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GPS based Handheld System for Land Area Measurement

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***Abstract* — Most often there arises a situation of not being able to measure huge areas of land using the conventional methods like measuring tape because of different reasons like the land being uneven or presence of trees, bushes or buildings in the path. To overcome this problem, we can use the GPS module for measuring land and calculating the area. The borders of the land which we want to measure can be marked by finding the location coordinates with the help of GPS module. The land is divided into triangular portions and area of individual portion is calculated and then all the areas are added to get the total land area. By using this method, distance between two points and area of a given field can be calculated with ease. This would require less man power when compared to the conventional methods and the task of land measurement will be simplified.**

***Keywords*— GPS module, Area calculation, location coordinates.**

I. INTRODUCTION

In the olden days, land measurement was done by following traditional methods like using the measuring tapes. Land measurement becomes difficult if we need to measure huge plots or if we have any obstacles in the path. It is difficult if the land in irregular or when there is a tree, bush, building or a cliff in our way. These problems can be overcome by using the GPS module for land measurement. This saves lots of effort as there is no need of stretching the tape throughout the path. If we need to measure the area of a given field, then the task becomes even more hectic using the conventional methods. We must mark all the borders separately and then find the area by regular calculation. So, we have developed a system which can measure the land using the GPS module. To find distance between two points, we need to find the location coordinates of two ends of the path. So, we can simply use the device which notes the positions of two points with help of GPS module and then displays the distance between them. We can also find the area of polygon shaped fields by noting the end points of all sides and dividing them into triangles. The areas of individual triangle are calculated and then added to get the final area. In this way, we can even find areas of large fields. This method requires less man power and also consumes less time when compared to the conventional methods. The error rate of a GPS module is about 2 to 5 meters, so the error we get is very less which practically can be considered to be negligible while measuring large areas in scale of kilometres or miles. Land measuring using the GPS module simplifies the task of finding distance between two points or area of a field. Even if one end is located at a higher altitude and other end is located at lower altitude, the horizontal distance between the points can be found with ease. The boards used in this project are Arduino and GPS module.

II. LITERATURE SURVEY

A. Surveying

It is a popular method to find the terrestrial or three dimensional positions of the points and distances between them. A land surveying professional is called land surveyor. The equipment used involves total stations, theodolites, GNSS scanners, radios etc. Land measurement using surveying becomes difficult if an obstacle is present in our path.

B. Measuring Scales

Scales which can also be termed as rulers are used in measuring of shorter distances. We generally use a metallic strip on which measurements are marked. We use the metallic strip to measure distances which takes a lot of time and there is a possibility of errors. The error may occur due to wrong marking on the scale or due to expansion or contraction of metal strip due to climate.

C. Measuring Tapes

The most widely used instruments for land measurement are the measuring tapes. The measuring tapes are the long flexible rulers usually made of plastic or fiber or metal. The readings are marked on the tapes, so we need to extend the tape to cover the distances. This may involve some errors because of presence of any obstacles in between or presence of irregular lands.

III. WORKING

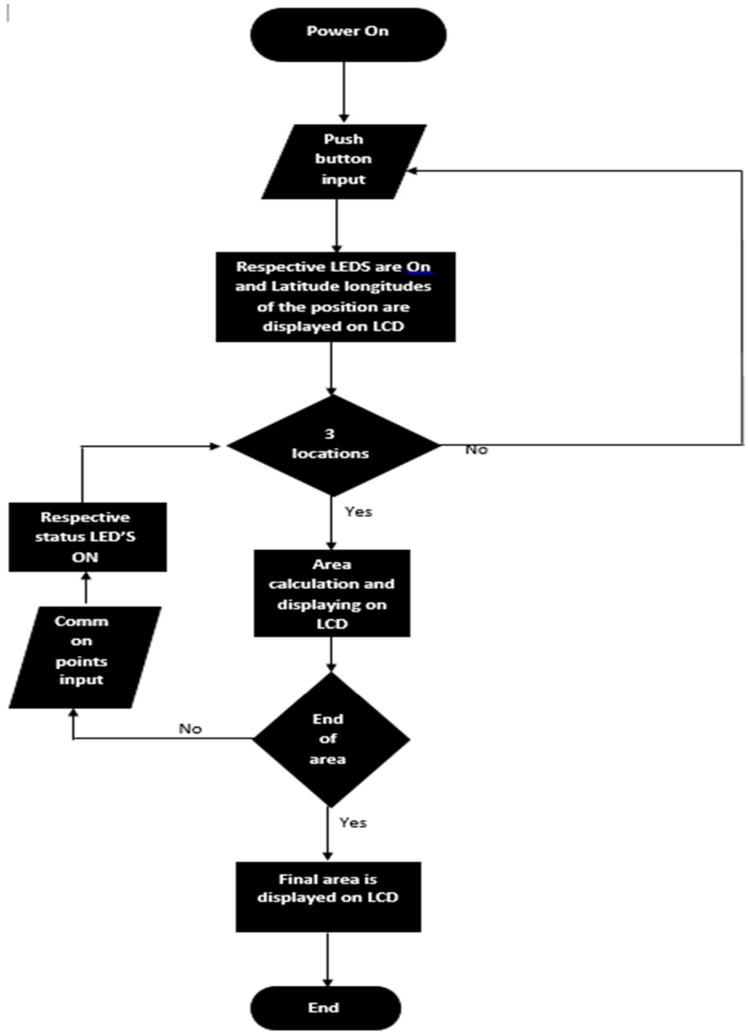

Fig.1 System flow diagram

We used five buttons in our project design in which three of them are used for updating the location coordinates of the initial triangle we consider. The program is written in such a way that when we press the first button, the GPS module which is connected to Arduino updates latitude and longitude coordinates of the first position. The functioning of the other two buttons also resembles the first one. The remaining two buttons among the five are used for selection of yes or no for continuation of the process. Each button is allotted with an LED which blinks during operation of that button. There are three more additional LEDs which show us the status of the active points during selection of a new point.

When the first button is pushed, the location coordinates of first position will be updated, when the second button is pushed, the location coordinates of the second position will be updated and in the same way, when the third button is pushed, the third position gets updated. We can find lengths of the sides of triangle formed by three points with the help of the formula in our program. Now, with the formula of area of the triangle, the area of triangular portion can be calculated. Then we are asked to select whether the measurement of total field area is completed or not with the help of buttons. If the measurement of field is completed, we press yes and the final area will be displayed on the LCD screen. If the measurement of field is not completed, we press no. If we select no, the status of the active points will be asked where we can add a new point by replacing the old one. The sides of the new triangle are then calculated from which we get area of the second triangle. Again we are asked if the measurement of the field is completed or not. This process is continued until we press yes and entire field measurement gets finished. The total area of the field can be obtained by adding the areas of individual triangles. The final area is calculated by the Arduino and displayed on the LCD. By using this project, the process of land measurement gets simplified as it saves lot of time and man power. Distance between any two points or area of any given field can be calculated easily.

IV. CIRCUIT DIAGRAM

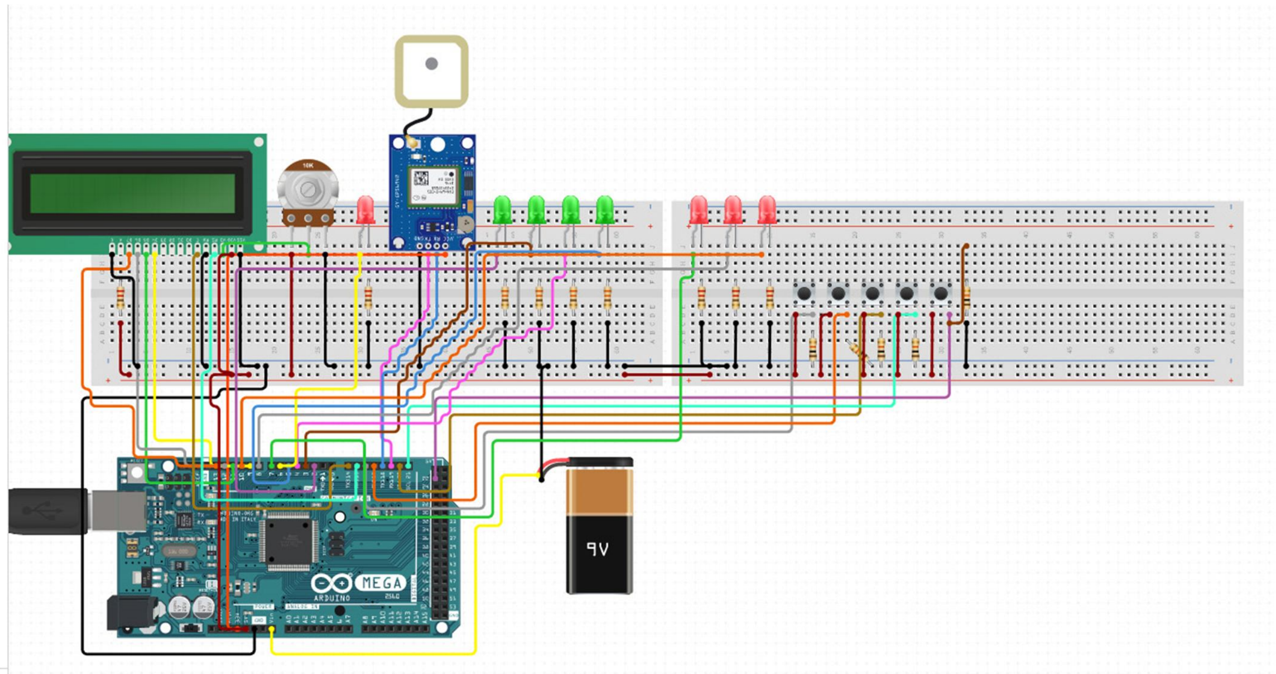

Fig.2 Circuit diagram

A. LCD is powered with 5V from Arduino Mega and all others pins are connected.
B. GPS module is powered with 3.3V from Arduino and transmitter and receiver of GPS are connected to serial 1 port of Arduino Mega.
C. 8 LEDS are connected to digital pins with the help of resistors.
D. 5 pushbuttons are connected to digital pins again with the help of resisters.
E. Arduino is powered with the help of 9V battery.

V. ALGORITHM

A. First, provide power supply to the device.
B. Now, push the input button to note the location coordinates of given position. The LED adjacent to button turns on showing the button which is in access currently.
C. If the location coordinates of three points are noted, the distance between points can be found which are noted as sides of the triangle we consider.
D. Now, from the sides of triangle, the area of first triangle is calculated.
E. We are asked whether the measurement of entire field is completed or not. So by using the push buttons we either select yes or no.
F. If the entire field is not covered, we push no and the status of active points is asked. Here we can update a new point in place of old point.
G. Now area of the next triangle is calculated. This process is continued till entire land is covered.
H. Once the entire land is covered, we push yes button for further progression.
I. The total area of field is found by adding all the individual triangle areas and the final value displayed on the LCD screen.
J. The process ends after finding the final area.

VI. RESULTS

A. *Sample: 1 (Area of a Single Triangular Piece of Area)*

Actual area: - 394.04155 sqm (When measured using a tape. Sides are - 32.5m, 30.5m and 28m)

Trail Number	Latitude & Longitude Values	Area calculated (sq.m)	Error (sq.m)	Error Percentage
1	Lat1 = 16.565867457354965 Long1 = 78.08792419731617 Lat2 = 16.56570356384575 Long2 = 78.08773342519997 Lat3 = 16.565697458006447 Long3 =78.08812469244003	392.538757	1.502793	0.38%
2	Lat1 = 16.56587227775018 Long1 = 78.0879245325923 Lat2 = 16.56570581336544 Long2 = 78.08774515986443 Lat3 = 16.565695851206595 Long3 = 78.08812033385038	379.477294	14.564256	3.696%
3	Lat1 = 16.56587838358395 Long1 = 78.08792755007744 Lat2 = 16.5657112764846 Long2 = 78.08773878961802 Lat3 = 16.565709026964964 Long3 = 78.08812033385038	379.269897	14.771653	3.748%

Error in distance between same point in different trials:

Point-1

Trial 1-2 : 1.352 m
Trial 1-3 : 0.924 m
Trial 2-3 : 0.570 m

Point-2

Trial 1-2 : 1.505 m
Trial 1-3 : 1.196 m
Trial 2-3 : 0.924 m

Point-3

Trial 1-2 : 1.515 m
Trial 1-3 : 1.329 m
Trial 2-3 : 0.728 m

B. *Sample: 2 (Area of a Quadrilateral)*

Actual area: - 661.37468 sq.m

Area of triangle-1= 328.9089 sq.m (Sides are 24 m, 27.5m, 35m)

Area of triangle-2=332.46578 sq.m (Sides are 27.5m, 25.5m, 31m)

(When measured using a tape. Sides are - 32.5m, 30.5m and 28m)

Trail Number	Latitude & Longitude Values	Area calculated (sq.m) Triangle-1	Area calculated (sq.m) Triangle-2	Total Area (sq.m)	Error	Error Percentage
1	Lat1=16.565906663232575 Long1=78.08774247765541 Lat2=16.565899271961182 Long2=78.08799795806408 Lat3 = 16.56567881912734 Long3=78.08799158781767 Lat4=16.56568813856711 Long4=78.08773208409548	327.645294	336.937341	664.582635	+3.207955	0.48%
2	Lat1 =16.565907305951814 Long1=78.08773342519997 Lat2 = 16.56590055739971 Long2=78.08798555284739 Lat3=16.56568235408731 Long3=78.08798052370548 Lat4=16.56569135216693 Long4=78.08773141354322	327.299743	322.186157	649.485900	11.88878	1.79%

Error in distance between same point in different trials:

Point-1	Point-2	Point-3	Point-4
Trial 1-2 : 1.455916 m	Trial 1-2 : 1.468245 m	Trial 1-2 : 0.752313 m	Trial 1-2 : 0.379741 m

C. Product Design

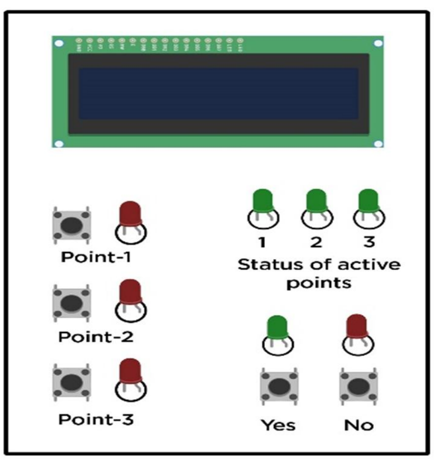

Fig.3 Proposed Design

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D. Working Images

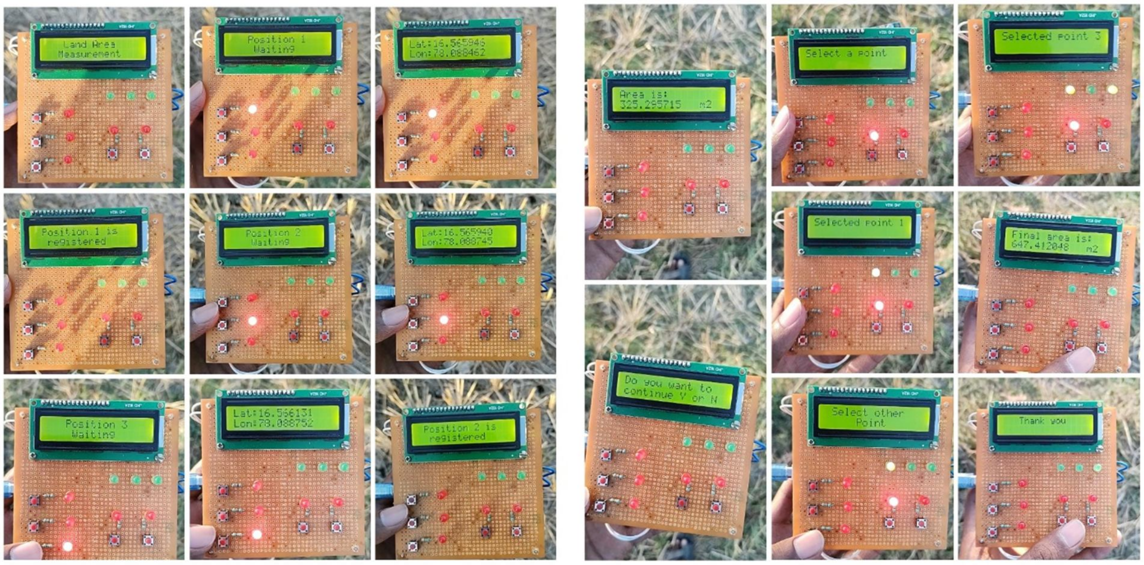

Fig.4 Output Images

VII. FUTURE SCOPE

The main advantage of this project is that the land measurement process can be simplified. It saves lot of time and man power. The field measurement becomes difficult only if the given field is complex in shape. In that case, more location coordinates must be taken for field measurement. All the areas of smaller triangles must be calculated individually and then they must be added to get the final area. This process will consume more time in that situation because it involves noting of multiple location coordinates. Another issue is if the field is in a circular or oval shape, the division of field cannot be done in form of triangles. In such cases, length of the arc must be found which causes lot of complexity. If the lengths of arcs can be found without errors, this drawback can be overcome. In that case, the efficiency of the project can be improved to a good extent.

VIII. CONCLUSION

We here by conclude that this method is very handy in finding the distance between any two points. The area of large fields can be calculated quickly. With help of this project, all the farmers will be able to survey their lands and claim for any corrections from the government.

IX. ACKNOWLEDGEMENT

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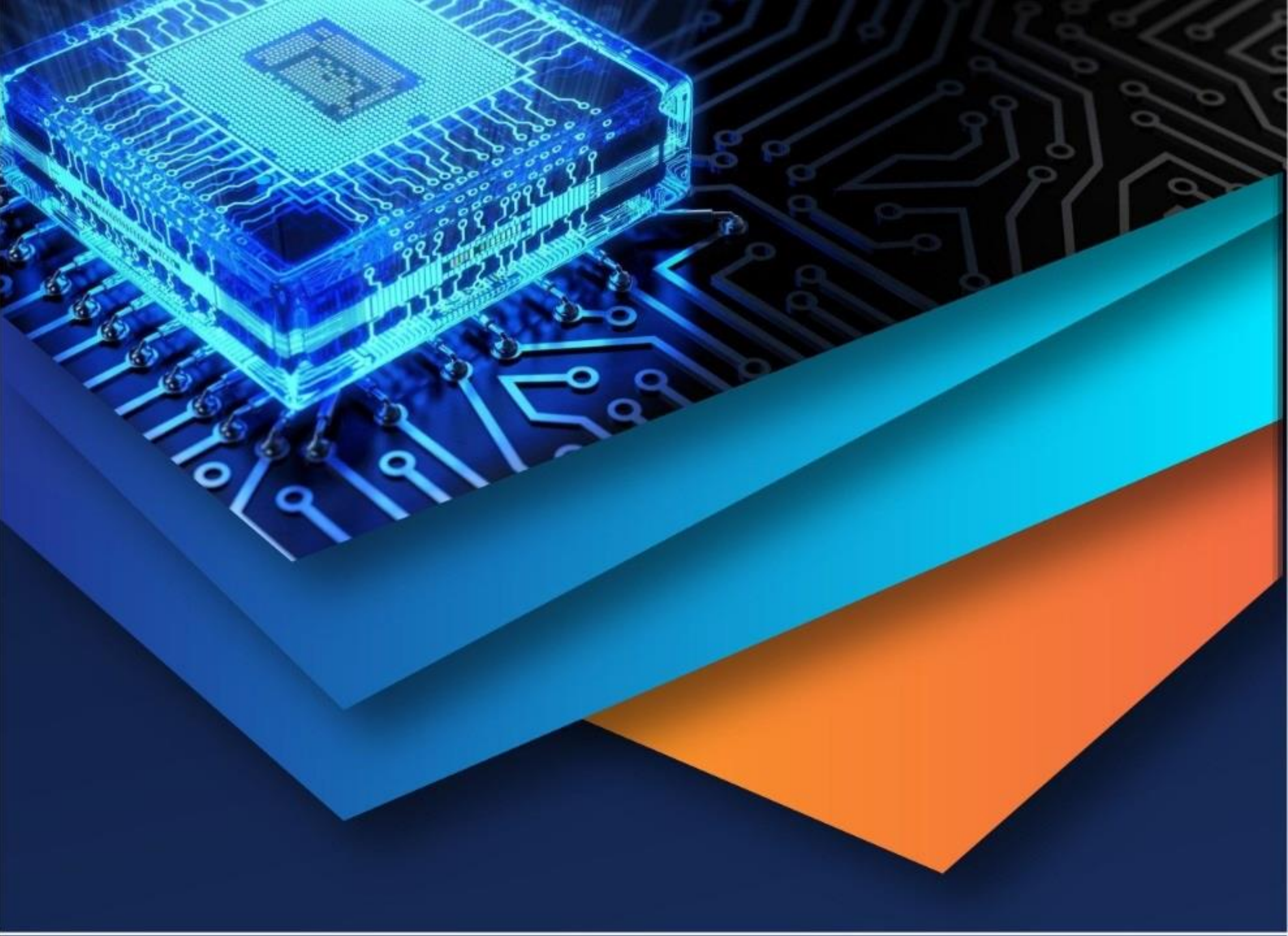

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