents required by the users / visitors and smartly provide such contents on several interactive platforms. At that point, it permits the execution of a location aware service by giving them with the positioning information coming from the localization infrastructure. These

administrations enhance the social experience of the clients by drenching them in a real smart intuitive. To get an artworks document like that audio, video, text, to proceed given user mobile device. User can see the given artwork media content.

IV. Results and Discussion

The artwork / image recognition method was tried on the real and unconstrained dataset procured with a head-mounted camera at MUST exhibition hall, Lecce, Italy. The dataset contains more than 2000 casings at 640×480 resolution commented on with the current noticeable works of art and their room area. These frames are represents a testing arrangement portrayed by various works of art, and blur because of movement. The recognition ability was assessed as far as recognition exactness also, review, and arrangement precision. The initial two measurements speak to the recognition ability: a high exactness implies that frames containing artwork are accurately distinguished, though a high review implies that few frames containing works of art are missed. The precision metric measures the coordinating execution, indicating what number of craftsmanship are accurately characterized. Since the proposed strategy depends on two distinctive thresholding steps, the outcomes concerning identification and recognition are demonstrated independently.
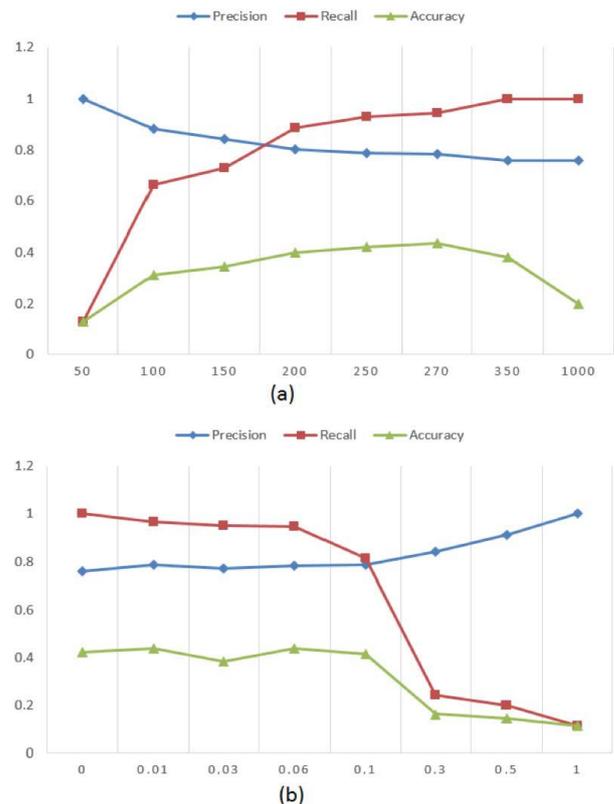

Fig 2 - Precision, recall, and accuracy of our painting recognition solution under different threshold values: (a) θS and (b) θD.

This permits breaking down how diverse qualities can impact the exhibitions of the proposed approach. At last, considering the granularity of a room, the right guest's limitation has been tried in two distinct cases. In the first place case, alluded as best case, the BLE gadgets portraying the limitation framework have been set on the parcel divider between the two rooms, with the goal that they are not in line of sight of each other. In the second case, alluded as most pessimistic scenario, the gadgets have been set in observable pathway at 5 m from the isolating entryway. Moreover, the proposed framework is battery controlled, and decreasing the measure of calculation required in every edge can significantly enhance the battery life taking into account longer visits.

As highlighted by the state of-craftsmanship examination proposed in Segment II, not a lot of arrangements address the issue of passing on tweaked content in the midst of an exhibition hall visit. To give an examination between the proposed framework and these arrangements, particularly Smart Museum and Museum Wearable a delineation of the got advances is at first given. Since a key part of every keen historical centre system is the ability to take after the traveller amid their visit, each one of the arrangements inspected around there manhandle adaptable advances. Either PDAs or wearable gadgets are used remembering the ultimate objective to give the visitor a little and light-weighted gadget. Past this fundamental component, the broke down models exhibit significant complexities in the advances relegated to recognize fine arts, restrict the client and execute correspondence. Furthermore, they give particular additional administrations to clients. The engineering showed in this paper has a couple of similitude to the beforehand said approaches, however demonstrates some basic complexities. All arrangements rely on upon cell phones and are fit for giving tweaked information in light of a couple of sort of area mindfulness. Taking all things into account, these components ought to be the inside parts of any savvy gallery gadget capable of propelling a guest's involvement.

v.   **Conclusion**

In this paper, an indoor location aware architecture for smart museum was composed. The proposed framework depends on a wearable device outfitted with image recognition and confinement capacities to automatically furnish users with cultural contents identified with the observed arts. The ability to identify the user's position is guaranteed by an infrastructure of BLE transmitters. The design likewise comprises of a handling focus, where the real business rationale is in control to: 1) access from the Cloud the cultural information identified with the observed artworks and 2) oversee the status of the indoor environment in understanding to users' position. The framework gets the Cloud to store interactive media substance created by the user. Finally, Users can get the information in an attractive format based on their age.

References

[1] Mainetti, V. Mighali, and L. Patrono, "A location-aware architecture for heterogeneous building automation systems," in IFIP/IEEE International Symposium on Integrated Network Management (IM), May 11–15, 2015.

[2] Thinagaran perumal,Soumya Kanti Datta and Christian Bonnet, "IoT Device Management Framework for Smart Home Scenarios" in IEEE 4th Global Conference on Oct.2015.

[3] Majed Rostamian , Maryam Parsa and Voicu Groza "Design and fabrication of a smart electronic guide for museums" in IEEE Transaction on Applied Computational Intelligence and Informatics (SACI), 30 July 2012.

[4] Angelo Chianese , Fiammetta Marulli , Vincenzo Moscato and Francesco Piccialli "SmARTweet: A Location-Based Smart Application for Exhibits and Museums" in IEEE Transaction on Signal-Image Technology & Internet-Based Systems (SITIS), 30 January 2014.

[5] Angelo Chianese and Francesco Piccialli,"Designing a Smart Museum: When Cultural Heritage Joins IoT" in IEEE Transaction on mobile Apps, 15 December 2014.

[6] Sisongkham Phimmasean and Somphone Kanthavong "Smart tracking system applied for Lao's museum using RFID technology based on fingerprint technique" in IEEE Transaction, September 2016.

[7] Ashish Mody , Muneeb Akram, Kamruzzaman Rony , Muhammad Sajjad Aman and Ridha Kamoua "Enhancing user experience at museums using smart phones with RFID" in IEEE Transaction, May 2009.

[8] Zhu Jianyong, Luo Haiyong, Chen Zili and Li Zhaohui "RSSI based Bluetooth low energy indoor positioning" in IEEE International Conference on Indoor positioning and Navigation, 28 September 2015.

[9] YounSun Cho, Lichun Bao and Michael T. Goodrich "LAAC: A Location-Aware Access Control Protocol" in IEEE Transaction on Mobile and Ubiquitous Systems.

[10] Deivid A. Tesch , Everton L. Berz and Fabiano P. Hessel, "RFID indoor localization based on Doppler effect" in IEEE Transaction on Quality Electronic Design, 16 April 2015.