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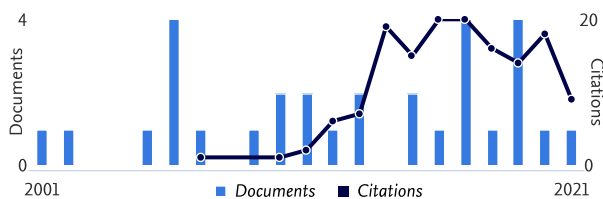
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Preface

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Near Field Communication Technology in Delivering Information in Museums

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Abstract—**Near Field Communication (NFC) is a close-range, high-frequency wireless communication enabling the exchange of data between integrated devices. The NFC service is used on Android-based mobile handsets allowing users to share and receive data or information instantly, interact with other devices using NFC technology. This research presents the development of mobile applications for use in museums to help visitors recognize objects in the form of multimedia information. There are two softwares developed, the first software is an application for visitors using Android Studio. The second software is the web application for museum administrators. As a result, the application developed for visitors has successfully displayed multimedia information in the form of text, images, audio, and video by scanning the NFC tags near the object. Museum administrators can obtain the statistical data for future museum development.**

Keywords—Museum; NFC; tag; Android; multimedia; mobile; the web.

I. Introduction

Near Field Communication (NFC) is a short-range wireless connectivity technology that enables safer and simpler two-way interaction between electronic devices. NFC also allows users to conduct contactless transactions, access digital contents and connect electronic devices with just one touch. NFC communicates via magnetic field induction, where two devices are located in adjacent areas that effectively form a transformer with an air core. The Communication is between two devices that support NFC technology when the devices are within 4 cm or closer to each other. NFC operates in 13.56 MHz radio frequency licensed ISM band [1].

There are several studies concerning this NFC Technology. One of them is a research on digitalization for objects in a museum [3], the others are an e-health application for in-patient-tracking and identification of patients in a hospital [5], the utilization of NFC in tourism [6], m-payment system based on NFC to detect the locations of people using smartphones through wireless communication network [7], Smart-posters to display information on bulletin boards at universities by utilizing NFC tags [8], m-commerce with NFC tags to make it easier for shoppers in

the supermarkets [9]. The research related to the use of NFC technology in museums is the study of Guiding Mobile Applications in Support of Digitalization of Museums [3]. This study aims to replace the function of a guide and also supports the digitalization of a museum by using mobile technology. This research uses QR code technology through QR code information on objects in the museum that can be accessed via mobile device by visitors.

This research undertakes the development of that research by using NFC technology to replace QR code technology. This is because the QR code itself has a weaknesses when performing the scanning process. The camera on the mobile device should be focused on the QR code first and also the orientation (slope) should be completely appropriate, so this process will take a long time. If the condition of the museum is quite crowded then the use of this QR code would be an obstacle for the museum. In the implementation, this mobile application will use NFC technology to send information of the location (URL) about the objects inside the museum. The mobile application will then capture and forward that location (URL) into the database server containing all the information about the objects. Then the content will be delivered to the visitor's smartphone. The Content about the objects can be accessed by visitors via smartphones. It can be text, images, sound, or video to make the information interesting to observe. This application will take the advantage of WiFi, in retrieving the content from the database server.

II. Near Field Communication (NFC)

Near Field Communication (NFC) is a communication protocol-based on Radio Frequency Identification (RFID) technology that uses magnetic field induction for communication between electronic devices containing NFC tags for use at a close range. NFC can be considered as an extension of RFID. Data exchange on NFC also involves initiators and targets such as RFID, but NFC can do more than simply exchange UIDs and read or write data to the target. The most interesting difference between RFID and NFC is that NFC targets are often mobile devices. It means that the NFC target is not only providing static data of the memory, it can actually generate unique content for each

exchange and send it back to the initiator. For example, if it uses NFC to exchange address data between two phones, the NFC target device can be programmed to provide only limited information if the device has never seen the initiator before [3].

Devices using NFC chips are divided into two types, one passive tag device and one NFC active device on the smartphone. NFC tags are often considered as a substitute for barcodes. It is because NFC has many advantages over the use of barcodes. When compared to barcodes, NFC has several advantages that are difficult to forge. In addition, NFC can provide a high level of security, while barcodes can be falsified by copying barcodes. Barcodes that have been copied can be used. It is one of the advantages of NFC over barcodes. NFC is also easy to use because it does not need to focus the scanner or set the orientation (slope) as in the barcode system and it only needs to close it to the NFC tag, but the NFC does not completely replace barcode technology, due to the price factor. In some cases, the use of NFC will be very useful later on. Its uniqueness is traceable when moving from one location to another. This application can help the company to overcome the theft and loss of product. NFC can also be used in point-of-sale applications replacing the cashier with an automatic machine without having to do barcode scanning. Samples of NFC tags can be seen in Figure 1.

Figure 1.   Example of NFC tags [4]

The NFC device has two modes of communication. If the initiator always supplies radio frequency energy and the target will be supported by the field of the initiator, then they are said to be involved in the passive communication mode. If the targets and initiators have their own energy sources, they are in an active communication mode. This mode is the same as regular RFID communication mode. Passive operating modes are important for battery-powered devices such as mobile phones and PDAs that need to prioritize energy use. The NFC protocol allows the device to be used in a power-saving mode so that energy can be saved for other operations [2],[10].

Normally, the NFC tags are passive devices, so their usage does not require a power supply and only utilizes active devices within its operating range before being activated. Consequently, the NFC tag can not operate on its own. It can only be used to transfer information to an active device such as a smartphone. To provide power to these tags

NFC, electromagnetic induction is used to generate current to passive devices. The principle is that the coils of wire can be used to produce electromagnetic waves, which can then be picked up and turned back into the current by another coil of wire. The technique is almost the same as wireless charging, with a less capability.

III.   ANDROID AND NFC

Android supports NFC with two packages: *android.nfc* and *android.nfc.tech*. The main class of the *android.nfc* package is [4]:

- NfcManager
Android devices can manage all common NFC adapters. However, since most Android devices only support one NFC adapter, NfcManager is usually called directly with *getDefaultAdapter* to get a specific adapter with the phone.

- NfcAdapter
It works as an NFC agent, which is similar to a network adapter residing within the computer, where mobile phones access NFC hardware to initiate NFC communications.

- NDEF
The NFC standard defines a common data format called NFC Data Exchange Format (NDEF) that can store and transmit everything from any MIME-type object to ultra-short RTD-documents such as URLs. *NdefMessage* and *NdefRecord* are two types of NDEF for the data format defined by the NFC forum, which will be used in the sample code.

- Tag
Android defines it as a passive object like labels, cards, and more. When the device detects a tag, Android creates the tag object, then puts it in the Intent object, and finally sends it to the corresponding *Activity*.

The *android.nfc.tech* package also contains many other important sub-classes. The sub-class provides access to tag technology features that contain read and write operations. Depending on the type of technology used, these classes are divided into different categories such as *NfcA, NfcB, NfcF, MifareClassing*, and others.

Basically, NFC can operate on Android by sending and receiving NFC data in the form of NDEF message.

IV.   PROPOSED SYSTEM

There are two applications developed in this research, the application on mobile devices and the application running on the server. The applications are implemented in the Mpu Tantular Museum located in the city of Sidoarjo, East Java, Indonesia.

A.   Mobile Application

This mobile application consists of 6 menus, which are Main Menu, NFC tags Scanner, Museum Profile, Mini-games, Map Museum, and Events. These menus can be accessed through the navigation drawer when opening the main page of the application after the login. Flowchart of the main menu can be seen in Fig. 2.
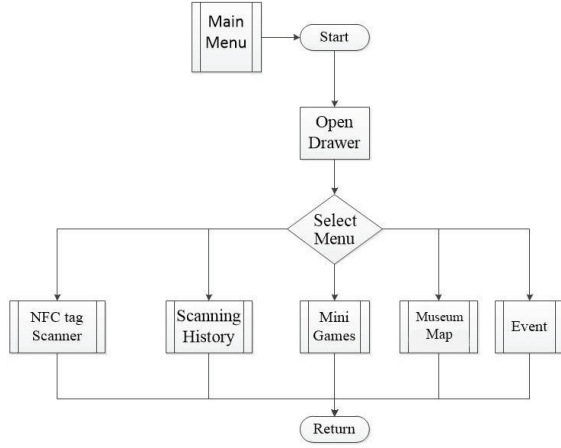
Figure 2. Flowchart of Main Menu

The NFC *tags scanner* menu is used as an NFC tags reader containing the *URL* address information of the objects collected in the museum. Using this menu, the user can scan the objects of the museum collections that have been equipped with NFC tags by moving the smartphone close to the NFC tag. If the scanning process is successful, then the mobile application will then capture and forward the *id* of the object to the database server containing all the information about the object. Through this menu, visitors can get information about the objects in the museum either in the form of text, images, sound, or video using wi-fi technology. Flowchart of the NFC tag Scanner can be seen in Fig. 3.
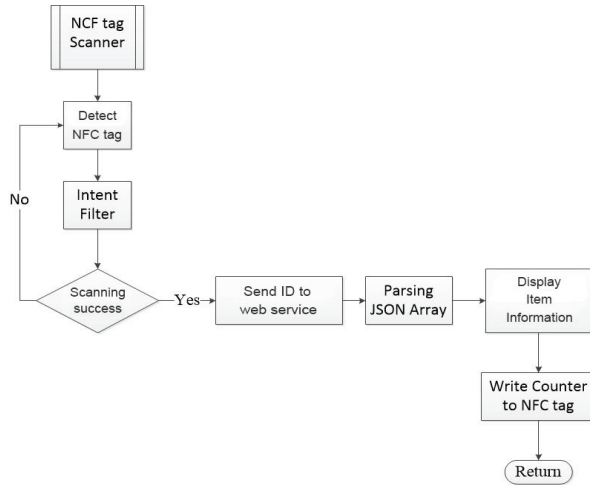
Figure 3. Flowchart of NFC tags Scanner Menu

B. Server Application

This web application is a back-end software for the administrator of the museum having features for database management such as inserts, updates, and deletes data related to existing museum content including mini-games for this mobile application. In addition, the software for the administrator can also display graphs for statistical reports and evaluation reports from the visitors on the information that is still lacking or required by the museum visitors. The museum administrator can also do some editing on the map view of the museum by using the canvas of HTML5 so that the museum map displayed by the mobile application will be dynamic. Flowchart of the web application can be seen in Fig. 4.
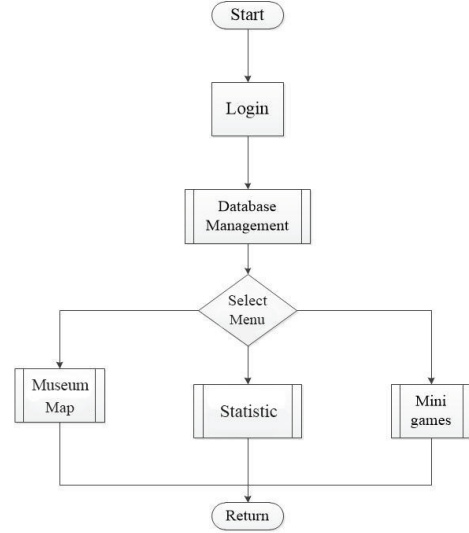
Figure 4. Flowchart of the Web Application

V. EXPERIMENTAL RESULT

To use this mobile application, a smartphone that includes the NFC feature is needed. Without the NFC feature, this application can still run, but the user cannot run the NFC Scanner tag menu in this application.

A. Menu Login and Register

On this menu, the user will be asked to fill in the username and password as seen in Fig. 5. However, if the user has not yet registered in the database then the user will be directed to perform the registration process by pressing the Register button. The personal data of this user will then be used as statistical data by the museum.
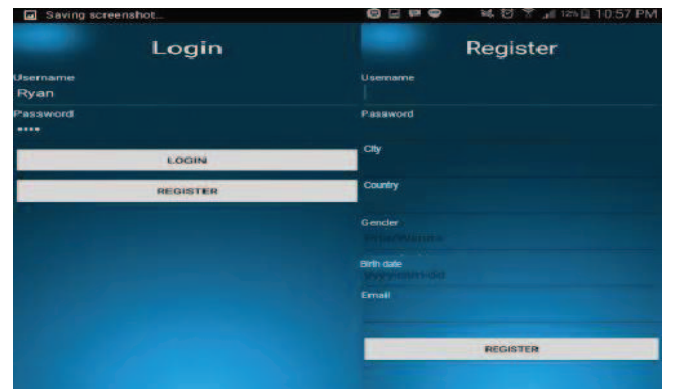
Figure 5. The Login and Register Menu

B. Main Menu / Profile of the Museum

As a user enters for the first time at the start page, user can see a short profile of the Museum Mpu Tantular on this page. There is also a navigation drawer to direct the users to other menus contained in the application. This view menu can be seen in Fig. 6.

Figure 6.   Main Menu of the Application

C. NFC Tag Scanner Menu

This menu is used to get information about the objects in the museum by doing a scanning of the NFC tag. When this menu is opened, the user will be prompted to scan the NFC tags found on the objects in the museum. The NFC tag contains the id of the object. After the tag is successfully scanned then this menu will forward the id obtained to the database server. After that, this application will display the information about the object in the form of text, images, video, and audio. The Display scanning process can be seen in Fig. 7.
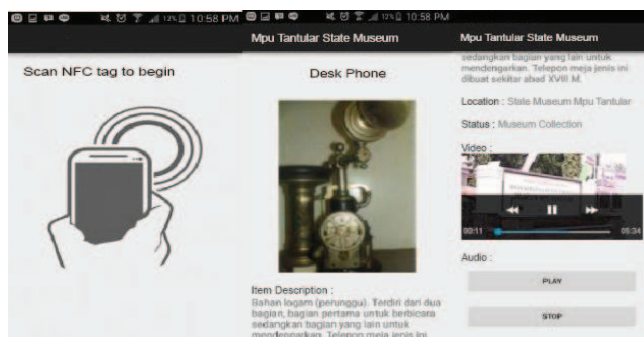

Figure 7.   Scanning Process of NFC Tag

D. Events

This menu will display the existing events in the Mpu Tantular Museum in the form of *listview* sorted by the most recent activities. If one item is clicked then the application will display complete information on the event in accordance with the user selection as seen in Fig. 8.

Figure 8.   Events Menu and the Information of the Event Selected

E. Map of the Museum

When first opened, the user will be prompted to select the museum layout option that user wants to display in a dropdown or spinner. Then after selecting, the layout will be displayed by the application as viewed in Fig. 9.
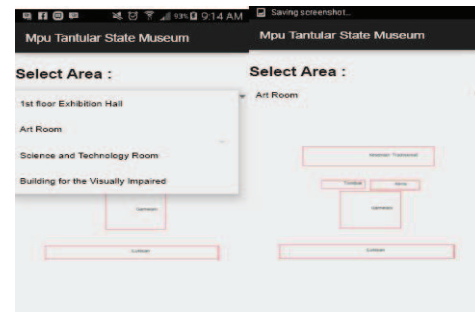
Figure 9.   Layout of The Museum Map

F. Scanning History

This application displays the results of scanning that has been conducted before by the user in the form of a listview so that if the user has scanned the NFC tags, the user does not need to scan again. Once one item is clicked it will move to the detail of the object that looks the same as the scanning result of the NFC tag. The view can be seen in Fig. 10.
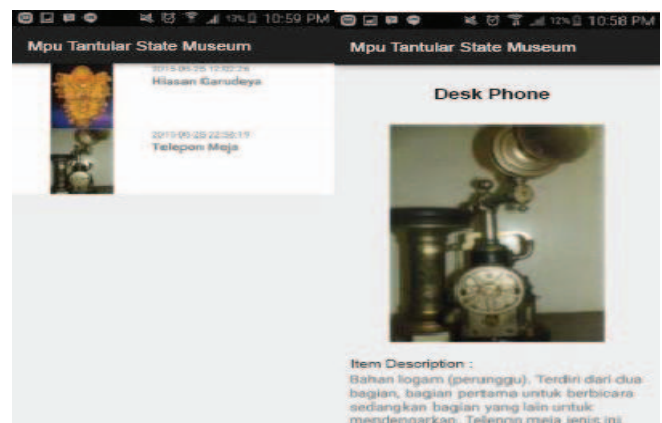

Figure 10. Scanning History

G. Web Application

This web application is intended for the museum administrator to perform database management of visitors, admins, objects in museums, and museum events. This application can also display statistical data from visitors, counting the number of objects scanned in the museum, and the results of mini games.

Fig. 11 displays the statistical data on the number of visitors per country and per city in Indonesia.

Figure 11. Statistical Data per Country and per City in Indonesia

Fig. 12 shows the statistics of the number of scanning for each object in the museum.
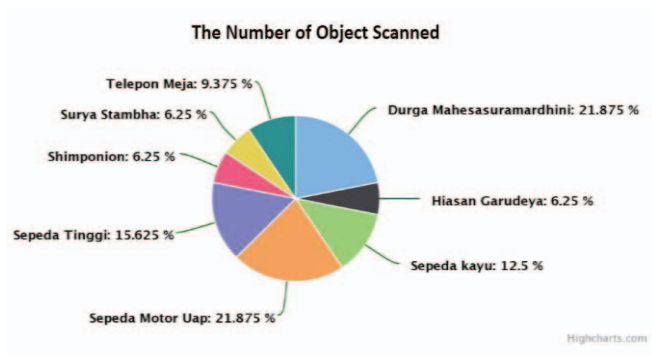

Figure 12. Graph of the Calculation the Number of Objects Scanned

Additionally, through this application, the administrator can also perform some editing on the map of the museum to be displayed on mobile applications using HTML5 canvas.

VI. CONCLUSIONS

- Mobile apps can display information on objects in the form of text, images, sounds, or video in the museum by utilizing NFC technology.
- Utilization of NFC technology can be used to calculate the statistical data of the museum.
- The museum can obtain various statistics for better museum development through this application.
- This technology can facilitate the museum if there is a change of content because all the information on the mobile application is integrated with the one on the server

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