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Smart Artifact Tag:
Disseminating Encapsulated Knowledge through IoT

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Abstract

Like other knowledge systems a museum also generates, store and dispense various kind of information related to different aspects of a museum. Such information could be voluminous depending upon the size of the museum and so is very difficult to manage for both museum staff as well as the museum visitors. While presenting such information through the showcases, it is a challenge to keep a tap over the dispensing of correct artifact information. Moreover, dissemination of the contextual information to the 'needy' person is also a challenge because bombarding a museum visitor with administrative information is useless and moreover risky. Similarly, providing too much artifact information to a casual museum visitor is useless as it will only result in congestion of network. This paper starts with addressing such kind of lacunas in a museum and how it could be resolved by the implementation of RFID and IoT technology. The paper instigates an innovative idea for 'Technology in Museums'.

Key Words : Knowledge, Museum, Dispense, Voluminous, Lacunas, Implementation, Technology.

Introduction:

Knowledge, through information constitutes a significant component of our life. May it be information related to academics, professional courses, medicine, technology, research, transport, entertainment, food-joints or anything related to our daily life. Heritage institutions like museum which provides entertainment as well as education to us, is no exception to it. Museums themselves are sources of vast information which is not only related to artifacts but also comprises of information generated by visitor's feedback, administrative procedures, intra and inter-museum communications etc. Thus, a variety of information is associated with a museum. Further, it must also be understood that not every information is useful or required by every person in a museum. Another important aspect of museums is information related to the artifacts and their representation. With such a wide domain of museum information, it will not be a rightful approach to address every aspect of museum information in this single paper. Having said that, the focus of this paper has been narrowed down to 'artifact information' and its representation through 'Smart Artifact Tag' only. While the former address the critical aspects of artifact information like genuineness and apprehensibility, the later addresses the innovative issues like easy and categorized dissemination of artifact information by using technologies like – Internet of Things (IoT). This paper is an extended version of one of the 11 recommendations that I have suggested

and explained in my Ph.D. thesis work, and will certainly be very useful for the museum professionals like museum directors, curators, museum technologists and IoT experts in procuring new ideas that will pave the way for further research and productive inventions.

Artifact Information

The term 'Artifact Information' refers to the various kind of information associated with an artifact in a museum after it has been added officially into the museum's collection. Such information can be classified into three basic categories, which are:

i. Basic Information: which comprises of primary information such as accession number, date of manufacture, date of acquiring the artefact, place of acquiring the artefact, person from whom the artefact has been acquired, mode of acquiring etc.
ii. Academic Information: which comprises of the historical information related to the artefact, its authentic identity with lucid description.
iii. Conservation History Information: which comprises of information and images related to all the conservation treatments to which an artefact has been subjected over a period with full details including the position of artefact before conservation and after conservation, chemicals (if any) used, method used, person responsible etc.

Besides, the aforesaid information a museum also provides a brief information about every artifact which is on display for the museum visitors. Representation of such information is done with the help of – Labels, and the process as labeling. Though, it appears a simple task but in fact it is again one of the most significant aspects of museum activity and needs to be handled with proper responsibility, failing which it will cast a poor show for the visitors. Some of these observed cases have been discussed here:

CASE – 1: The enclosed picture – shows a showcase without any artifacts and with vacant placeholders while the second showcase exhibits unlabelled and unexplained items just piled like storage. – Enclosed author's images (figure - 1 & 2).

Figure 1 - Showcase with labels &without artifacts

Figure 2 - Showcase without labels & with artifacts

CASE – 2: In the following picture, numbering-label 1 and 9 are missing from the items display, though they have been mentioned in the 'description card' (kept below). Label 6 and 7 are wrongly labeled. – Enclosed author's images (figure - 3&4).

Figure 3 - Showcase with wrong labeling.

Figure 4 - Mismatched & wrongly labeled showcase

CASE – 3: In the following case of a museum showcase, two similar artifacts have been kept and labeled as "Alam ka Panjā". The phrase 'Alam ka Panjā' is in Hindi language and could not be understood by any foreign tourists. Further, the meaning can only be understood by the Muslim community as this object is being used on the occasion of their Muharram procession, so no non-Muslim or foreign tourist will have any idea as to what is 'Alam ka Panjā' and therefore just

labeling the object as 'Alam ka Panjā' will not make any sense for the museum visitors. A brief description is very much required for such artifacts. This is not one case but many artifacts that belong to different communities and religion like Buddhist, Jain and Hindu and different sects of Hinduism etc. also needs a lucid explanation which is not found in most of the cases. – Enclosed author's images (figure - 5).

Figure 5 - Label not depicting a clear meaning about the artifact

CASE – 4: The following picture is a realistic case of a museum where an artifact has been tagged as 'Cannon of Sirohi State'. Looking at the image reveals that it is not a 'cannon' rather it is a World War – I machine gun (either of Maxim MG08 or Vickers model). – Enclosed author's images (figure - 6).

Figure 6 - A label depicting wrong information

The four cases discussed above are few of many such cases where the showcase artifact information is either not displayed or wrongly displayed or displayed in an incomplete manner or completely vague or ambiguous manner. Representing the artifacts in such manner not only creates a bad impression about the museum and its intellect status but also spoils the 'Word of Mouth (WOM)'. Further, it also makes a museum as untrustworthy source of information for research personals as the genuineness of information becomes questionable. Having said that, it is an important responsibility of every museum to serve the visitors with precise and truthful information and so this task needs a dedicated team of scholars who not only prepare the labels for museum objects but also develops the historical details of museum artifacts using proper references.

Categorization of museum visitors

Another aspect, worth discussing is catering to the information requirement of museum or heritage site visitors. In many cases it has been observed and experienced that the museum infra and museum staff is unable to provide a lucid explanation about artifacts/places to the visitors who shows interest in the museum collection or are from academic background. With such phenomenon happening repeatedly, such kind of visitors lose their interest in museums and heritage places which ultimately causes indirect damage to the industry. This damaging effect is further amplified for the research scholars, as due to the lack of information providers they have no clue as from where to get authentic information. The observations under the research conducted, clearly shows that on the basis of 'importance of information', the museum visitors could be classified into four categories. They are:

A. Casual or uneducated museum visitors, for whom information hardly matters as they just see an artefact and pass by without reading it.

B. Museum visitors, who see the artefacts and read their respective labels.
C. Museum visitors who see the artefacts and read their respective labels and are still curious to know more about them.
D. Museum visitors consisting of students and research scholars who come to study and know various kind of details about a specific or a group of artefacts or all artefacts.

The visitor's categorization mentioned above clearly reflects that importance and need of artifact/heritage information differs person to person. Therefore, it is necessary to identify and classify the significance of information according to the profile of the people visiting the museum. The advantage would be when a particular category of visitor walks in a museum, s/he is provided with relevant information. This could be done with the help of IoT based RFID tags. In order to understand and appreciate the concept a basic understanding of IoT and RFID is required and so a crisp explanation of both is provided as under.

IoT and RFID

The term 'IoT' stands for 'Internet of Things' which comprises of two words 'Internet' and 'Things'. Internet as we know have become an integral part of human population as now it defines and dictates many important functionalities in human life – from medicine to manufacturing to education to home automation. In laymen language, it is defined as network of networks which means computers and its accessories are connected to each other, forming a network and further this network is connected to other such networks globally for intra and inter communication and exchange of data & information. Thus, the basic definition of Internet goes as:

> "*A collection of interconnected networks is called an internetwork or just Internet.*"[1]

> *"The term – IoT, was coined in 1999 by Kevin Ashton while he was working at MIT Media Centre."*[2]

Previously, internet was confined to computers and other computing devices only. However, the last two decade witnessed a scope-extension of the internet whereby it encompassed other non-computing objects as well. These non-computing objects are called 'Things' in the phrase 'internet of things', which may comprise of pen, stapler, watch, comb, shoes, raincoat, glucometer etc. Now, these physical objects cannot do any work unless they are fitted with some electronic gadgets that can perform three basic functions like:

a. Perform the task of observation

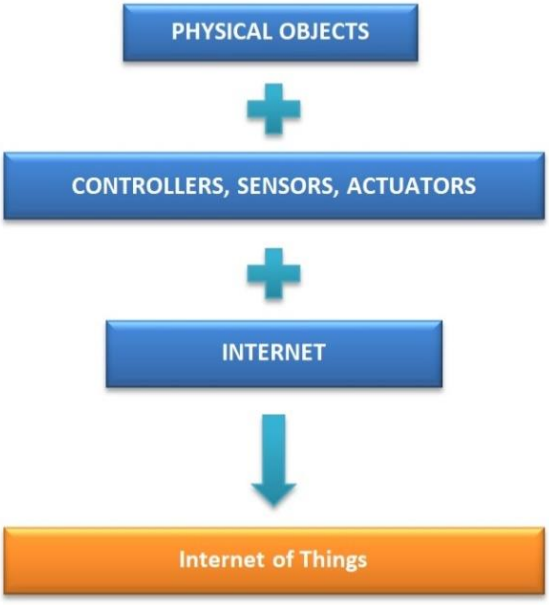
[1]Tanenbaum, A. S. (1996). Computer Networks (Third Edition). Prentice-Hall of India Pvt. Ltd., New Delhi. p16
[2]Norris, D. (2015). The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and Beagle Bone Black. McGraw Hill, New York. p.1

b. Analyse the situation on the basis of observed data
c. Taking the decision and acting accordingly.

Having said that, the task of observation is done by 'Sensors', the task of analyzing the situation on the basis of observed data is done by 'Controllers' and finally the task of taking decisions and acting accordingly is done by the 'Actuators'. For example: A household vacuum cleaner is a general commodity for cleaning the dust and dirt but when fitted with a computing device can yield useful information like – total square feet area cleaned, total time for which it has been used, amount of dust/dirt collected, amount of empty space left and even about the dust/dirt component. So, Internet of Things (IoT) is defined as:

> "*Internet of Things is the network of physical objects or 'things' embedded with electronics, software, sensors and connectivity to enable it to achieve greater value and service by exchanging data with the manufacturer, operator and/or other connected devices. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure*."[3]

The working of these component scan be summarized with the help of the following equation diagram.[4]



[3]Kamal Raj. (2018). Internet of Things: Architecture and Design Principles. McGraw Hill Education (India) Pvt. Ltd. p2
[4]McEwen A. & Classically H. (2014). Designing the Internet of Things (1st ed.). Wiley India Pvt. Ltd., New Delhi. p11

RFID stands for Radio Frequency Identification. It is a wireless technology which is used to read or capture data. The RFID system comprises of two components – RFID tag and RFID reader. The RFID tag contain a code which gives a unique identification to an object and in addition it also contains data or information related to an object. The tag is then fixed to the object. When someone carrying the RFID reader comes near the vicinity of the object, it checks for the identification of the reader and on finding it valid, dispenses the information. However, if there is an identification mismatch between RFID tag and RFID reader, then the RFID reader won't be able to read any information from the RFID tag. The data and information transfer takes place through wireless mode so no wiring is required. Further, the data and information stored in RFID tag are transferred in an encrypted manner (using various algorithms) so it is secure and cannot be manipulated.

Smart Artifact Tag

RFID system (tags + readers) are now very common in museums and are extensively used in museums of countries belonging to almost all major populated continents. Currently, the RFID system is associated to location tracing, security and imparting artifact information to the museum visitors. Focusing on the later i.e., 'imparting artifact information to the museum visitors', it can be observed that not every bulk of information carries equal weight age for every museum visitor. This has already been discussed in the section above – *Categorization of museum visitors*. For example: bombarding museum visitors of category A & B with bulk of information related to every artifact goes in vain as neither they can understand nor they are interested in reading/listening to so much of information. Similarly on the other hand, providing museum visitors of category C & D with scanty information will not serve their purpose of knowing about the artifact in detail. Therefore, it is best that the dissemination of information is categorized on the basis of the profile of museum visitors thereby reducing the unnecessary load on the wireless network thus keeping it steady in performance. This can be achieved by '*Disseminating Encapsulated Knowledge through IoT*', which means that the museum visitors category is classified into three categories:

1. Category-1 consist of category A & B i.e., casual or uneducated museum visitors, for whom information hardly matters as they just see an artefact and pass by without reading it and Museum visitors, who see the artefacts and read their respective labels.
2. Category-2 consist of category C i.e., museum visitors who see the artefacts and read their respective labels and are still curious to know more about them.
3. Category-3 consist of category D i.e., museum visitors consisting of students and research scholars who come to study and know various kind of details about a specific or a group of artefacts or all artefacts for their thesis or project.

Now, on the basis of these three categories, the artifact information could be encapsulated in a way that when a category-1 visitor approaches the artifact in a museum s/he is provided with basic

information about them. Similarly, when a category-2 visitor approaches the artifact in a museum s/he is provided with basic information and additionally a FAQ (Frequently asked questions). Further, when a category-3 visitor (researcher) approaches the artifact in a museum s/he is provided with complete academic data and information assisting in his/her research work. So, it can be realized that the network is not unnecessarily burdened with data and information which if unchecked may lead to network congestion, making the visitors dissatisfied. For example: for a category-1 visitor, a display of Raag-Raagini painting may not have much significance or interest whereas for a category-2 visitor it may draw such interest that s/he goes for the FAQs or may ask queries to gallery-in-charge. Similarly, for category-3 visitor (researcher), who is researching the topic of Raag-Raagini painting, the display and its detailed information would be vital and of greater interest. Having explained that, the question arises as to how to disseminate this encapsulated knowledge? This is explained in the following section.

Smart Artifact Tag: The working

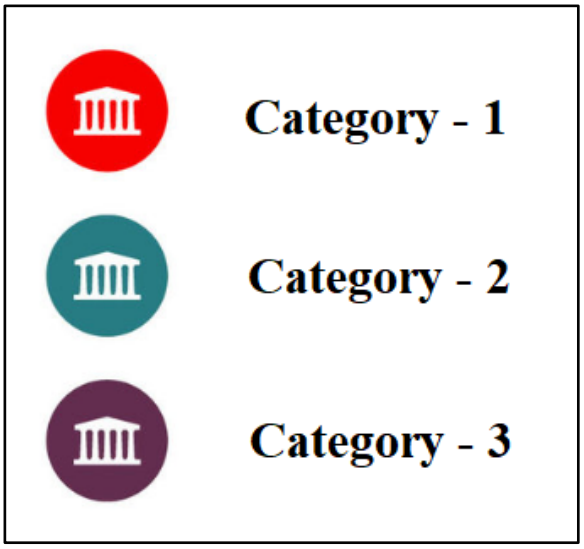


Figure 7 - Category Tags

Based on the visitor's profile (category) or the interest s/he may express while getting the e-tickets at ticket window s/he is provided with category-tag(figure - 7).

It is this tag which eventually controls the artifact information retrieval for the visitor. As the visitor nears any artifact in the museum his/her tag-type is detected and accordingly the data or the information relevant to him/her is provided by the artifact's RFID tag through the RFID reader. This means that when the artifact's RFID tag detects a visitor with category-2 through its sensor, then it sends its observation/reading to the controller. The controller in turn, process the reading (category number) as per the embedded logic of 'information encapsulation algorithm', that makes the decision and directs the actuator to deliver the information specific to the category of visitor.

Thus, implementing the IoT technology in RFID system with knowledge encapsulation makes the dissemination of information easy and specific for specific user. This could be illustrated with the help of following diagram(figure - 8).:

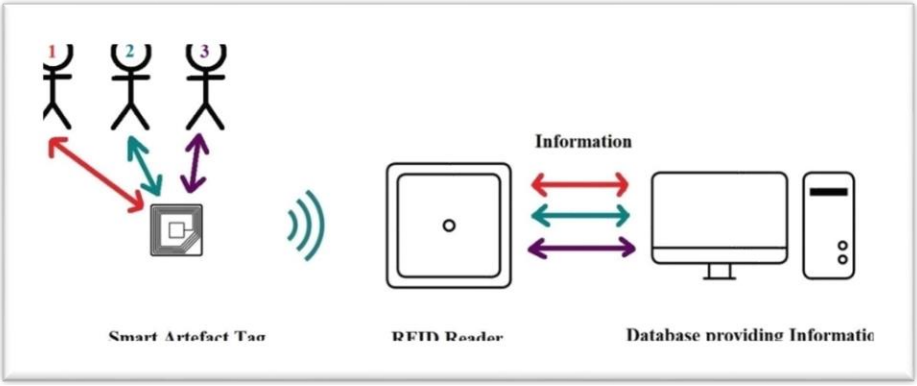


Figure 8 - Smart Artifact Tag working

So, the Smart Artifact Tag detects the category, sends the reading to its controller which takes the decision and instructs the actuator to retrieve only the category-specific information which is relevant for that specific visitor and display it on RFID reader. The algorithm logic could be represented as:

Detect the visitor category.

Store the category value in a variable: n Category.

If n Category equals to 1

{Display artifact name and brief detail.}

Else if n Category equals to 2

{Display artifact name, brief detail and also provide the FAQs.}

Else if n Category equals to 3

{Display artifact name and the entire historical details related to the artifact along with all relevant images and valid references.}

Figure 9 - RFID Card Reader[5]

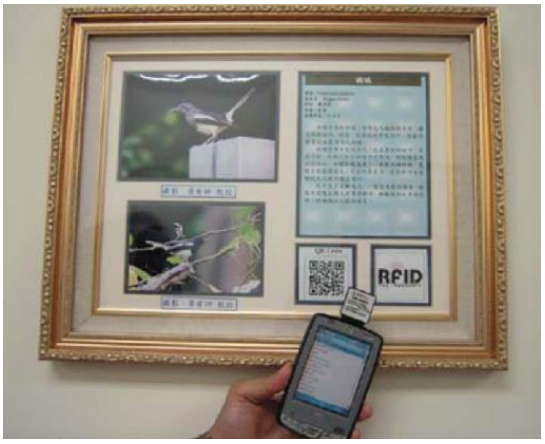


Figure 10 - RFID Tag being read by a Reader[6]

Epilogue

Like other knowledge houses, a museum also generates a voluminous data and information. Some of this data and information are related to administration while some related to artifacts. As the time goes by, the volume of information increases – which in terms of information technology is called '*Information Explosion*'. Almost all knowledge houses are struggling with information explosion and therefore it becomes very important to manage the information in a proper way so that its usage can be optimized. At the same time, it must be noted that 'not all information is for all people', therefore only relevant information must be catered to relevant visitors in a museum such they receive encapsulated knowledge which is relevant to them. This remarkably reduces the information carrying load on the network and secures the information as well. Imagine, if any sensitive information about any artifact gets leaked through this system, then it could be hazardous for the museum. Similarly, another aspect which needs very special attention is the availability of authentic information, images and references in context of every artifact in a museum. This can only be possible if the data entry for the artifacts are done under the supervision of an artifact expert and an art historian. It must be understood that information technology follows the principle of 'GIGO' which stands for 'Garbage-In and Garbage-out', so if one is feeding wrong information (garbage-in) into the system then it will only display the same (garbage-out). Keeping this in mind a museum can avoid the embarrassment cases that has been discussed at beginning of this paper.

[5]Image retrieved from website - http://www.falkensecurenetworks.com/PDFs/0822_RFID_in_Museums_and_Art_Galleries.pdf , visited on 20/07/2023

[6]Image retrieved from website - https://www.semanticscholar.org/paper/RFID-Based-Guide-Gives-Museum-Visitors-More-Freedom-Huang-Wang/8d3628ab4ae4180284e2fc4ab0f5cdd1bf8f08a7 , visited on 20/07/2023

Use of Smart Artifact Tags will certainly bring a revolutionary change in the information imparting methods in a museum and may proof to be a delight for researcher who have to run here and there asking for information in a museum currently.

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