Integrated ZooEduGuide with Multimedia and AR

From the largest living classrooms to wildlife conservation awareness

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***Abstract*—Dissemination of information in today's digital lifestyle has grown beyond prints, multimedia contents are no longer luxurious elements but necessary components. Combined with an advanced navigation system on Android-based mobile devices and augmented reality technology, we achieve a context-aware self-guided application that not only assists users navigating an unknown territory but also delivers facts about places they are visiting as well as living and non-living things they are encountering. Applying such a system to zoos, the largest living classrooms in existance, while incorporating cartoon-like kids' friendly interfaces and games, we have developed a portable educational gadget. Our application, named ZooEduGuide, is designed to effectively attract and motivate young children and teenagers to learn about animals and wildlife along with ecological footprints. It encourages their love for animals and raises their awareness for environmental conservation as today, more than ever before, there is an urgent need to actively protect wildlife at a global scale. Enhancing zoo experience with ZooEduGuide, a planned field-trip at the zoo could be personalized. Furthermore, the flexibility and generalizability of our system allows local zoos to customize their maps and to dynamically schedule show events. At the same time, many zoos across the country can share common information and news through a centralized on-board database managed by the national zoo organization.**

I. Introduction

Zoos always top the list of a child's places to visit. Present days at a zoo draws out natural love and interest children and teenagers are known to have for animals. Fostering lifelong connections, every zoo is determined to provide a comprehensive educational experience, through which wildlife protection and conservation is automatically realized. Engaging the young generation, especially those born into the digital world, however, poses considerable challenges. Their attention span is short; their patience is wearing thin. A conventional wooden board about an animal next to its exhibit does not draw enough attention. Having to wait for an animal to wake-up or to come out of hiding significantly tapers off enthusiasm. Capturing a perfect moment, being at the right place at the right time, is so incredibly rare that it hardly persuaded any interest.

To reconnect these young generations to animals, wildlife, and ecological environment through good impressions on zoo experiences, there has been an increasing use of mobile electronics with rich multimedia. A prototype proposed by Hlavacs [1] equips a visitor with a personal digital assistant (PDA). Wireless LAN is required as contents are fetched from a server on demand whenever a radio-frequency identification (RFID) tag, affixed near an animal exhibit, is read. The authors highlight their backend peer-to-peer system for content sharing at a global scale, which also enables presentations in many languages. Another case study that focuses on media and content management system is WebMoZis [2], a collaboration between the Institute for Geoinformatics and Remote Sensing and the Osnabrueck Zoo in Germany. Both two- and three-dimensional data are provided via conventional web browser operating on desktops, pocket- or ultra-mobile PCs. Virtual reality modeling language is used to create a 3D scene and geo-tagging (or geo-coding) stamps coordinates onto photographs providing another dimension for data retrieval process.

Handheld Zoo Ranger, available in the United States [3], uses Global Positioning System (GPS) location realization as a means to trigger media contents, showing automatically once a zoo visitor is within a pre-defined proximity of an exhibit. Extending the usage of GPS coordinates to assist navigation, an iPhone application released by the Woodland Park Zoo and later Houston Zoo [3], tracks visitors while they explore the zoo ground. As a result, visitors know where they are on the zoo map. To this end, interactive ZooOz guide [3], a case study developed at Melbourne Zoo in Australia, adds pre-defined hotspots and switches from Wi-Fi connections to Bluetooth.

Primary shortcomings of the abovementioned systems are limits with respect to personalization, generalization, and flexibility. Maps and hotspots, along with their associated information are fixed and pre-programmed. Navigation capabilities are often limited. The applications are mostly designed specifically for inside a selected zoo. They oftentimes consider only coordinate locations but not heading directions. Constant reliance on network connections is largely required and, for some, a specially configured device is mandatory. These limitations and restrictions constitute major drawbacks. Conservation awareness requires continuous inspirations and, consequently, zoo education must not be confined to any zoo. Once home visitors should be able to freely review the contents and continue relating themselves to animals' natural habitats, while furthering their knowledge of interested species.

In this work we designed and implemented a comprehensive, fully customizable, zoo self-guided ubiquitous application on Android-based mobile devices. Distancing itself from others, our system focuses on environmental protection and wildlife conservation through education, starting at zoos, the largest living classrooms ever existed. Especially targeted users are children and teenagers, whose unlimited potentials are awaiting to be evoked by proper inspirations and motivations.

978-1-4799-4075-2/14/$31.00

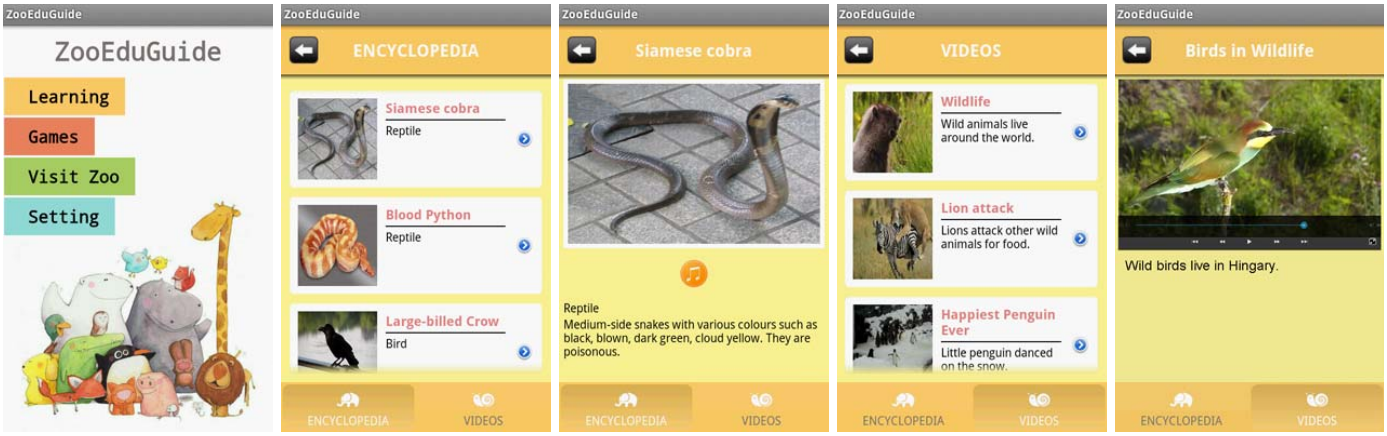

Fig. 1. The left most is the front page of ZooEduGuide. The next two are screenshots of Encyclopedic pages: one is a list of animals, the other is a description of a user's selected species with a link to hear how it sounds. Similarly, a list and a footage of video contents are shown on the two rightmost screenshots.

To be suited for these young generations who are digital native, practical and effective applications of advanced electronics, as well as attractive use of it have become essential. Meeting these specifications and requirements, our ZooEduGuide system is highly interactive, effectively combining zoo education and entertainment with robust navigation and planning. Running exclusively on nonproprietary software, it is freely available. Being network independent, it is capable of operating both on-line and off-line. As reflected on the front page of the application (displayed in Figure 1), there are three main operating modes: learning, games, and visit zoo, plus setting, described in Section II, III, IV, and V, respectively. Technicality and implementations of the system is explained in Section VI. We conclude with system testing and future work in Section VII.

II. Learning Zoo Education

Zoos around the world house an enomously large varieties of animals from common to rare as well as endangered species. Behind the scenes, a number of scientists, researchers, veterinarians, and animal caretakers, many of whom are volunteers, work restlessly around the clock to ensure general well-being and safety of all animals: habitat conditions, nutritious diets, reproductive stages, behaviors, and communications, to name a few. Full of exhaustive knowledge and discoveries, zoos rank first in animal science and education. Crucially important is how to share this invaluable information from real experiences and original experiments with visitors and the general public. Animal exhibits inside a zoo, though constituting very important elements, are becoming inadequate. Only a limited amount of data can be printed on a physical board. When details change, it is essentially impractical and non-economical to modify a board in a timely manner. Animals' most interesting behaviors are not oftentimes observable, for instance play or feeding time, bathing, fighting and prey-captured moments.

As a consequence, uses of electronic formats become vital ingredients. Presentations of animal facts in our ZooEduGuide system encompass rich interactive multimedia comprising pictorial illustrations, audio sound effects, and video footage. Our kid friendly interface (Figure 1) warmly invites users to a large collection of encyclopedic records. In addition to its common name and the class to which it belongs, every animal listing is accompanied by an adorable portrait, making it pleasantly attractive to users as well as making it easier to identify an animal of interest. Once chosen, its facts and dominant as well as recessive features are displayed. Its behaviors are explained. Information includes but limited to natural habitats, senses, communications, reproductive cycles, migration, adaptation, endangerment, and conservation. Also available is an audio recording of respective animal sounds. Alongside, in another category, is a diverse collection of videos bringing users closer to animals' natural environment spanning their interactions with other organisms, creating passions for animals in the wild.

ZooEduGuide stores data on-board rather than retrieves it directly from a server or the internet for two reasons. First, it allows the system to be independent of any network connection which is neither always stable, reliable, nor available such as in zoological parks with very large safari. Secondly, information on the internet is excessively overloaded. Not every detail is appropriate for children and teenagers. Letting zoo organizers collaboratively and individually install their own descriptions, though substantial work is imperative, their selective information reflecting from their priceless experience is significantly more concise and the language is much more age-appropriate.

III. Educational Games for Entertainment

It is widely recognized that the majority of young children and teenagers spend significant amount of their time on games. Strategically placed, while kids enjoy playing games, they get to know animals. Getting down to their level, we created two educational games built into our ZooEduGuide (Figure 2). The first is an identification of animals from their sounds; the second is a trivia quiz, comprising multiple-choice questions about animals. Bringing out their natural competitive character, both games are timed and high scores are ranked, implicitly persuading kids to play more and inevitably learn more.

IV. Facilitating a Pleasant Visit at the Zoo

Most differentiating ZooEduGuide from existing systems is Visit Zoo mode complete with technical components and practical functionalities that effectively piece together education and navigation. Learning about animals is at a finger tip. Navigating the zoo ground is effortless. Large-scale satellite roadmaps are overlaid onto small-scale custom maps (typically available on-site on paper), enabling a smooth transition

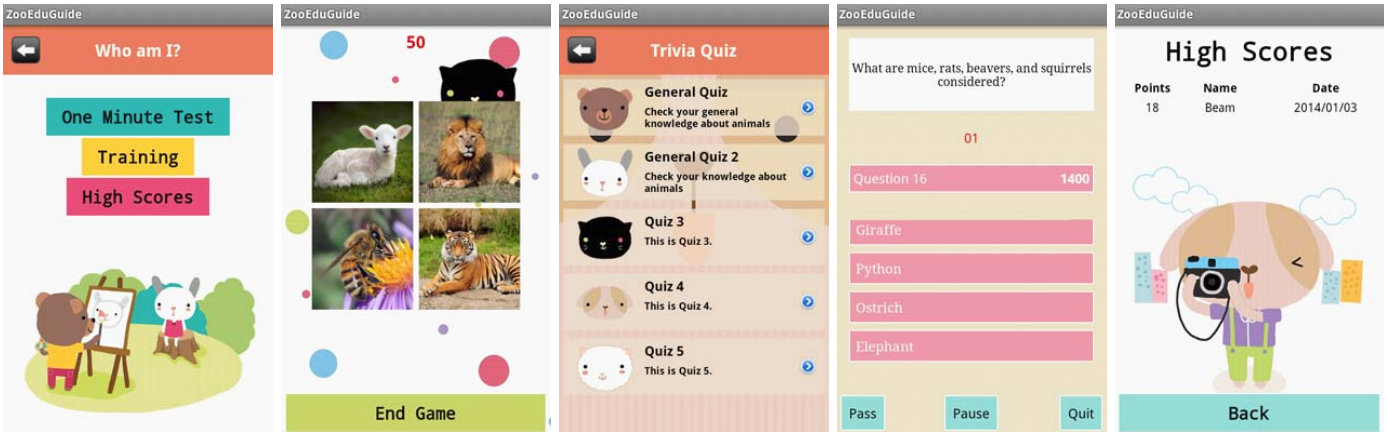

Fig. 2. Two educational games for entertainment: Who am I? (two on the left) and Trivia Quiz (two in the middle). A high score page is depicted on the right.

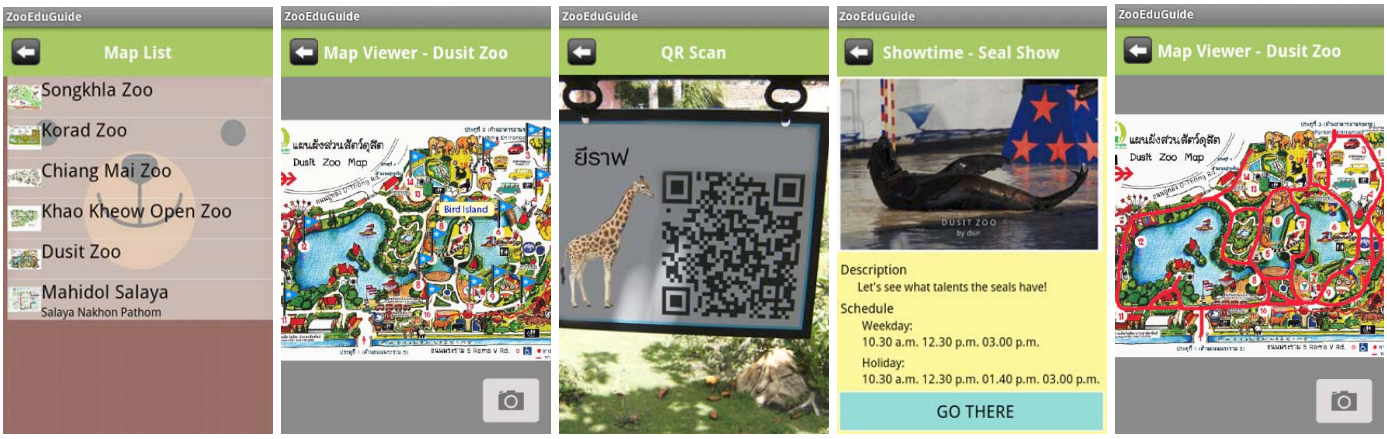

Fig. 3. Inside the Visit Zoo operating mode from left to right: a menu for specifying a zoo to visit, a digitalized custom map with POI flags and selected POI highlighted, QR code affixed at an animal exhibit, special event and show schedule and venue, and a suggested route around the zoo ground.

between common GPS-assist on-the-road driving and inside-a-zoo walking tour. Tracking and following is facilitated by an integration of a GPS, a compass, and an accelerometer, all of which are readily available on most of today's mobile devices. Information offered is ubiquitous based upon where a visitor is and what lies ahead. Users have full control of what to display: animal facts, games, or event show times. Last but not least is the generalization of the system. Zoo organizations can customize their own custom maps, points of interest (POIs), and/or special events. Visitors can compare different zoos and pre-plan their trip, personalizing it to their interest.

Entering Visit Zoo (Figure 3), a list of zoos are presented. This includes every zoo whose information has been installed, either pre-loaded by a system developer team, pre-specified by a zoo organization, customized by an individual user, or some combinations of the three. The next screen shows the custom map of a selected zoo and prompts a user with nine options:

Follow mode provides a map view with an arrowhead, which not only indicates the current location, but also points towards the direction a user is heading. It tracks a user instantaneously. Matched with what most are familiar to, the arrow points up and is fixed in the center of the screen in order to maximize a view of the surrounding; the underlying map is then rotated accordingly. Additionally, POIs are flagged right onto the map.

Camera mode tracks a user, similar to follow mode, but instead of a map view, it shows actual scenes of what lies ahead using a device's built-in back-camera. Augmented reality (AR) technology places POIs directly on a map in real-time. Included is how far each is from current location. A user can also control proximity: closer for more details, and further for more POIs.

Where am I reveals the current GPS coordinates of the user.

POIs lists every known point of interest associated with the current map. Clicking on one brings up a map with a flag at a location of a chosen POI; another click leads to its description.

QR scan permits scanning quick response (QR) codes affixed by animal exhibits. Zoo visitors can access facts about animals, same multimedia information as in the Learning. To zoos, a QR code board is much more economical and practical than a physical board on which substantially limited details can be printed, and any modification calls for a new board. Moreover, QR code readability is tolerant to everyday's smudges or stain marks. A QR board takes minimal space, making an exhibit much cleaner and leaving more space for visitors to experience the animals. It is also well-suited to enable multiple languages.

Shows lists all ongoing shows, events, and special occasions. When one is chosen, its brief description is presented, followed by its schedule dates and times. At the bottom of the screen, a go there button specifies on a map where the show venue is.

Routes suggests walking paths around the zoo ground.

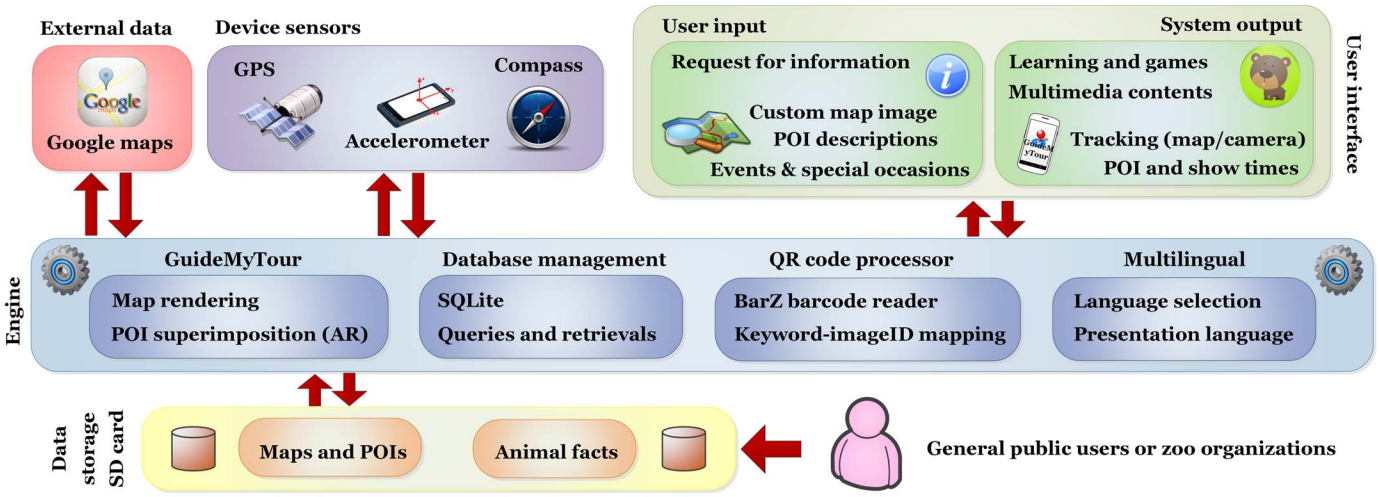

Fig. 4. ZooEduGuide's system architecture diagrams technical components of the applications: how they are interconnected and associated data flow.

Add New POI allows individual users to define their own points of interest and zoo organizations to specify their hotspots.

Help is the how to of the application in case users get stuck.

V. Setting for Multilingual Presentations

Concerning international travelers of foreign nationals and the upcoming ASEAN economic community (AEC), ZooEduGuide is fully equipped with multilingual capability. Aside from translations and interpretations between several desired languages, dissemination of information in assorted digital formats does play a big part in making this plausible. Imagine one board for each language nearby an animal exihibit or a single large board with every language on it; both options are neither practical nor feasible. In contrast, users of ZooEduGuide can go to Setting mode and, with a click of a button, switch between many langauges, such as English (default), Thai, and Malaysian, to name a few. Then, at an animal exhibit an installation of only a single QR-code is required; it is the database engine that handle retrieval of the requested language.

VI. Implementations

The system architecture of ZooEduGuide is composed of 6 main components illustrated in Figure 4: external data, device sensors, user input, system output, processing engines, and data storage. Fundamental elements constituting each component are presented in the diagram. At the heart of the application is a processing unit comprising four engines pulled together. The first is an extension of our GuideMyTour context-aware system [4]. It is responsible for aligning geographic sattelite images with corresponding custom map images, rendering for map-view mode, and superimposing POIs onto live scenes employing augmented reality technology for camera-view mode. The second engine manages database queries and retrievals of requested data. SQLite library is selected for its compact size and fast response time. The third engine attends to QR code processing. The ZBar barcode reader [5] has been adapted to generate, scan, read, and interpret QR codes. Each QR code is mapped with a unique ID identifying a corresponding database record, enabling a retrieval of queried animal transcripts. The fourth and last engine handles multilingual settings. A choice of languages must be propagated to every engine and consistency must be maintained. Having a secure digital (SD) card for data storage enables effective information sharing; this is in addition to data transfer over a network. Many zoos can easily and conveniently share information on common animals, pre-loaded into the system. More specific and dynamic data, as well as individual preferences can be entered either by general public users or organizers either directy into the database or via provided user interface while the system is being engaged.

VII. Conclusion

A zoo self-guided ubiquitous application was implemented and successfully tested at Dusit Zoo, the oldest, most popular zoo of Thailand, located in the heart of Bangkok. Its potential to attract young visitors has been positively promising. Comprehensive features for learning, entertainment, and navigation could effectively leads to medium- to long-term interest and consequently wildlife conservation awareness. In collaboration with the Zoological Parks Organization of Thailand, the ZooEduGuide application will be deployed not only at the Dusit Zoo but also at other major zoos across Thailand, including Khao Kheow, Chiang Mai, Nakhon Ratchasima, and Songkhla.

Acknowledgment

The authors would like to thank the organizers of the 16th National Software Contest 2014, Thailand, for their support.

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