The internet of things for South African tourism

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Abstract: This paper presents examples of internet of things (IoT) applications that could enhance the management of tourism activities in South Africa. Although information and communication technologies (ICT) have been adopted in some aspects of the tourism industry, there is further room to enhance this functionality through the adoption of IoT technologies. The IoT technologies in this research have been categorised under wildlife monitoring and tracking, monitoring seas and waters, monitoring birds, plant species monitoring, tourist information services, hospitality services, tourism marketing and mountaineering and weather monitoring as identified from the South African Department of Tourism website. A literature review was conducted to identify IoT applications in tourism in the international arena that would apply in the South African environment. An architecture of a wildfire detection and alert system using IoT is given as an example. The question that this research answers therefore is, "What IoT technologies can be adopted to impact on South Africa's tourism industry".

Keywords: Please insert main key words.

1. Introduction

According to the World Tourism organisation UNWTO, tourism is a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business purposes (UNWTO, 2015). Although information and communication technologies (ICT) have been adopted in some aspects of the tourism industry, there is further room to enhance the performance of this industry through the adoption of IoT technologies. The IoT is what happens when everyday objects have inter-connected microchips in them which enable them to sense their surroundings and report it to other machines or people for actuation of functionalities in these machines or people (Zhihao, 2015), (ITU, 2005), (Raunio, 2009). The IoT technologies in this research have been categorised under wildlife monitoring and tracking, monitoring seas and waters, monitoring birds, plant species monitoring, tourist information services, hospitality services, tourism marketing and mountaineering and weather monitoring as identified from the South African Department of Tourism website.

The paper therefore is on identifying potential applications of the IoT in tourism for the South African economy. It looks at available applications in the international market. Section 2 is an introduction to tourism in South Africa. Section 3 is on the IoT. Section 4 is on the potential applications of IoT to tourism in South Africa. Section 5 is an example of an architecture of a wildfire alert system using IoT. Section 6 is on the business benefits of IoT in tourism and Section 7 is the conclusion.

2. Tourism in South Africa

The mission of the South African Department of Tourism is to create a conducive environment for growing and developing tourism through innovation, strategic partnerships, provision of information and knowledge management services and strengthening institutional capacity (www.tourism.gov.za). Domestic tourism contributes 70% of South Africa's tourism volume.

South Africa is endowed with archaeological sites, arts and culture sites, botanical gardens, caves, historical sites, museums, natural wonders, waterfalls, world heritage sites, blue flag beaches, etc for tourism. According to the International Ecotourism Society, ecotourism is tourism to exotic or threatened ecosystems to observe wildlife or to help preserve nature. It is defined as travel to areas where flora, fauna and cultural heritage are primary attractions. In South Africa, the Kruger National Park in Limpopo, The Addo National Park in the Eastern Cape, The Hluhluwe-Umfolozi Game Reserve, the Karoo National Park, the Tsitsikama National Park in the Eastern Cape, the Table Mountain National Park and the Wilderness National Park are hubs of wildlife, birds and plant species. South Africa has 3000 km of coastline, with beaches and fishing villages. Robben Island is a world heritage site, home to Robben Island museum. The Namaqualand spring wild flowers are spectacular phenomenon along about 1000 kilometres of the west Coast. The Fynbos is natural shrubland occurring in a small belt of the Western Cape in winter.

Adventure tourism in South Africa offers a multitude of adrenalin-inducing activities in a variety of natural landscapes – including oceans, mountains, and forests. It involves hiking, backpacking, mountain biking, trail running, canoeing, river rafting, horse riding, fishing, bungi-jumping, paragliding, rock climbing, kayaking, shark cage diving and sky diving. South African adventure tourism destinations include the Drakensberg Mountains, Eastern Cape Highlands, KwaZulu Natal Midlands, Wild Coast, the Tugela Valley, the Garden route, Namaqualand and the Bushman's River.

Geotourism, on the other hand, is tourism that sustains and enhances the geographical character of a place – its environment, culture, aesthetics, heritage and well-being of its residents (Dowling, 2010). Geotourism is essentially 'geological tourism' focusing on geology, landscape, rock types, sediments, soils, volcanoes, glaciers and erosion. The tourism element involves tourists visiting, learning from and appreciating geosites. The rock art site in Ukhahlamba Drakensberg Park is a world heritage site. The Cradle of Human Kind is an archaeological attraction that takes visitors on an informative journey through the evolution of life and the origins of humankind. In addition to the Howick Falls in KwaZulu-Natal, the Mac Mac and Lydenberg Falls in Mpumalanga, South Africa's Drakensberg mountains are home to the world's second largest waterfall – the Tugela Falls. The Table Mountain is the focal point of every view in the city of Cape Town. Cape Winelands is home to superb landscape of blue mountains, steep sided valleys, sparkling streams and sweeping vineyards.

3. The internet of things

The term internet of things (IoT) is used as an umbrella keyword for covering aspects related to the extension of the internet and Web into the physical realm, by means of widespread deployment of spatially-distributed devices with embedded identification, sensing and actuation capabilities (Miorandi, 2012). IoT envisions a future in which digital and physical entities can be linked by means of appropriate ICT, to enable a whole new class of applications and services.

The basic idea of the concept of the IoT is the pervasive presence of a variety of things or objects such as RFID tags, sensors, actuators, mobile phones, etc – which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbours to reach common goals (Atzori, 2010). According to (Kortuem, 2010) the combination of the internet and emerging technologies such as near-field communications (NFC), real-time localisation and embedded sensors lets us transform everyday objects into smart objects that can understand and react to their environment. Such objects are building blocks for the IoT and enable novel computing applications. The connection of physical things to the internet makes it possible to access remote sensor data and control the physical world from a distance (Kopetz, 2011).

4. Potential applications of IoT in tourism

Potential applications of IoT in tourism include the areas of wildlife monitoring and tracking, monitoring seas and waters, monitoring birds, plant species monitoring, tourist information services, hospitality services, tourism marketing and mountaineering and weather monitoring.

4.1 Wild animal tracking and monitoring

IoT has a place in the monitoring and tracking of wild animals in many ways. A sensor implanted on the animal transmits data to a server for access by game staff in order to track the animal movements. Animal sounds are detected through sensors embedded in the environment and transmitted wirelessly to a middleware to analyse sound and decipher what animal it is and communicate the result back to the source. Animals can be tracked through voice recognition or fingerprinting if they cannot be tagged in the wild. The voice of each animal is unique and is determined by the shape of the vocal trap and cavity, and the vibration of the vocal codes. To reduce the risk of poaching, the movement of animals outside a predefined perimeter can be monitored through body heat sensors or movement vibrations. Electronic fences can be wireless or in-ground. Wireless fences have electronic base units that emit radio waves up to a certain range. A receiver and transmitter send an alert to the relevant authority. The in-ground fence picks up radio waves and beeps once an animal or someone crosses the fence (Gruber, 2012).

4.2 Monitoring seas and waters

The IoT examples identified for monitoring seas and waters include whale/dolphin tracking and coral reef monitoring

4.2.1 *Whale/dolphin tracking*

Dolphins/whales use traversal waves for communication. Dolphins/whales are automatically identified based on the sonic sounds they make and their movement in the water. Taking advantage of the underground networks in oceans whales can be tracked and monitored. Scientists at the University of Buffalo have tested an underground network that could make internet-like communications across the world's oceans a possibility. Satellite imagery is the new whale watching mechanism. Researchers from British Antarctic Survey have tested a way of identifying whales while remaining on dry land using satellite imagery (Satellite imagery in whale watching, 2015). High resolution images are provided by the commercial satellite WorldView2. One band of the image using light towards ultraviolet

end of the spectrum reveals whales in water, as its smaller wavelength meant it could penetrate about 15 metres below the surface through movement for differentiation from rocks.

4.3 Bird monitoring

iBird is a bird watch application with social, mobile, analytic and cloud features which offer popular field guides for birds, topographic maps, high density images, ability to import photos and also connects to the www.whatbird.com forum where experts are standing by to help identify any bird that cannot be found on the search engines, bird song, links to the iBird journal, spectrographic audio, GPS integration with data and time (Benedict, 2014).

Smart birding matches songs with species. WeBird (Winsconsin Electronic Bird Identification Resource Database) (WeBird, 2015) submits a bird's call wirelessly to a server and retrieves a positive ID of the species. When a bird sings, the song may have varying amplitudes and frequencies. WeBird dices songs into time-ordered chunks using data organisation techniques applied by geneticists to jumbled bits of DNA to align temporally misaligned data, working around a lot of variation.

4.4 Plant species monitoring

The examples identified for plant species monitoring are alien plant and forest fire detection.

4.4.1 *Alien plant detection*

There are a number of ways to detect alien plants in conservancies by using IoT. Image fusion techniques integrate passive and active energies concurrently collected by an imaging spectrometer and a scanning waveform light detection and ranging (LiDAR) system respectively (Huang, 2009), (Asner, 2008). The approach provides a means to detect the structure and functional properties of invasive plants of different canopy levels. Via temporal resolution remote sensing the abundance of invasive plants is estimated. A GPS device is used to map where the alien plants are.

4.4.2 *Forest fire detection*

Edith Cowan University (ECU) Centre for Communication Engineering Research (CCER) (Sharwood, 2012) has built sensors which sniff out forest fires then use WiFi to inform the world. The sensors use solar- panelled batteries, and each node has a range of 25 kilometres. They run on 802.11n WiFi. They detect gas. ECU put together their own media access control (MAC) protocol. The network is self-healing.

For forest fire detection through monitoring of combustion gases and pre-emptive fire conditions to define alert zones, scientists from the University of California have designed a satellite using state-of-the-art sensors, and analysis software to minimise false alarms. The system, Fire Urgency Estimator in Geosynchronous Orbit (FUEGO) (Pennypacker, 2013) snaps pictures of the ground every few seconds in search of hotspots that could be newly ignited fires.

4.5 Tourist information services

Tourist information services encompass interactive virtual tours, tourist maps, and mobile tourist information.

4.5.1 *Interactive virtual tours*

(Ch'ng, 2011) suggests that on-site discovery and learning can be mediated through interactive media, augmented reality, location-based services or ubiquitous computing. Related but obscured objects can be linked via RFID and GPS so that users are 'notified' when they are within range of the objects.

4.5.2 *Tourist maps*

One example of providing tourist maps is via Google Maps. Google Maps on Android has offline support for tourists. Map areas can be downloaded to a phone for offline viewing. When in an area one can open Google Maps and use a smartphone's GPS as well as the saved maps to view where they are. If Google Maps is queried for directions while on a WiFi connection and then goes offline, one can continue to follow directions and view the location on the map completely offline. Only searching for directions requires a WiFi connection.

4.5.3 *Mobile tourist information*

M-tourism is related to the tourism industry and new technologies to obtain tourist information. The GAT platform (Rodriguez-Sanchez, 2013) is a solution for fast building and automatic knowledge management of context-ware services for tourism for indoor and outdoor environments. It is made up of a generation and updating way-finding mobile application, automatic knowledge management, a multiplatform architecture and indoor/outdoor location and technologies applied to way-finding functionalities, e.g. GPS, 3GH, WiFi, Bluetooth.

4.6 Hospitality services

The information on the positions of rental cars is collected via GPS and stored on a cloud platform. The information can be accessed via mobile phones or desktop in real time. Tourists pick up and drop cars anywhere within the service area of a car rental company. Embedded sensors behind the car's windshields recognise the chip cards of service users and exchange account validation, location and status information with the company's data centre.

4.7 Marketing tourism

The marketing of tourism involves the collection and processing of sales data, storytelling and enabling communication between tourist and seller

4.7.1 *Collecting and processing sales data*

A cyber-physical system is where the interaction between the internet and the real-world is evident. Near-field communications (NFC), radio-frequency identifiers (RFID) and QR codes can build novel marketing applications based on the active participation of tourists.

The integration of telecommunication technologies with social media enables interaction between people and things. NFC, QR, RFID link the identifier to an IoT platform for processing of the data. The store that has sold hand-crafted souvenirs now has more information about the destination the goods go to so that at the end of the business cycle, the retailer gets a report of the purchasing behaviour of tourists across the globe.

4.7.2 *Storytelling*

Storytelling is what objects around would say if they could talk. As more of our objects and environments become actuated, connected and data-enabled, these enchanted objects are developing the capacity to contain their own stories. An object can remember its history and can understand how it is used, can talk to other objects around it to understand its environment. As these capabilities evolve, objects no longer become inert backdrops to our experiences, but active participants in a world that can share stories about themselves and us (Lloyd, 2014). For example, the wine bottle can tell the story of the history of the wine, that is, where the grapes came from, how long the wine has been left to mature in tanks, etc. The 'thing' and its history is connected to the internet of things. The ID of the 'thing', e.g. its URL and barcode, is given to a smartphone and an application on the smartphone retrieves the data.

Tale of Things and Electronic Memory-TOTEM (taleofthings.com is a simple way of adding memories to physical objects to share with others. The Tale of Things platform allows anybody to attach web content (text, image, video and audio) to an artefact through the generation of a unique QR barcode that the owner is encouraged to stick to their thing. When scanned by someone using a smart phone, media is launched and the object can be seen/heard to tell a story about the memories associated with it. 3D copies of historical artefacts are kept for documentation, use in teaching and learning and for tourist information

4.7.3 *Enabling communication between tourist and seller*

Tourists need to communicate. In utilising IoT as a medium for exploring cultural and social identity, the future will be spoken and not written. For communication between the tourist and the seller, information is stored on a cloud database of objects and names in different languages. The seller and tourist have smart devices which recognise each other. The tourist speaks into a smart device which in turn accesses the cloud database, retrieves the word and responds to the seller's device.

4.8 Mountaineering and weather monitoring

Mountaineering can use GPS navigation aids and smartphones equipped with GPS technologies to communicate the location of the mountaineer to a rescue centre. GPS technologies and smartphones with GPS technology work by detecting the position and signals from a series of satellites. The devices calculate their position by reference to those satellites. GPS technologies have longer battery life than cell phones, and therefore ideal for mountaineers.

Sensors on mountains tell about local conditions at any particular spot, that is, the temperature, wind strength, moisture levels, etc. Weather prediction for tourists should be microscopic and for a local facility as opposed to wide area prediction that the S.A. weather bureau gives. Multiple wind speed and wind direction sensors are placed in the game reserve, or tourist area to alert the tourist to the weather in the vicinity of their visit. A

crowd-sourced weather map can be viewed. The weather-map application may use sensors on a smart phone that have an array of pressure, temperature, humidity sensors. It uses Bluetooth low energy to communicate readings to a gateway and from the gateway to middleware. The gateway is a proxy server that talks to the smart phone and on the other side sends to the middleware.

5. Architecture of a wildfire detection and alert system

In a typical wildfire detection and alert system is a series of heat sensors that exist in a network. These sensors are low-powered devices whose sole purpose is to collect data on heat and perform minimal processing. The sensors push the information they have collected to a proxy server which performs pre-processing and forwards the data to the backend/middleware. The backend/middleware is where computation occurs. Device provisioning is preparing a device to provide a product or service to users. In this case the service will be alerting the fireman, the fire stations and the tourist on the imminent danger. The service is also processing information collected in the cloud and monitoring sensors for information. The service is also providing authentication and security to the data received and processed.

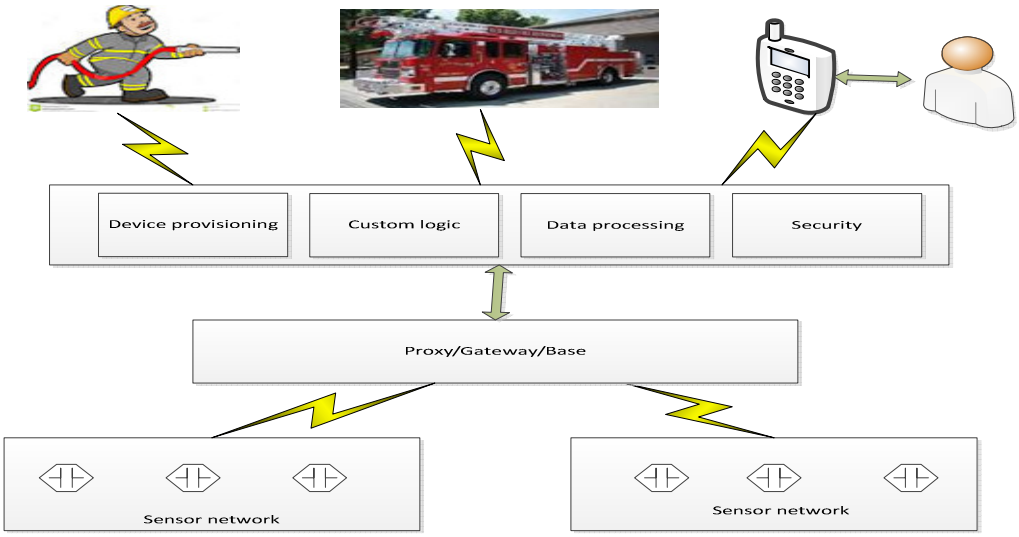

Fig 1: Wildfire alert and detection

6. Conclusions

The adoption of IoT for the South African tourism industry enhances the efficiency of the industry, and impacts on the South African economy. This paper answers the question of what IoT technologies can enhance the tourism industry. The potential applications which are of business benefit to IoT in tourism span the areas of wildlife monitoring and tracking, monitoring seas and waters, birds, and plant species, providing tourist information services, marketing tourism, hospitality and adventure tourism. The research, as it stands, documents what is in the market and not the future technologies. Once S.A. tourism industry starts adopting IoTs it will require its own skills to further develop and customise these IoTs to the South African environment, and to manage the IoT in tourism industry. This will lead to skills and expertise that can even be exported.

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