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PROGRAMMING AND DESIGNING SURVEYING AND CIVIL ENGINEERING APPLICATION FOR ANDROID

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Abstract

In response to the technical revolution that the world is experiencing, the mobile phone represents one of its most prominent features. Engineers face some problems at work sites that require software to perform calculations such as calculating coordinates and areas. This research aims to present the design of an engineering application for mobile phones for surveying and civil engineers to facilitate the calculations that they need at work sites to save time and effort. This paper was started using Matlab and then Android Studio to design the application interface and to make the connection between the elements of the user interface, where some surveying calculations were programmed that may take some time to calculate manually and also take advantage of the GPS that the device contains to determine the location and do some surveys such as calculating the distances, areas and also raising points for a specific area, the application was raised on the Google Play platform. The application can be downloaded to the smartphone by searching Google Play with the name Surveying Calculations or through the link.

https://play.google.com/store/apps/details?id=com.uob.zevlog

Keywords:

Matlab,
the Basics of Java,
the Google Play,
the Android Studio,
GPS,
Surveying Calculations

1 Introduction

Surveying can be defined as the science of determining geographic location on the surface of the earth in two- or three-dimensional representations that help in producing maps, contour lines, or a three-dimensional model [1, 2]. Computers and smartphones through the Android system and others have the ability to have fast processors and high-resolution screens, and they are also available in the markets and sometimes at reasonable prices, so some engineering applications can be programmed using smartphones, computers, or tablets [3,4,5,6]. MaqTest is an application programmed using Android Studio, easy to use, with accurate results, and can be used through tablets and smartphones [7,8]. The Java language, as a result of the convergence between smartphone technologies, tablets, and computer programs, has helped provide a good opportunity through the Android system for these applications to work on a library of applications in the economic and financial field, as this application helped in calculating business and financial volume forecasts in an ideal time and with good accuracy [9,10].Engineers need to make quick and accurate calculations in order to save time at work sites, discussions and research using modern programs that give high-precision results in a short time [11 ,12].The surveying works in engineering sites involve filed surveying or monitoring of concrete buildings, engineering roads or large dams. These works begin with the use of engineering survey devices of all kinds, whether total stations, GPS or other devices. In addition, the surveying office works involve the operations off calculating distances, directions and areas, determining locations, storing the data and using office work or drawing some contour lines or drawing maps safely by using some specialized programs that give the required accuracy within previously specified limits.in current time, the surveying office works has become much easier thanks to the development of computers and programming. To collect field data in many engineering sites, but with the development of smart devices and the

expansion of the use of mobile phones with advanced technology, the old method of mapping and surveying has been replaced [13,14].

2 Research objectives

This research aims to demonstrate that a smartphone with processing and sensors is a tool that can be used to collect field exploratory information in addition to a GPS accuracy test to see if it is suitable for gathering exploratory information and also to prove the fact that mobile applications can be used as a simple and effective learning tool in all cases and conditions.

3 Literature review

In 2013 Borland, M., found that the free TAPAS application provides many quick and convenient calculations to use in circumstance and analysis estimates that are usually performed with a brochure and calculator [3]. In 2018 Eduardo, C. A. and others showed that education has progressed well through the use of the Android application due to its ease of use, especially with the use of smartphones, which helped students understand mechanical theory and machine theory. The number of students using it increased from 14.84% to 37.76%. This indicates that the application was useful for students. According to the survey, 89% of students consider the application to help study and improve their grades, while 91% of students find it suitable [7].

4 Designing the programs

Surveying engineering has taken another form as a result of the development through the development of software and computer as well as the technology of the GPS navigation system, The software languages have become important in engineering through which we make an application that helps in surveying work, and these applications include ground survey and aerial survey. Survey engineering needs attention and development of data processing from these applications through planning and designing programs for data processing that is accurate and fast is an important element today in all various fields.

5 Background for Android Studio

Under the tremendous increase in the use of smart phones and tablets, smart phone applications are among the most demanding programs in the IT market. Java is one of the programming languages that many engineers and software developers use in the field of large development. in smart devices. This language is considered one of the programming languages most used by developers and programmers to create applications and games for the Android system [14]. Kotlin is also an Object-Oriented programming language that works on the Java platform and can be run on a JavaScript platform. The language was developed by a group of programmers at JetBrains, the same company that developed Android Studio, and Kotlin was designed to deal and fully compatible with Java and allows writing code with fewer lines, faster and more efficiently compared to Java, as it is similar to Apple's swift language .MATLAB is a very powerful language for technical computing stands for Matrix Laboratory, because its basic data element is a matrix. MATLAB can be used for mathematical calculations, the most natural expression of computational mathematics, modeling and simulation [14,15]. The Android Studio designing interface consists of 1: Object Attributes. 2: UI. 3: Tools Palette.

4: Component Tree. 5: File manager. 6: Gradle Sync and Compiler Builder 7: Programming window. as shown in figures (1) and (2).

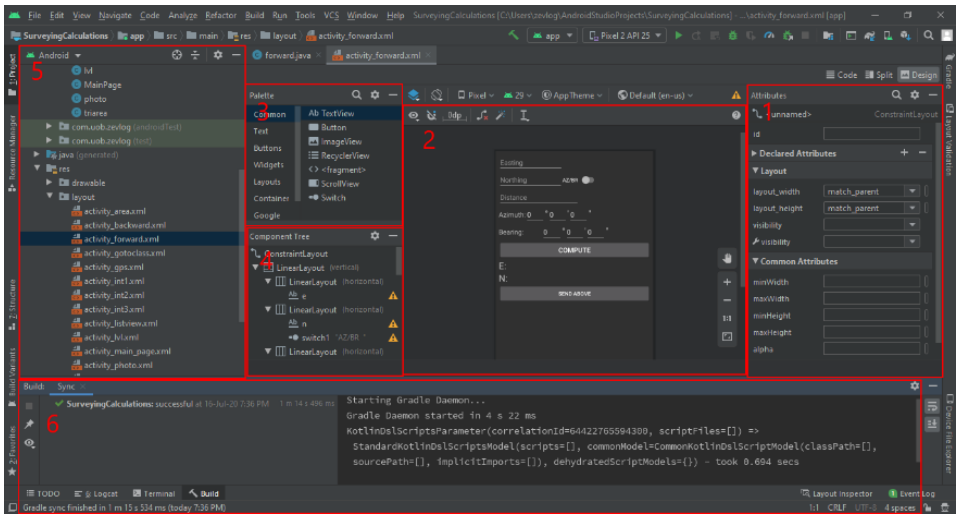

Fig. 1: Android Studio designing interface

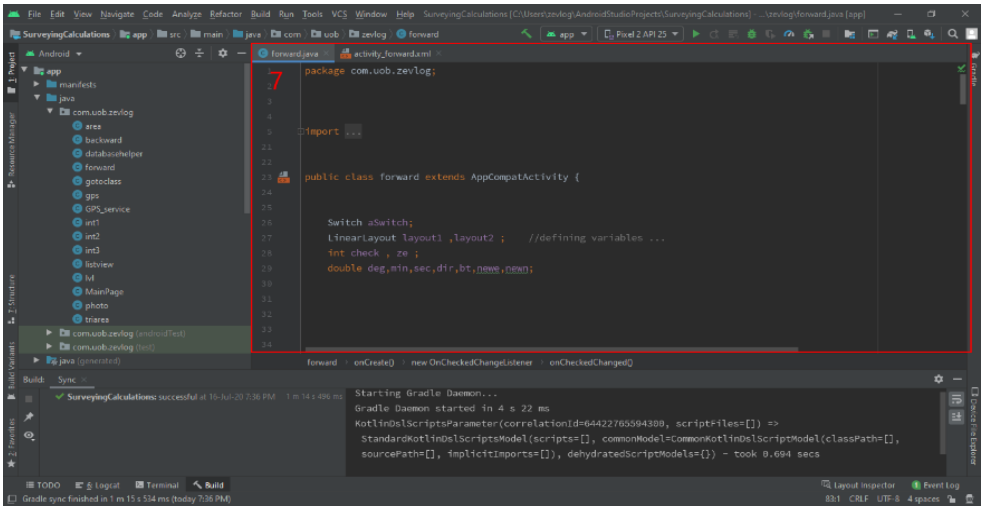

Fig. 2: Android Studio programming interface

6- Application design

The most important laws used in the application:

6.1 Forward Computations

Forward calculations are used to obtain the coordinates of the end of the line. If you know the coordinates of the starting point and the length and direction of that line in the figure (3), the known is the coordinates or location of the point P1, which are (E1, N1) and the length of the line (S) and its direction (Az). The required is to calculate the coordinates of the endpoint, P2, is (E2, N2), and it is calculated from the following formula [2]:

$$N2 = N1 + S.Cos(Az) \quad (1)$$

$$E2 = E1 + S.Sin(Az) \quad (2)$$

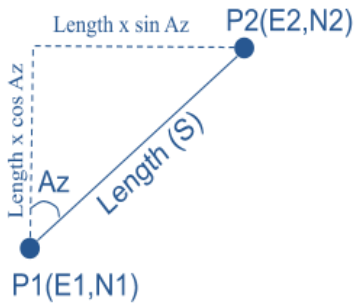

Fig. 3: forward calculations example

6.2 Inverse Calculations

Inverted calculations are used to obtain the length and direction of a line if you know the coordinates of the beginning and ends of that line, it is also used to obtain the true direction of a side in the work of ribbing and triangulation if necessary, and you find two points. The coordinate information in the figure (4) is known as the coordinates of the starting point P1 and they are (E1, N1) the terminal is P2 and are (E2, N2)

As for what is required: it is to calculate the length of the line (S) and its direction (Az) from the first point P1 to the second point P2, and it is calculated as follows:

$$Az_{1\to2} = Tan^{-1}\left(\frac{E2-E1}{N2-N1}\right) \quad (3)$$

$$S = \sqrt{(E2-E1)^2 + (N2-N1)^2} \quad (4)$$

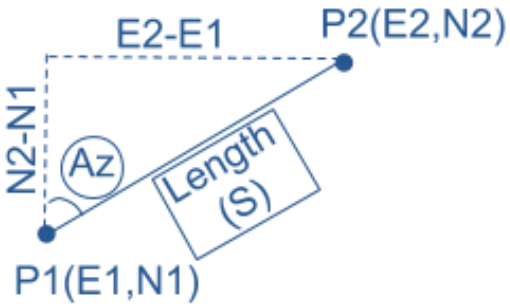

Fig. 4: backward calculations example

6.3 Intersection

This intersection is geometrically represented by the intersection of two straight lines, because the two sides are known in both directions, and therefore their slopes are constant, as they are straight intersecting at a point. Parallels (according to the existing case of the connection of the sides with each other, the sides so that they make the two unknown sides adjacent and form a triangle that can be solved in one of the ways that will be mentioned in each intersection. Thus, a known shape is formed in which the coordinates of the two end points and two unknown sides intersecting at a point (symbolized by To her, P) as shown in the figure (5) and the line connecting P1 P2 is called the base line. As for what is required is to calculate the location of the point 3. The first intersection can be calculated from the analytical method through the following laws [2]:

$$E3 = \frac{E1cot\measuredangle 2 + E2\ cot\measuredangle 1 + N1 - N2}{cot\measuredangle 1 + cot\measuredangle 2} \quad (5)$$

$$N3 = \frac{N1cot\measuredangle 2 + N2\ cot\measuredangle 1 + E1 - E2}{cot\measuredangle 1 + cot\measuredangle 2} \quad (6)$$

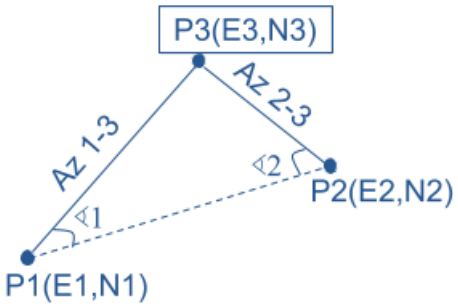

Fig.5: Intersection I example.

6.4 Area Calculations using Coordinates method.

If you know the coordinates of the corners of a closed-shaped segment as shown in the figure (6 and 7), then the segment area can be computed by using the coordinate law to calculate the area, which can be formulated as follows:

Area = [(X1.Y2+X2.Y3+.X3.Y4+X4.Y1)-(Y1.X2+Y2.X3+Y3.X4+Y4.X1)] / 2 (7)

E	N
X1	Y1
X2	Y2
X3	Y3
X4	Y4
X1	Y1

Fig. 6: Area calculations example

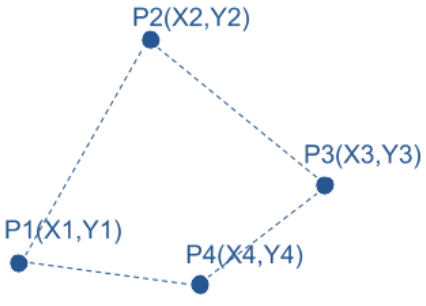

Fig. 7: Area calculations example

6.5 Leveling

The levelling work has great importance in finding the elevations of unknown points from known points or hypothetical points that can be used in earthworks and calculating volumes[16,17].The levels are calculated as shown in table (1).

Table 1: Calculating elevations

Point	Back sight	Intermediate-sight	Foresight	Elevation
BM1	2.554			50
A1		1.786		50+(BS-IS)=50.768
A2		0.927		50+(BS-IS)=51.627
A3	1.305		3.589	50+(BS-FS)=48.965
A4		1.422		48.965+(BS-IS)=48.848
A5	3.250		0.571	48.965+(BS-FS)=49.699
A6		1.925		51.024
A7	0.462		3.015	49.934
A8			0.780	49.616

These equations have been programmed to give the output directly after each step and to be saved in a table designated to be printed and saved as a Text file in the device's memory to be included in the work report after the completion of the work.

6.6 Determining location by GPS

All cell phones contain an antenna to capture information from satellites to locate the device, and it appears as Longitudes and latitude (λ, φ) Then it is transferred to (E, N) according to the equations below.

$$N = N_\circ + K_\circ(m\text{-}m_\circ + Term\ 1 + Term\ 2 + Term\ 3) \quad (8)$$

$$E = E_\circ + K_\circ\, \upsilon\, \omega\, cos\varphi\, (1 + Term\ 1 + Term\ 2 + Term\ 3) \quad (9)$$

The result can be saved in the SQLite database of the Android device and accessed at any other time.

7 Results and Discussions

A program for the computer and mobile phone that calculates some of the main calculations in the area and as follows:
The program can be used to calculate the forward computations problem after entering the data and pressing Compute as shown in the figure (8). The outputs are output to the bottom of the graphical user interface and are strictly 4 values in decimal after the sorter. String. format is used in Java and sprintf in MATLAB.

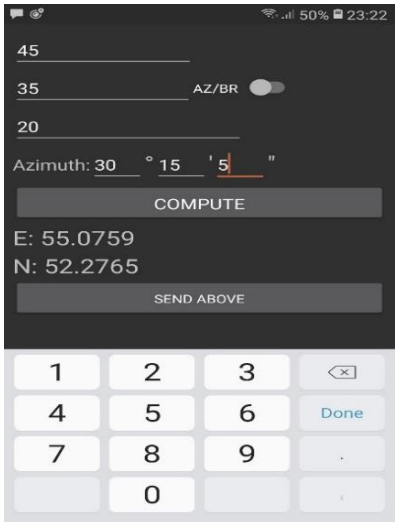

Fig. 8: forward computations android application UI

In inverse computations the distance and direction can be calculated between any two points after entering them in the user interface and the outputs will appear at the bottom of the user interface and the direction will be in the form of Azimuth and Bearing, and they can be converted by the Switch Button in the upper left part of the interface in Android and you do not need that in the MATLAB interface as Points can be called from the saved database from GPS coordinates as shown in figures (9 and 10).

Fig. 9 inverse computations android application UI Figure

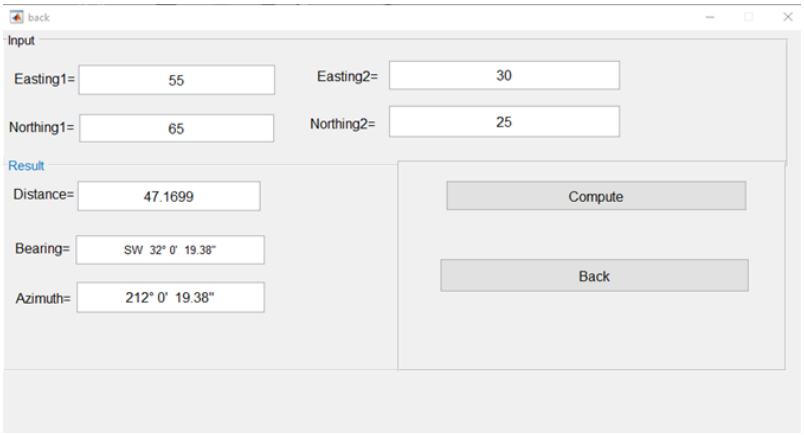

Fig. 10 inverse computations MATLAB UI

To solve intersection problem, the application or program that has been prepared can be used by entering the information given in its designated places and pressing Compute to calculate the output and it will appear to the bottom of the interface as in the figure (11). It should also be noted that the directions must be towards the unknown point on Android and in the case of MATLAB, the second direction should only be from the unknown point towards the second known point.

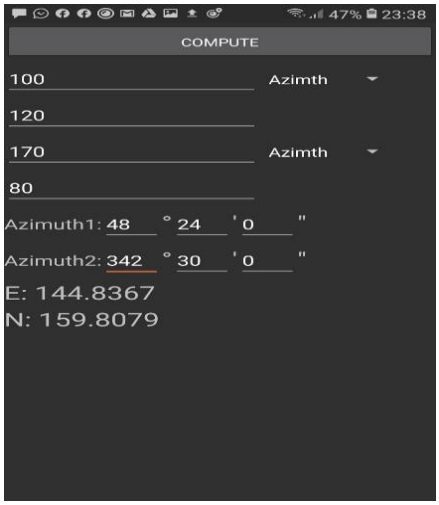

Fig. 11: Intersection I android application UI

The application can be downloaded to the mobile phone by searching Google Play with a name Surveying Calculations or through the link
https://play.google.com/store/apps/details?id=com.uob.zevlog
the icon of the application and its QR code are shown in figure (12).

Fig. 12: application icon and QR code for obtaining Surveying Calculations from the Google Play store.

8 Conclusions

From the results obtained by this research the main conclusions have been as follow:

- The smartphone has become an important part of our life, so the idea arose to set up an application to do cadastral calculations, the most important of which is to calculate areas and the inverse calculations, which is one of the important problems to surveying engineer.
- The fact that the smartphone contains a GPS antenna to capture coordinate information with an accuracy of 1-3 meters makes the phone a useful tool for collecting reconnaissance and near real coordinates for a specific area with the ability to save them and transfer them to a computer for further work.
- The notebook can be dispensed with in the fieldwork with the leveling device, and the application can be used to record and save data, and to perform calculations on Microsoft Excel and attach them to the work report without using paper to record them.
- After browsing some of the applications on Google Play, it was noticed that most of the survey applications for mobile devices are paid applications or not integrated, or may be missing some survey computations, so most of the surveying engineer needs were collected in one application with an easy-to-use interface so that everyone can use it without restrictions.
- After the application was released on the Google Play platform, it became available to everyone and free of charge the application can be used for educational purposes and does not need the Internet to use it.

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