

Design and Implementation of an Android GIS Data Collection Application for Students with Non-Programming Experience Using the MIT App Inventor: A Case Study on a Tick Data Collection APP

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Abstract

Learning programming can be a daunting task, especially for students without a programming background or non-computer science students. Most Geographic Information Science (GIS) experts and students come from a non-programming background and the development of applications has mostly been perceived to be a field for computer science students and has mostly been shunned by other non-programming students and courses. Compounded by the availability of Open-Source Data collection tools like the Open Data Kit (ODK), learning programming and android application development is often overlooked by Geo Spatial Scientists. Many studies have been done to identify a suitable application development kit to introduce application development to students in non-programming classes. MIT App inventor is a user-friendly drag-and-drop application development platform that is ideal for introducing application development to students with a non-programming background. In this paper, students doing an undergraduate honors degree in spatial sciences were introduced to the MIT App inventor for the development of a Geo-App capable of collecting spatial data that can be exported into a GIS system like Arc GIS, and QGIS after the data has been collected. The paper investigates the suitability of MIT App Inventor in the development of Geo-Spatial Applications. The application was developed for collaborative mapping of tick species for Mashonaland Central Province in Zimbabwe. The main purpose of the application developed is to act as a tool for veterinary extension workers under the Veterinary Services

Department of Mashonaland Central Province allowing them to collect location information for tick monitoring. The application helps expansion workers to moreover outwardly communicate the circumstance at the tick controlling focuses such as plunge tanks by collaboratively making an outline and uploading multimedia records subsequently with an alternative of making calls straight to the veterinary call center in near real-time.

Keywords

App Inventor, Android, Mobile Phone, GIS, Ticks

1. Introduction

Ticks are significant global health and economic issue. Numerous infections can be spread by ticks to both people and animals [1]. The pathogen species involved, the location, and the recording date are crucial pieces of information for defining the geographical spread of ticks. Additional details on tick reservoirs, vectors, research types, and diagnostic techniques will be known when they become accessible [1]. Technologies for ubiquitous computing open up innovative new opportunities for real-time monitoring and analysis of user experience [2]. Centralised databases for the collation of data submitted by field workers are a good utility to spatial scientist, and a centralised geo-database can significantly decrease the time between collection and analysis of data collected by multiple users [3]. Different criteria can be used to identify ticks. In some cases, morphology may be the only criterion [4], but a more comprehensive method may base identification on host species, preference places, geographical occurrence, seasonality, and other factors [5]. Transferring data to these databases and GIS software (e.g. from field notebooks) can be tedious and in some cases will be subject to transcription errors [3], some transcription errors can be corrected of site however it is hard to correct location data while off site thus accuracy is important concerning location component [6]. An alternative to paper collection, such as mobile devices, offers attractive opportunities for spatial data collection in many areas. For example, EpiSurveyor (<https://www.episurveyor.org/>) allows the use of standard Nokia mobile phones for the collection of text-based data and has been utilised in resource-poor areas of Africa for many kinds of data collection [3]. Spatial decision support system (SDSS) has been a lacking component in the data collection, the growth and development of SDSS in Africa has been a tool in the development of location base decisions techniques [7]. With the use of GPS coordinates and possibly accelerometer measures, modern mobile devices offer abundant sources of data for implicit authentication, location, and co-location [8]. Co-location is indicated via WiFi/Bluetooth connections and USB connectors. Additionally, successful sync with a known PC or firebase, as well as successful authentication to a known access point, is all significant fa-

avourable indicators [9].

As data collection is one of the many tasks that spatial scientist does to minimize errors and the need to clean the collected data, usage of digital platforms to collect data will greatly reduce the work load of spatial scientist. The most common data collection tool being used by spatial scientist in Africa is the Open Data Kit [10]. However the ODK architecture has its own limitations and disadvantages especially for users in Africa where internet connectivity is usually expensive, slow and not reliable [11].

Mobile applications are an effective way of collecting geo-spatial data with the most popular platforms IOS and Android now capable of collecting geo-spatial data for example the An Android/IOS Application for Car Parking System Using GPS [12] developed by L D'souza and M Deshmukh. Tick being one of the disease vectors in both domesticated and wild animals mapping of ticks occurrences is very important, thus location based data for ticks help in decision making geographically [13] however GPS units are not affordable by everyone, thus it is better make use of location sensors on the android mobile phones and development of android application for collecting spatial data [14].

The challenge is the development of Geo-Apps by users with a non-programming background and the availability of platforms that can help such users develop the relevant applications with ease but at the same time achieving the goal of collecting spatial data that can be exported further into geo-databases and other GIS software for further processing. R Mall suggests the use of Rapid Application development [15], whose objectives can be summed up in one sentence: the commercial need to deliver working business applications in shorter timescales and for less investment [16]. With the android operating system Play Store, which together represent more than 98.9% of the smartphone app market share [17] it would be prudent to design an application compatible with the android software. Thus there is need for the identification and usage of an RAD that will allow spatial scientists to develop their own applications for data collection with little time invested and less programming effort [18].

The main objective of this study is to assess the applicability of the MIT App Inventor, a drag-and-drop visual programming tool for designing and building fully functional mobile apps for Android [19]. App Inventor promotes the creation of meaningful mobile applications using an intuitive programming metaphor and incremental development capabilities allowing the developer to focus on the logic for programming an app rather than the syntax of the coding language which is based on Android Mobile Application Development is based on Java language codes [20]. It allows people without a programming background to develop applications. To control tick-borne epidemics and potential pandemics, a centralized method of data and information gathering is required. Tick and tick-borne disease researchers, veterina-

rians, medical practitioners, and public health specialists are collaborating to share their expertise on tick ecology, disease transmission, diagnostics, and treatment [21].

2. Materials and Methods

MIT App Inventor Platform

Students were introduced to the MIT App Inventor platform and taught how to design a basic application. Afterwards students were challenged to develop a GIS-Application capable of collecting spatial data. The students used the web-based method in which the developer needs to login to the website to access the development platform (<http://ai2.appinventor.mit.edu/>). When creating an MIT application there are two different screens that are developed; there is designer screen which make up the screen object of the application building up the front end of the application as shown in **Figure 1** then there is block screen which is the back hand of the application with all application programming logics complimenting the designer screen as shown in **Figure 2** [22].

Testing the functionality of developed application the developer could make use of android emulator, App Inventor Companion or USB connection. We only used USB connection method which does not require wireless services but only the connection of the android device to the computer then transfer the application file to the device storage then install the application [13]. For database we

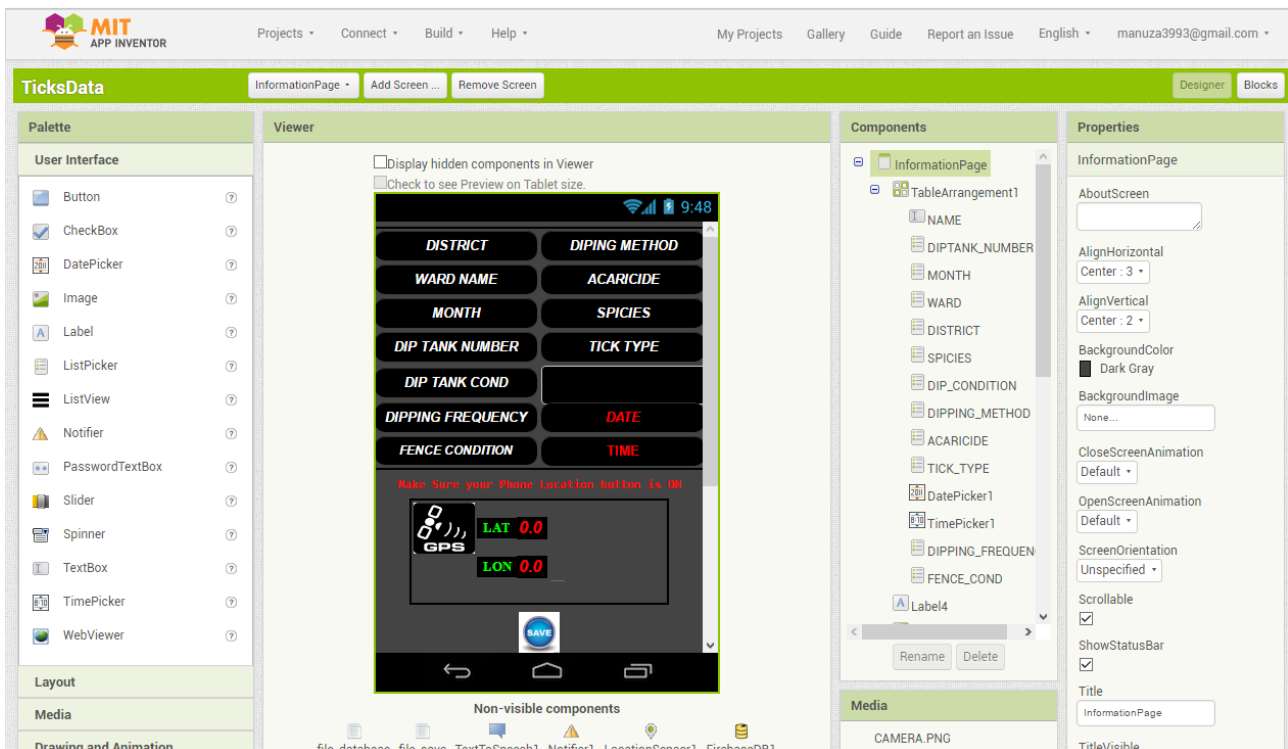


Figure 1. Designer screen.

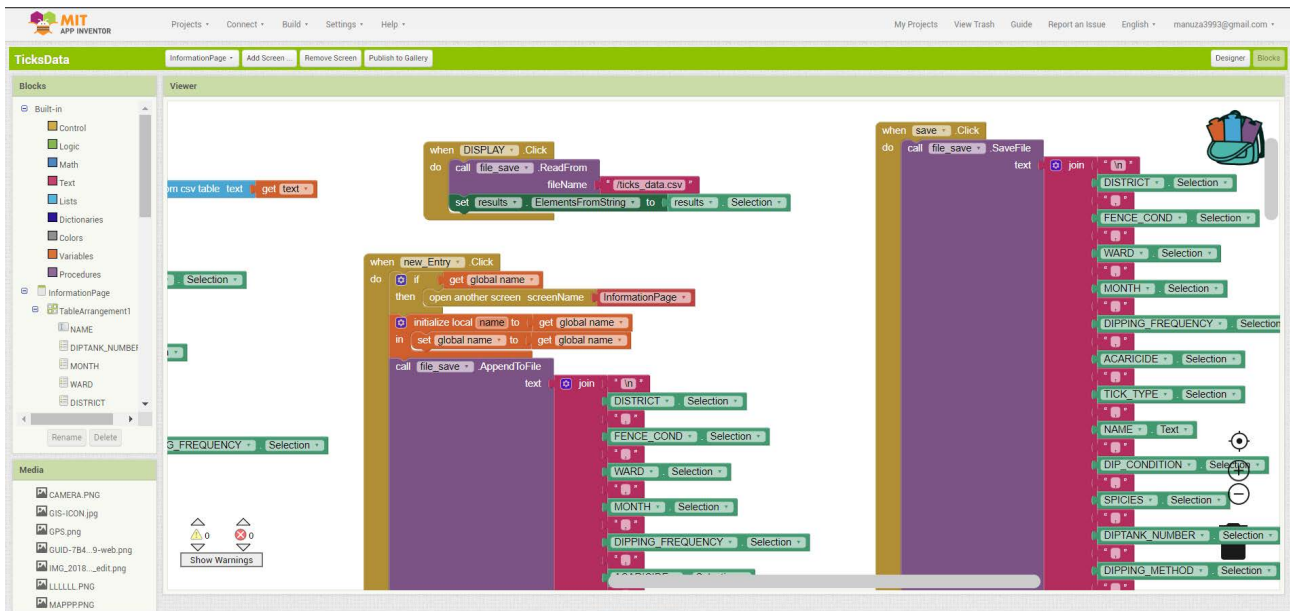


Figure 2. Block screen.

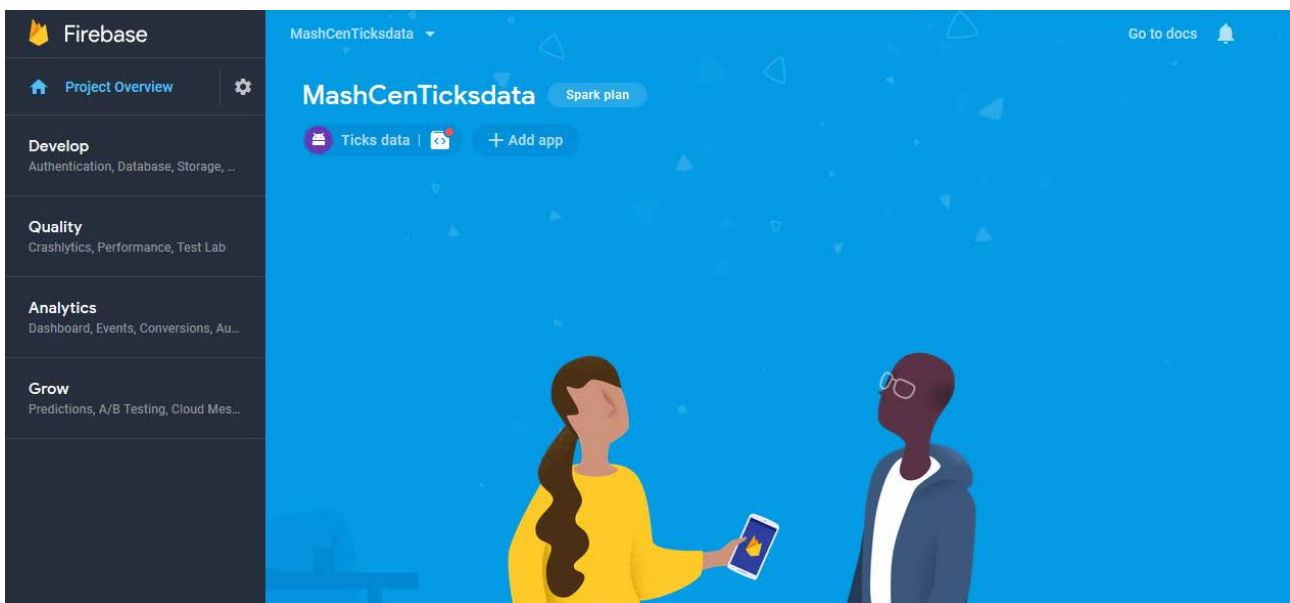


Figure 3. Ticks data Firebase.

made use of file database and firebase database to cater for both offline and online storage serves. To create firebase database, we logged into firebase website (<https://console.firebase.google.com>) and created the database that was connected to the application for real-time data submission as shown in **Figure 3**. To the Firebase database of ticks project it is where all collected data are transmitted all of the output results [23]. Firebase offers a simple method for storing sensory data gathered at the device level and integrates well with Android Things' support for the Android APIs. Many programmers for mobile and handheld devices I encounter struggle with server-side programming.

Firestore genuinely aids in bridging the gap and making it simpler [24]. Firestore delivers features like a real-time database and backend. The application, we were given access to an API that enables the synchronization of application data between clients and cloud storage with Firestore. The business offers the client libraries that allow integration with JavaScript, Android, and iOS application.

3. Results

The design and implementation of android GIS data collection application for students with non-programming experience using MIT app inventor was successful. **Figure 4** shows application login page secured with user name and password. The user name and password have to match the set credential otherwise alert notification for incorrect username or password pops out. Matching user name and password with the set credentials leads to the opening of new screen once login button is clicked on the white tick icon.

Once login is successful the application proceeds to the data collection form. The data collection form was developed with different options, list picker, auto date and time picker, auto latitude and longitude GPS data display.

Most of the data fields are in list picker format with example shown in **Figure 5(c)** an example of district and acaricide fields where by all options are made available, the collector picks from the designed list picker. Date, and time auto

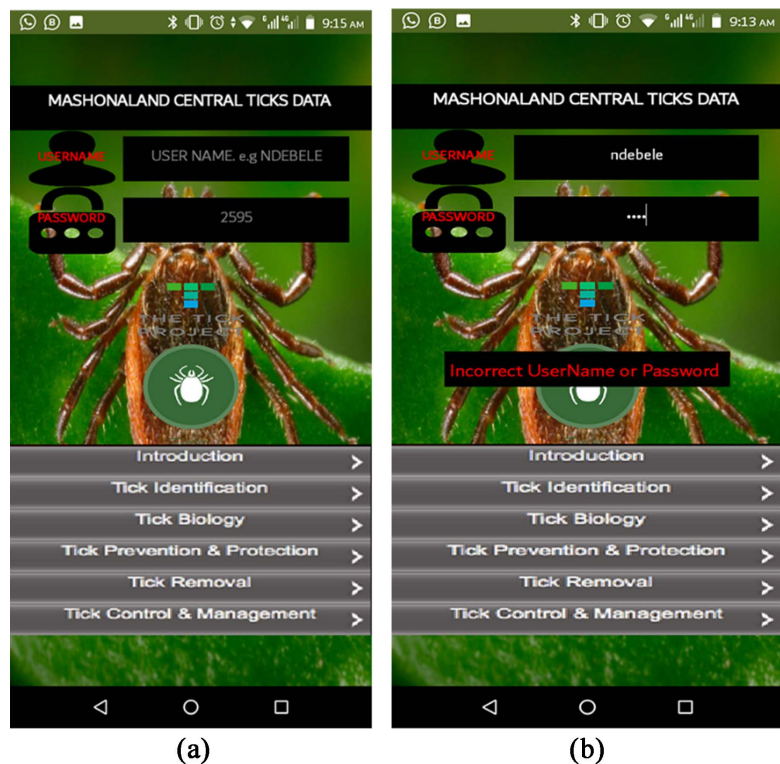


Figure 4. Login page with user name and password hints (a), alert notification for incorrect user name or password entered (b).

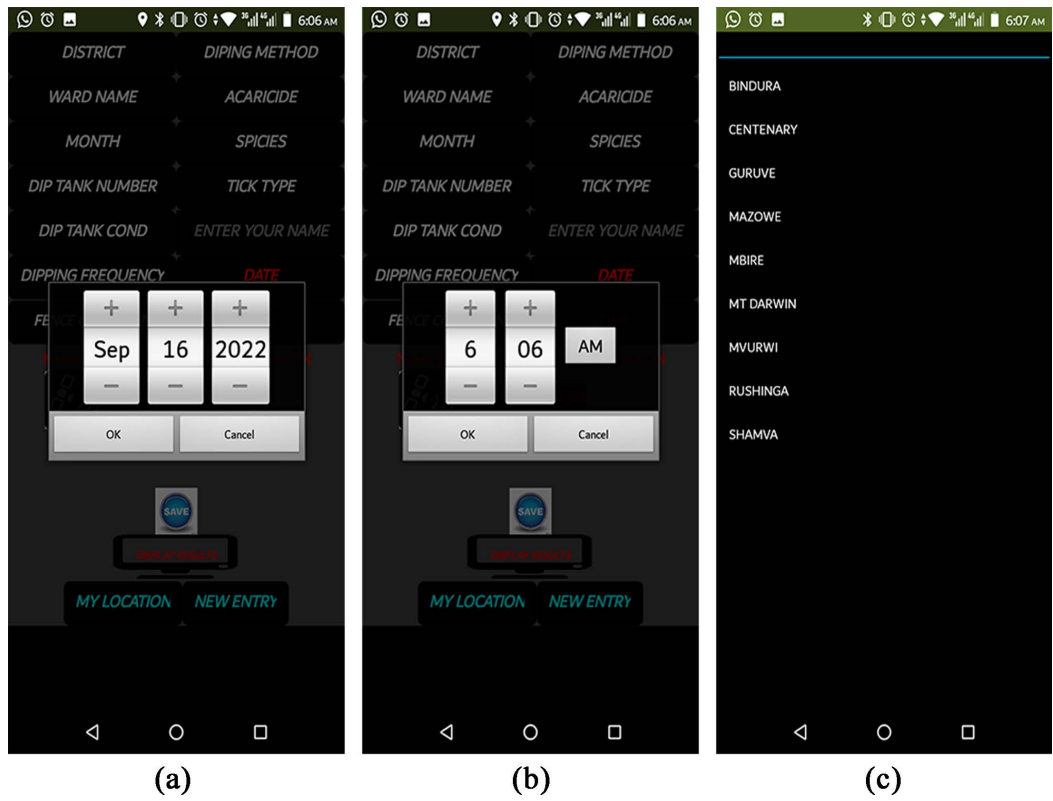


Figure 5. Auto date picker (a), auto time picker (b), list picker(c).

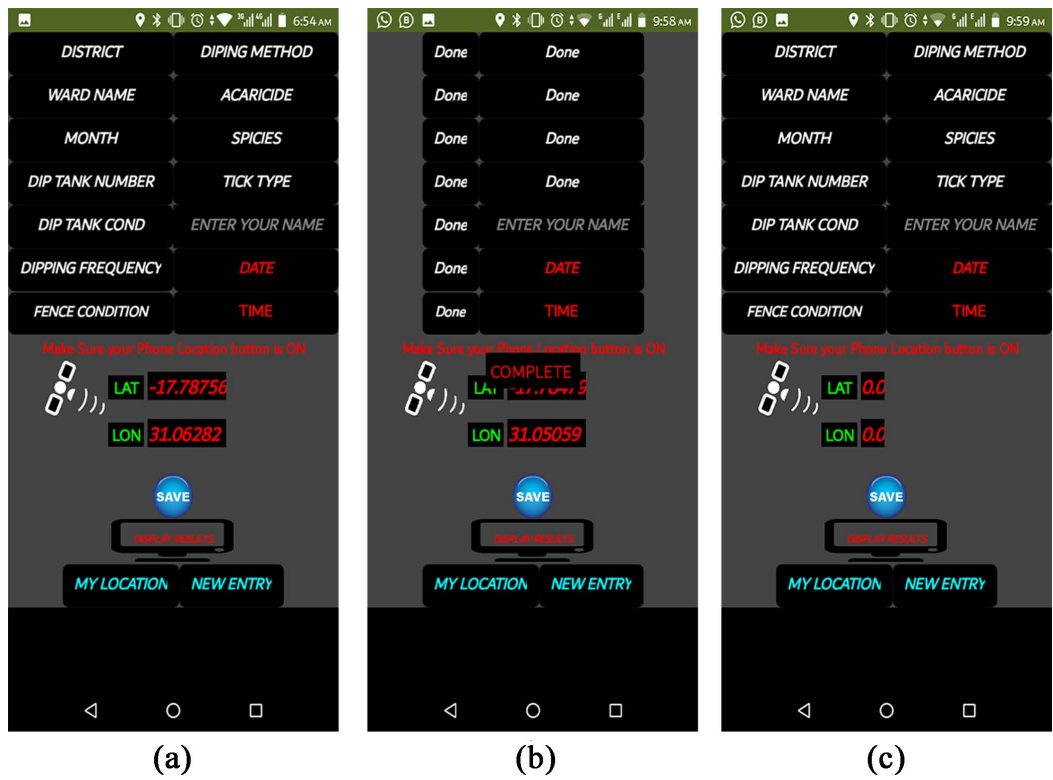


Figure 6. Data collection page (a) collection page after collecting data, (b), collection page after clicking the “NEW ENTRY” button, (c).

pick the date even though it does not display on the collection form rather it displays when display result button is clicked. Lat-long GPS information also auto updates however it updates when the mobile gadget location services is on. In **Figure 6(a)** the data has been entered but not saved, in **Figure 6(b)** the collected data has been saved a condition was set that after saving the collected information all fields are to be cleared and remain written “done” ready for new entry. To input new data entry collection, a condition was set for clearing all previously entered data on the form, this happens after clicking the button the “NEW ENTRY” as shown in **Figure 6(c)** then the form would be ready for new data entry.

Once the data is saved it become saved a submitted to the fire base with incremental primary key set on the built-in control function. Collected data is also saved in file format on the mobile gadget storage system for the purposes of effective and alternative data storage in the event of poor or lack of internet to save on the firebase database. The data saved on the mobile gadget storage is saved in file format as comma-separated values (CSV) such that the collector can easily recall the collected data by clicking the “DISPLAY RESULTS” button and results can be displayed and scrolled while on data collection as shown in **Figure 7(c)**.

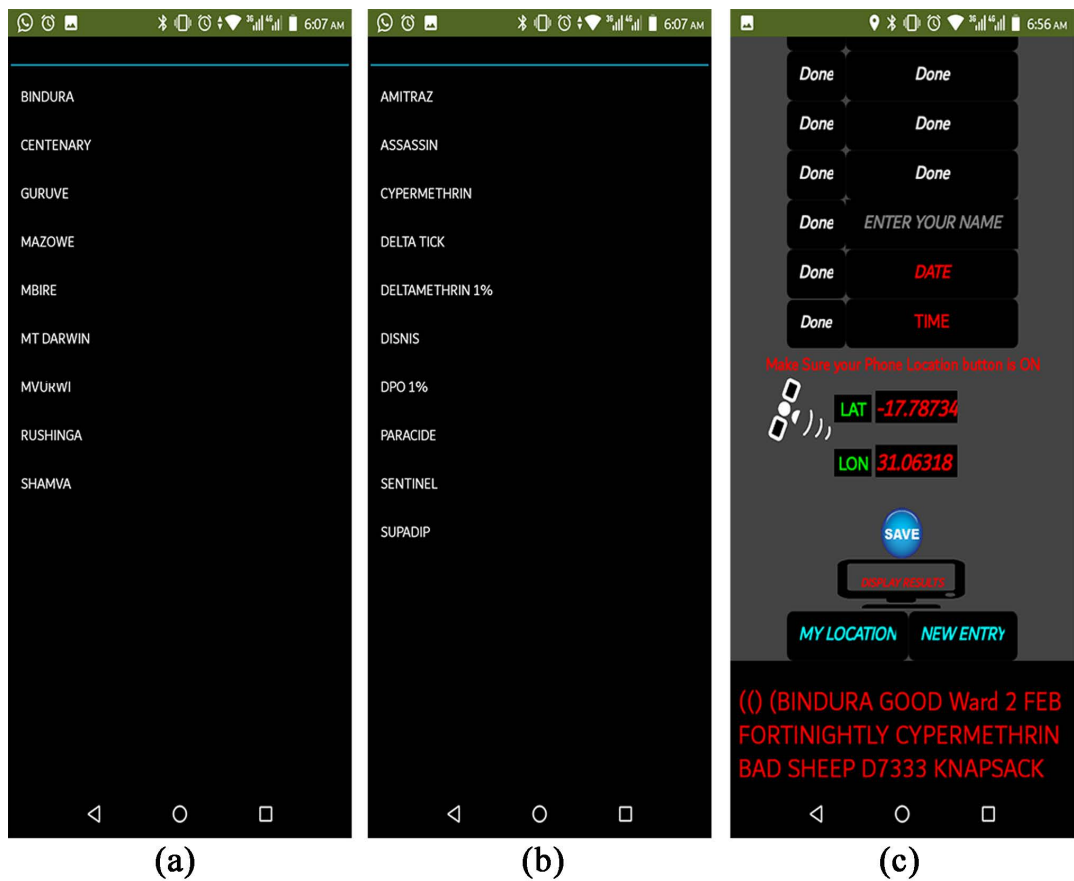


Figure 7. Data collection page. (a) Example of list picker for district field, (b) example of list picker for acaricide field, (c) collection page after clicking display results button, results displaying below.

Figure 7(a) and **Figure 7(b)** demonstrate an example of list picker method of entering the data on the collection form all possible entries for each field were made available in list format, the collector has to pick the appropriate choice for the collected data required.

There is communication and location page are accessed by clicking the button “MY LOCATION”. The purpose of communication and location page is map navigation using Google maps relative to the current location of the collector as shown in **Figure 8(a)** and **Figure 8(b)** and other communication and multimedia options. Camera is also one of the locations and communication which could be used for capturing images in case of a new tick discovery. This is done to have a pictorial view of the tick before being put into preservation bottles where it can possibly die and deform its original view. Camera is also used for taking picture of the controlling point such as dip tanks for purposes of effective reporting for infrastructure management. Collected pictures and videos are stored only on the mobile gadget storage.

Another communication page option is for viewing Google map with current location query taken from Lat-Lon GPS information displayed in the communication

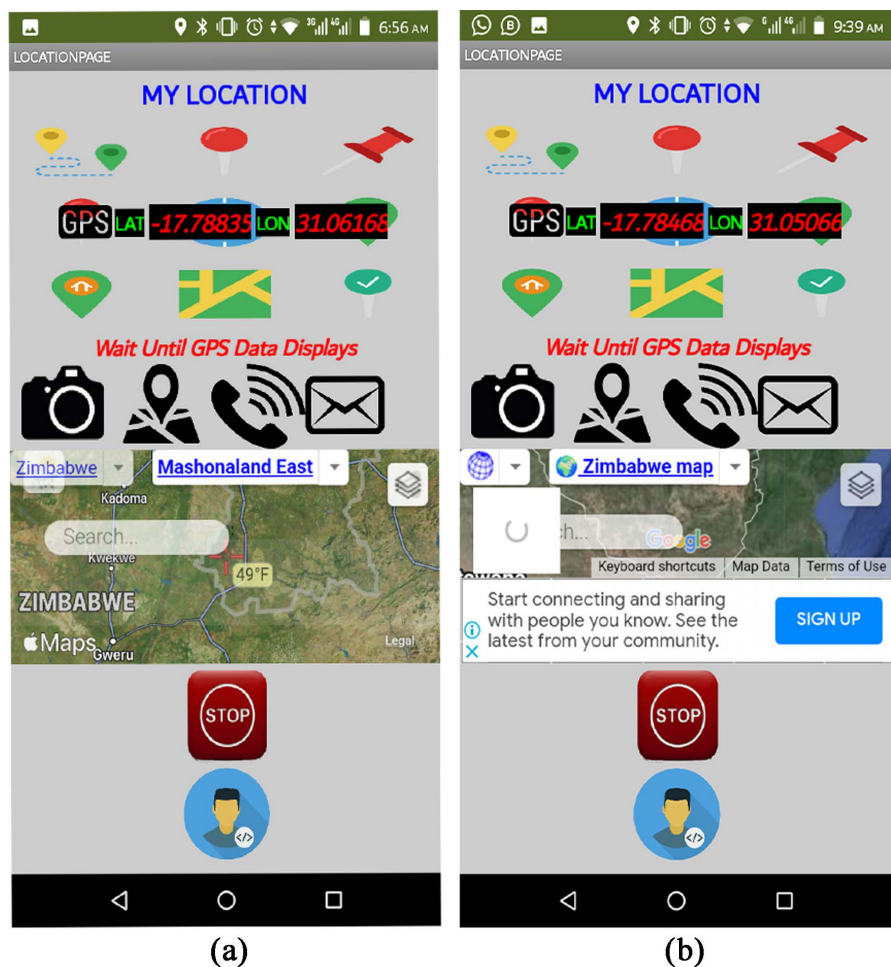


Figure 8. Location and communication page.

and location page. Mobile calling option was also added successfully for direct calling to the veterinary office with the call number with ability to send a text to the same call centre mobile number. All the functions were presented in small icon buttons. For map navigation the map start navigation one map icon button is clicked, to stop map navigation one has to click stop button as shown in **Figure 8** with stop button icon.

There is also developer's page which is accessed by clicking the developer icon button under stop button as shown in **Figure 8(b)** the button leads to next page with contact information of the application developer. The background of the page has developer's picture. There are three main buttons on the developer's page, the name button, contacts button, and website button. Contacts button displays contact details of the developer contacts as shown in **Figure 9(b)**. Name button displays the name of the developer yet website button directs to a light weight website developed by the developer as shown in **Figure 9**.

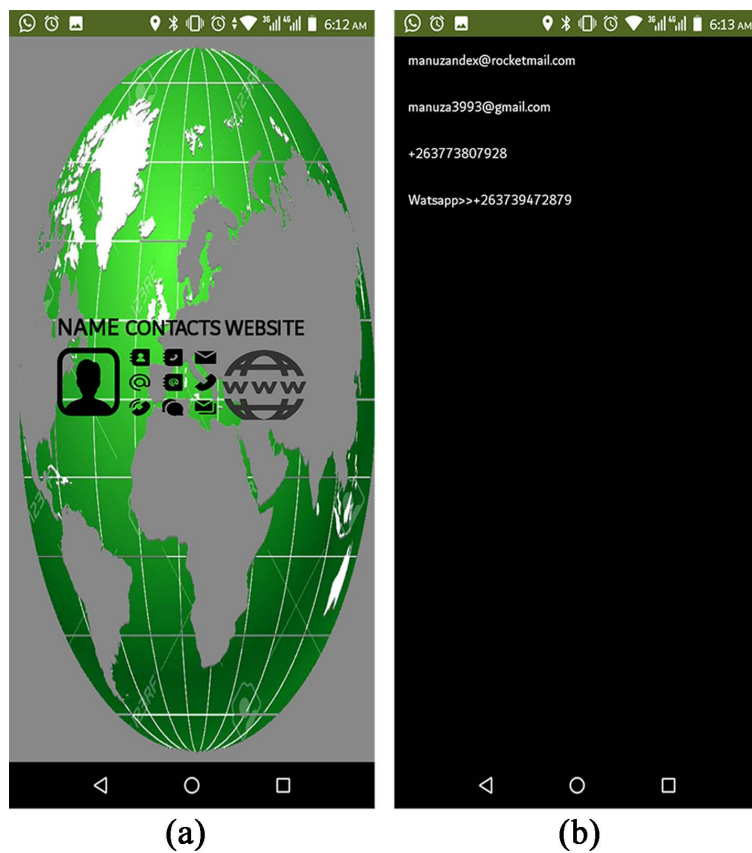


Figure 9. Developer's page.

4. Discussion

The intended design and implementation of an android GIS data collection application for students with non-programming experience using the MIT App Inventor was successful. The design and blocks developments were developed stage by stage with easy development of blocks in the google MIT app Inventor

environment [22] following the five general phases of application development which are discovery, wire-framing, prototyping, implementation, and deployment [25]. Besides that, MIT app inventor is a drag and drop way of programming. It constituted an alternative, quite easy way of developing customised data collection application with location services thus MIT app inventor became a powerful programming base for students with little or no programming experience [26]. The easiness of development of tick data collection application did not compromise the standards of data collection applications especially the GIS component of the applications as MIT app inventor has ability to develop mobile applications with GPS sensors, application using databases and database online servers such as Firebase online database. The developed application has functionality of visual and interactive maps, mobile calling, mobile texting and other advanced concepts without having to lay down a hard or complicated code or learning any programming language [27]. The collected data is saved in CSV format that can be exportable to a GIS package such as ArcMap or Quantum GIS (QGIS) [28], the data file with high integrity. The data collection form was made with a much data being collected using list picker all options being included on the list this helped in maintaining database integrity and errors during data collection. The collected data is ready for spatial analysis and modelling using different methods such as ensemble techniques using Species Distribution Models (SDM) [29]. The tick data collection application was tested on various Android mobile phones with different frameworks, the responses from the tested Android mobile gadgets are satisfying the users.

5. Conclusion

Design and implementation of an android GIS data collection application for students with non-programming experience using the MIT App Inventor for Android mobile phone has been discussed. The purpose of the built developed application is to use mobile phone's inbuilt GPS facility for collecting data with location characteristics in near real time also increasing database integrity hence reducing errors in data collection. The complete application so has been designed using MIT App Inventor for Android. The application program was tested on various Android mobile phones with various Android versions in which results are quite satisfactory.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Vesco, U., *et al.* (2011) An Integrated Database on Ticks and Tick-Borne Zoonoses in the Tropics and Subtropics with Special Reference to Developing and Emerging Countries. *Experimental and Applied Acarology*, **54**, 65-83.

- <https://doi.org/10.1007/s10493-010-9414-4>
- [2] Gaggioli, A., *et al.* (2013) A Mobile Data Collection Platform for Mental Health Research. *Personal and Ubiquitous Computing*, **17**, 241-251.
<https://doi.org/10.1007/s00779-011-0465-2>
- [3] Aanensen, D.M., *et al.* (2009) EpiCollect: Linking Smartphones to Web Applications for Epidemiology, Ecology and Community Data Collection. *PLOS ONE*, **4**, e6968. <https://doi.org/10.1371/journal.pone.0006968>
- [4] Tagwireyi, P., *et al.* (2022) Climate Change Diminishes the Potential Habitat of the Bont Tick (*Amblyomma hebraeum*): Evidence from Mashonaland Central Province, Zimbabwe. *Parasites & Vectors*, **15**, Article No. 237.
<https://doi.org/10.1186/s13071-022-05346-z>
- [5] Salman, M.D. (2012) Ticks and Tick-Borne Diseases: Geographical Distribution and Control Strategies in the Euro-Asia Region. CABI Publishing, Wallingford.
<https://doi.org/10.1079/9781845938536.0000>
- [6] Singhal, M. and Shukla, A. (2012) Implementation of Location Based Services in Android Using GPS and Web Services. *International Journal of Computer Science Issues*, **9**, 237.
- [7] Muhsen, D.K. and Hassan, R.F. (2018) The Intelligent SDSS Mobile Application to Find the Closest Hospital Using the Improved Dijkstra Algorithm with GIS and GPS. *Al-Ma'mon College Journal*, No. 31, 239-266.
<https://doi.org/10.36458/1253-000-031-013>
- [8] Alexander, H., Leo, J. and Kaijage, S. (2021) Online and Offline Android Based Mobile Application for Mapping Health Facilities Using Google Map API. Case Study: Tanzania and Kenya Borders. *Journal of Software Engineering and Applications*, **14**, 344-362. <https://doi.org/10.4236/jsea.2021.148021>
- [9] Piasecki, T.M., *et al.* (2007) Assessing Clients in Their Natural Environments with Electronic Diaries: Rationale, Benefits, Limitations, and Barriers. *Psychological Assessment*, **19**, 25-43. <https://doi.org/10.1037/1040-3590.19.1.25>
- [10] Brunette, W., *et al.* (2013) Open Data Kit 2.0: Expanding and Refining Information Services for Developing Regions. *Proceedings of the 14th Workshop on Mobile Computing Systems and Applications*, Jekyll Island, 26-27 February 2013, Article No. 10. <https://doi.org/10.1145/2444776.2444790>
- [11] Peroni, M. and Bartolo, M. (2018) The Digital Divide. In: *Multidisciplinary Teleconsultation in Developing Countries*, Springer, Berlin, 101-109.
https://doi.org/10.1007/978-3-319-72763-9_13
- [12] D'souza, L. and Deshmukh, M. (2018) An Android/IOS Application for Car Parking System Using GPS.
- [13] Rose, J., *et al.* (2017) Genetic Characterization of Spotted Fever Group Rickettsiae in Questing Ixodid Ticks Collected in Israel and Environmental Risk Factors for Their Infection. *Parasitology*, **144**, 1088-1101.
<https://doi.org/10.1017/S0031182017000336>
- [14] Hirwane, R., *et al.* (2017) Real Time Communication for Emergency Treatment & Nearest Hospital Searching IOT Based System Using Android Application.
- [15] Mall, R. (2018) Fundamentals of Software Engineering. PHI Learning Pvt. Ltd., Singapore.
- [16] Beynon-Davies, P., *et al.* (1999) Rapid Application Development (RAD): An Empirical Review. *European Journal of Information Systems*, **8**, 211-223.
<https://doi.org/10.1057/palgrave.ejis.3000325>

- [17] Giunti, G., *et al.* (2018) A Biopsy of Breast Cancer Mobile Applications: State of the Practice Review. *International Journal of Medical Informatics*, **110**, 1-9. <https://doi.org/10.1016/j.ijmedinf.2017.10.022>
- [18] Patel, P. and Cassou, D. (2015) Enabling High-Level Application Development for the Internet of Things. *The Journal of Systems and Software*, **103**, 62-84. <https://doi.org/10.1016/j.jss.2015.01.027>
- [19] Pokress, S.C. and Veiga, J. (2013) MIT App Inventor: Enabling Personal Mobile Computing.
- [20] Holla, S. and Katti, M.M. (2012) Android Based Mobile Application Development and Its Security. *International Journal of Computer Trends and Technology*, **3**, 486-490.
- [21] Sakamoto, J.M. (2018) Progress, Challenges, and the Role of Public Engagement to Improve Tick-Borne Disease Literacy. *Current Opinion in Insect Science*, **28**, 81-89. <https://doi.org/10.1016/j.cois.2018.05.011>
- [22] Jivani, M.N. (2014) GSM Based Home Automation System Using App-Inventor for Android Mobile Phone. *International Journal of Advanced Research in Electrical Electronics and Instrumentation Engineering*, **3**, 12121-12128. <https://doi.org/10.15662/ijareeie.2014.0309042>
- [23] Oo, Z., *et al.* (2019) IoT-Based Weather Monitoring System Using Firebase Real Time Database with Mobile Application. *International Symposium on Environmental-Life Science and Nanoscales Technology*, Yangon, 27-28 December 2019, 1-6.
- [24] Gupta, S., *et al.* (2020) Design of Home Appliance Control Unit Using Google Fire-base IOT Service.
- [25] Kang, H., *et al.* (2015) Application Study on Android Application Prototyping Method Using App Inventor. *Indian Journal of Science and Technology*, **8**, 1-5. <https://doi.org/10.17485/ijst/2015/v8i18/75919>
- [26] Gray, J., *et al.* (2012) Teaching CS Principles with App Inventor. *Proceedings of the 50th Annual Southeast Regional Conference*, Tuscaloosa, 29-31 March 2012, 405-406. <https://doi.org/10.1145/2184512.2184628>
- [27] Pokress, S.C. and Veiga, J. (2013) MIT App Inventor: Enabling Personal Mobile Computing.
- [28] Romero, D., *et al.* (2014) Fresh City Farms-Food Availability in the City of Toronto: Assessing Food Availability and Food Deserts in the City of Toronto with Respect to Fresh City Farm's Current Customers.
- [29] Chakuya, J., *et al.* (2022) The Status of Honeybees (*Apis mellifera scutellata*) Colonies in Hurugwe Safari Area-Rifa Section, Northern Zimbabwe. *Geology, Ecology, and Landscapes*, 1-11. <https://doi.org/10.1080/24749508.2022.2109829>