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Dimension and Deformation Measuring Instrument

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Abstract — ***DDMI (dimension and deformation measuring instrument) is an instrument which can be used to measure dimensions of any terrestrial structures like height, length, width, etc. The basic construction of this instrument is easy, operational and simple in nature. There are various instruments available in the market which can measure dimensions of structures like Theodolite, Total Station, but major drawbacks for using these instruments are complexity, difficulty to operate, high cost, etc. DDMI measure all dimensions from a remote place and send the co-ordinates to laptop or mobile via Bluetooth to create a basic block structure using the any structure designing software like AutoCAD, etc. with simple calculations considering minimal cost, maximum accuracy and minimal human intervention.***

Keywords—**AutoCAD, Bluetooth, DDMI, Theodolite, Total Station.**

I.INTRODUCTION

Now days, measurement of dimensions [1] of the structures is becoming more tedious job as structures are growing complex each day. Creative ideas for developing the structures are increasing the complexity of the structures and simultaneously the measurement of the dimensions. It has become the need of the engineers to measure the dimensions from remote distances. The fundamental principles upon which the surveying is being carried out are:

A) Working from whole to part.

B) After deciding the position of any point, its reference must be kept from at least two permanent objects or stations whose position has already been well defined.

The purpose of working from whole to part is

A) To localise the errors and

B) To control the accumulation of errors.

Our main objective behind designing this instrument is to measure all the distances from a remote place with simple calculations and measuring degree of deformation by creating the basic block diagram of terrestrial structures keeping cost into the consideration with maximum accuracy.

Our aim of designing this instrument can be given as follows

- To calculate height, length and width of any structure with minimum human intervention.
- To calculate the angle of inclination & elevation.
- To locate the (x, y, z) co-ordinates of the basic block structure.
- Design the block structure based on the co-ordinates in any structure designing software like AutoCAD [5].
- To operate the device using wireless remote.
- To transfer co-ordinates using Bluetooth network to mobile or laptops.

II.LITERATURE SURVEY

There are many height & length measuring instruments available in market, some of them are Theodolite [2, 6], Total Station [3] which we have used as a guide line for our DDMI. Theodolite is a precision instrument for measuring angles in horizontal & vertical planes. Theodolite is mainly used for surveying applications [1] and has been adapted for specialized purpose in fields like meteorology and rocket launch technology. Total Station is electronic optical instrument used in modern survey [1].Total Station is an electronic Theodolite integrated with an electronic distance meter to read slope distances from the instrument to a particular point. Besides this, extra advantage over Theodolite and Total Station for measuring horizontal & vertical length, DDMI is cheaper. Theodolite and Total Station are considered as the important part of this paper and need some explanations.

A. Theodolite:

Before explaining the working of DDMI it will be useful to understand the Theodolite. To take the measurement following steps are followed. Unlock the upper horizontal clamp (E). Rotate the Theodolite until the arrow in the upper or lower rough sight points to the feature of interest and lock the clamp. Look through the main eyepiece (M) (you may need to refocus) and use the upper horizontal adjuster (E) to align the vertical lines on the feature.

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To take the reading, you should look through the small eyepiece (S). Using the minutes and seconds adjuster (I) set one of the degrees on the horizontal scale so that the single vertical line on the bottom scale is between the double vertical lines under the selected degree. The reading is the degree you have aligned and the minutes and seconds read from the right hand scale and is the horizontal angle (in degrees, minutes and seconds) from your reference line. To measure a vertical angle, unlock the vertical clamp (G) and tilt the eyepiece until the feature is aligned on the horizontal lines. Gently lock the clamp and use the vertical adjuster to make fine adjustments. Now looking through the small eyepiece (S), use the minutes and seconds adjuster (I) to align one of the degrees on the vertical scale with the double lines just below it. The reading is the degree you have aligned and the minutes and seconds read from the right hand scale. This is the angle from the vertical; where vertical is 0 degrees. To complete the reading, you may now need to measure the distance from the Theodolite to that feature manually. As you can see that first stage gives the horizontal and vertical angles while to measure the distances you need to manually take the reading from Theodolite to the target. This drawback of human intervention can be reduced in the DDMI.

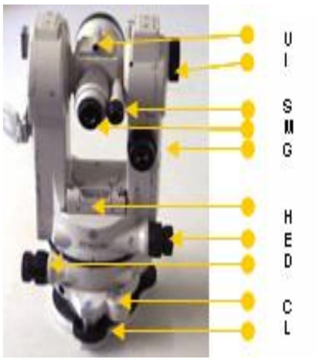

Fig 1: Theodolite

B. Total Station:

The working of the Total Station can be explained as follows:

Fig 2: Total Station

The Total Station is mounted on a tripod [1] and levelled before use. The other part of a Total Station, the electronic distance measuring device, measures the distance from the instrument to its target. The Total Station allows measurement of this type to be taken by simply targeting someone as they move down the avalanche chute. The Total Station provides a quicker solution to this measurement by allowing a light beam to measure the distance instead of a tape measure. The Total Station sends an infrared laser that is reflected from a porro prism and sent back to it. With the tripod and Total Station now centred over the top of the control point, adjust the tripod [1] legs by extending/contracting them, to position the bubble of the circular vial located on the tribrach of the Total Station to the centre. For reference purposes throughout these instructions, the front of the Total Station is the side facing the object to be measured and the back of the Total Station is the side with the LCD display [4] panel. Rotate the Total Station until the back of the unit is aligned with two of the levelling screws [1] located on the bottom plate of the Total Station. In the above paragraph you can see that you need to place prism to measure the distances through Total Station, but what if we can't reach the point to place the prism? Thus similar drawback of human intervention can be removed through DDMI Barring high accuracy of Total Station, it has many reasons to be replaced by DDMI.

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III.OUR APPROACH

The study of these two instruments lead to a conclusive idea to reduce as much human intervention as possible and reduce the cost of such a surveying instrument so that it can be useful as college level experiment and also at the field work. To improve or modify the principle of above two instruments we have put forth some guide lines for our instrument as

- The basic idea behind dimensions & deformation measuring instrument (DDMI) is to design an instrument which can measure different dimensions and angles keeping the cost in mind.
- If measuring is done manually it is very tedious and time consuming job which can be done within fraction of seconds using this device.
- It functions taking into consideration minimum cost, maximum accuracy and minimum human intervention.
- To locate the co-ordinates of the structure obtained by the device.
- To Transfer co-ordinates to laptop or mobile via Bluetooth or any Network.
- To develop an Interface to receive co-ordinates and provide it to the block designing software like AutoCAD.

By keeping the above objectives in mind we can make a fully compatible embedded device to measure the dimensions. To measure the dimensions we have divided our approach in following cases. By implementing geometrical concepts in embedded 'C' [4] we can develop such a device which minimum human intervention.

Case 1: **measurement of distance between instrument and object. (This is measured manually in case of Theodolite.)**

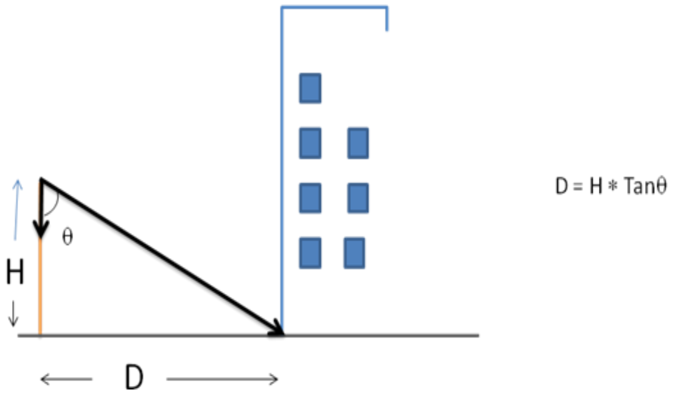

Fig 3: Measuring horizontal distance

Case 2: **measurement of height of the building.**

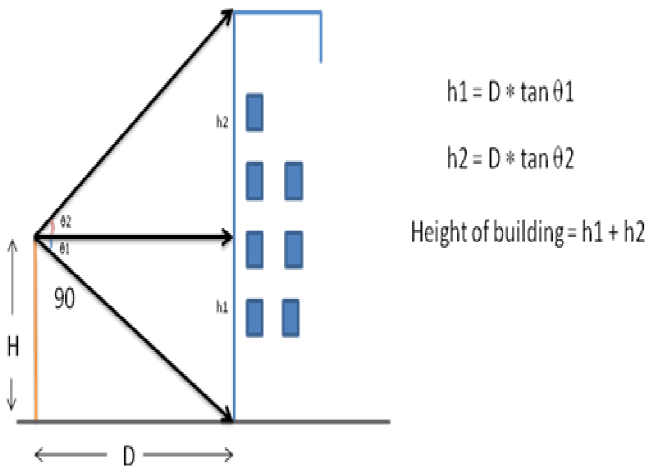

Fig 4: Measuring vertical distance

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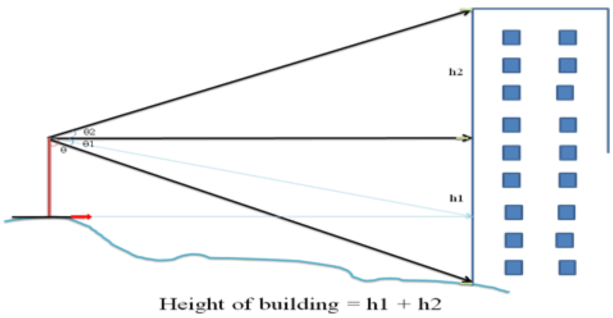
Case 3: **measurement of height of the building at uneven surface.**



D=H*tan θ
H1=D*tan θ1
H2=D*tan θ2

Fig 5: Measuring vertical distance at uneven surface

Case 4: **Measurement of horizontal distances.**

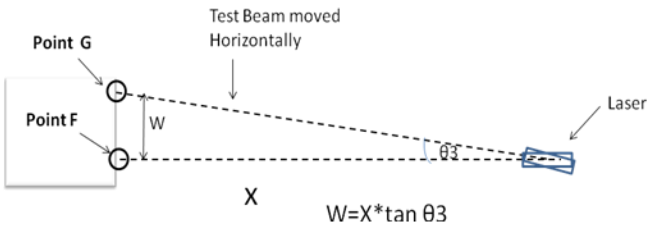


Fig 6 Distance between any two points.

Thus it can be seen that by implementing the geometrical concepts in an embedded device we can reduce a lot of efforts to measure the dimensions of the structures. We have also implemented a module to develop a basic block structure of a building using the co-ordinates of the building. The co-ordinates (x, y, z) can be obtained using the DDMI using geometrical concepts and can be feed to the software like AutoCAD or Civil 3D [5] for building the basic block structure of that building. Such blocks would be very useful to study the outer dimension of the building.To complete the reading, you may now need to measure the distance from the Theodolite [6] to that feature manually (Manual calculation of distance). The Total Station sends an infrared laser that is reflected from a prism and sent back to it (Placing the prism may be tedious job).

IV.HARDWARE DESIGN

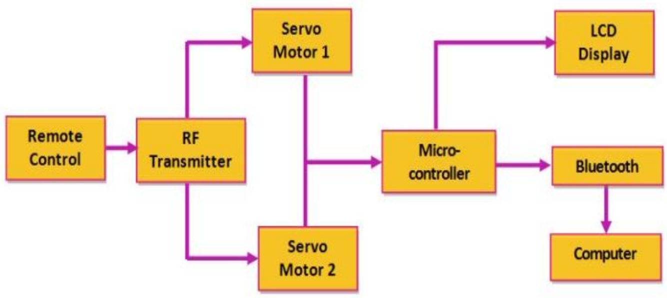


Fig 7: Hardware block diagram

The hardware block diagram for DDMI consists of a wireless remote control operated by a RF module [10] fitted in both, the remote and the device. Through the remote control the direction of the servomotors can be changed by rotating them. To rotate the servomotors in all four directions namely left, right, up and down the servomotors are mounted on a pantilt mechanism. A laser is attached on the pantilt-servomotor mechanism. The Laser is initially pointing at zero position, when user rotates the laser accordingly the encoder/decoder provides angles as an input to the 8051 microcontroller [9]. According to our specified case the

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microcontroller calculates desired distances and co-ordinates can be transferred to a remote computer serially through a cable or wirelessly through Bluetooth module. These co-ordinates can then be fed to AutoCAD for generation of a 3D block Structure.

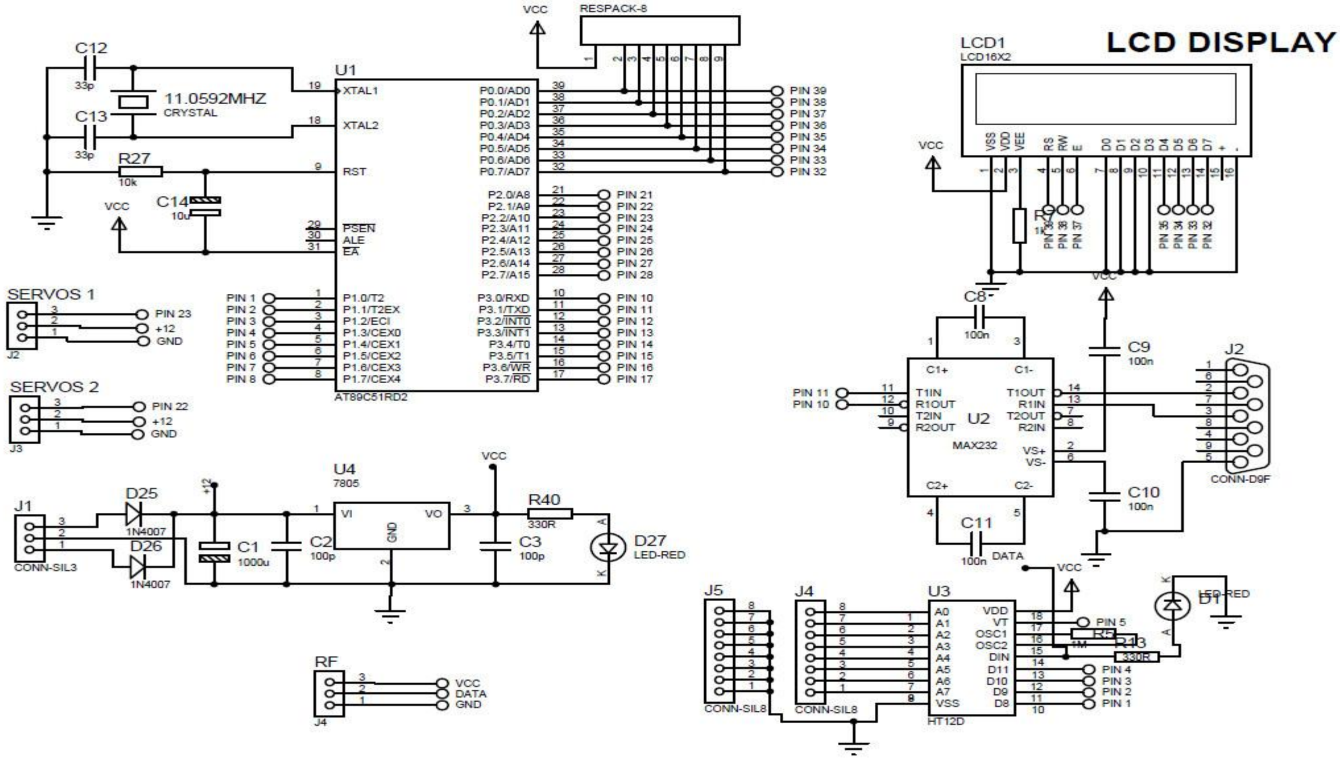

Fig 8 : Circuit diagram for DDMI

Flowchart

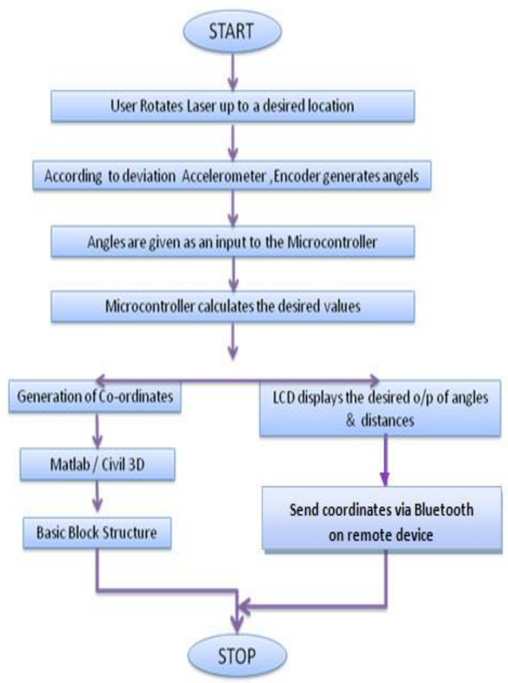

Fig 9 : Flow of tasks

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To measure the dimensions of a building the user has to rotate the laser up to the desired location in order to obtain the co-ordinate values. As the user rotates the laser, the encoder [8] generates angles. These angles are fed to the microcontroller for further calculations. The required distances and angle values are displayed on the LCD on the device. The co-ordinates so generated can be sent to a remote device such as laptop or a computer where a 3D block structure can be constructed using tools like AutoCAD or Civil 3D.

V.COMPARISION WITH OTHER INSTRUMENTS

On the basis of our study we have compared our instrument with others (Theodolite and Total Station) in various parameters. These parameters will be useful to highlight differences in these three instruments.

- DDMI can be made easily available to students and researchers for surveying and study purpose as it is cheaper than other competing device.
- DDMI also requires less operational skills as in case of Total Station which requires special training for operating the device.
- DDMI can also provide facility of transmitting co-ordinates to remote machine.

VI.CONCLUSION

In this paper the problems in surveying and modern instruments are considered and a better approach is presented using the geometry and the embedded concepts which will be useful to overcome the complexities in the measurement. The proposed instrument DDMI will be useful in developing modern concepts in the surveying. This proposed model also has combined the various branches in engineering such as Computer, Electronics and Civil which will be helpful for future research.

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