Automatic Borewell Distance Calculator and Indicator Using Optoelectronics Sensor System

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Abstract

To make a continuous online calculation of feet drilled and also to automate the spanner system using a PIC microcontroller which rectifies the error that occurs due to manual calculation of feet drilled and manual operation in spanner system. It is observed from a survey that the present method of calculating the borewell feet drilled is by means of counting number of rods used to drill which results in error and quite time consuming. The insertion and removal of spanner is operated manually. An idea is proposed where the spanner is automatically inserted and the feet calculation is done automatically while drilling itself as an online process that shows exact feet drilled, which is done using an embedded program. The presence of rod is detected using sensor. Once the rod is detected, the distance measurement sensor sense the feet drilled and displays the value in the display screen. If a rod is drilled, then drilled value is made as a constant and stored in memory. Then the next rod is inserted for drilling, the sensor again calculates the feet drilled value and added with the constant value. Whenever the rotation motor reaches the bottom end, the limit switch actuates the spanner system. This type of automation process helps the borewell operators to get rid of the manual operations.

Keywords: *borewell, microcontroller, sensor, feet, depth, automation*

1. Introduction

In the present scenario borewells are being constructed widely in order to meet the enormous scarcity of water for both domestic and other industrial purposes. The amount of feet drilled by a borewell unit is usually calculated depending upon the length and the number of rods used for drilling.

Each rod consists of a threaded adapter at its end which is used to connect it with another rod during drilling. The threaded rod adapter gets depreciated after a particular period of usage. In such cases the end adapter is cut in lathe section and a new adapter is threaded in the remaining rod. Hence the length of the rod gets decreased by a few inches during the cutting process. So, the length of the rods connected is not uniform and if each rod decreases by a few inches in length it is quite difficult to calculate the amount of feet drilled. This calculation is being carried out manually which results in error and quite time consuming.

A spanner system is used in the borewell drilling process at the time of inserting a new rod and removal of drilled rod. The insertion and removal of spanner is operated manually. This process is quite difficult to operate it manually.

S.R.S rig service Pvt. Ltd., the borewell drilling company, is drilling 25 - 35 borewells per month. The foot drilled by the borewell unit is calculated by means of number of

rods used to drill the borewell. Even the spanner operation is done manually by borewell operator. They have several length of rods used to drill the borewell. They have for certain rods of 5 feet, 10 feet, 18 feet and 20 feet. For domestic purposes, the borewells are commonly drilled 4.5 and 6 inches in dia. Even though 4.5 inches of drilled borewells are most widely used for domestic purposes, 6 inch borewells are drilled when higher yields are needed for large apartments or buildings and even for agricultural purposes. Initially bigger diameter bits are used to place the casing pipes up to the hard rock zone prior to drilling specified size of the borewell. The commercial borewell truck unit is shown in Figure 1.

Figure 1. Commercial Borewell Truck

Methods of drilling to be adopted depends on factors like suitability of a method for a particular type of geological formation (i.e. such as alluvial, bouldery and hard rock), cost factors, diameter and depth of borewell and the purpose intended. Most commonly used types of drilling methods are:

- Water Jetting - Narrow bores in alluvial foundations
- Augur Drilling - Narrow bores in alluvial formations
- Calyx Drilling - Shallow borewells in both hard rock and sedimentary formation
- Percussion Drilling – Deep bores in bouldery formation
- Rotary Drilling - Most common method used for drilling large and deep bores in alluvial formations.
- Down the Hole Hammering (DTH) Drilling – Most common method for drilling large and deep borewells in hard rock formations.

In the existing method, the calculation of feet drilled by the borewell truck is estimated by means of the number of rods inserted in the borewell. Each rod has the threaded adopter at its both ends for connecting rods at its ends. The threaded rod adapter gets depreciated after a particular period of usage. In such cases the end adapter is cut in lathe section and a new adapter is threaded in the remaining rod. Hence the length of the rod gets decreased by a few inches during the cutting process. So the length of the rods connected is not uniform and if each rod decreases by a few inches in length. If a single

rod is drilled into the earth to hold the drilled rod spanner is used. As well as after drilling, the rods need to be removed from the borewell. If a rod is taken up it has to be removed from the borewell unit. The remaining rods are hold by the spanner. For these operations spanner is used. The spanner is inserted and removed with the man power. It is hazardous for the borewell operators who working near the drilling unit. An idea is proposed to design an instrument which automatically calculates and indicates the total feet drilled and also the current position of drilling. This method reduces the complexity in calculation and rectifies the error that occurs due to manual calculation. Hence the exact amount of feet drilled is displayed. This system is beneficial for both customers as well as borewell workers.

Optoelectronic distance measurement sensor is used to [1] detect the feet drilled. In microcontroller Embedded C [2,3,4,5] programming is done such that depending upon the rotation motor movement in the borewell master the feet drilled is calculated. According to the change in displacement of the rotation motor the distance measurement sensor gives input to the microcontroller.

To monitor the temperature, RPM, oil pressure and condition of the radiator fan which fortifies the bore well [6,7] vehicle from getting ruined with the help of arduino is interfaced with the sensor and meter via voltage divider which is already available in the bore well vehicle.

The idea of making this system operate in such a way [8] is to ensure that the user have the power to decide if water is required in the tank at any point in time by choosing either to respond or ignore the SMS notification when water level is low and also being less attentive to monitoring when the water level is full as the system will automatically turn of the pump machine in this case. Wireless Sensor network based water quality [9,10] parameters are estimated to bring the good water supply.

One of the major problems faced by all borewell industries is calculating the feet drilled. Most of the industries carry the calculation only by the number of inserted for the drilling process. Even the spanner operation used for the insertion and the removal of rods is done manually. These processes result in more time consumption and hazardous for the borewell operators. Most of the borewell industries expect a system to automate the borewell operations like

- Feet calculator
- Spanner operation
- Rod insertion

Till today this is a challenging task. Hence the objective is to design an automatic feet calculator and spanner process using embedded system. Hence the aim is to calculate the feet drilled by the borewell unit. Then to automate the spanner system which is used during the time of insertion and removal of rods.

2. Proposed Model for Automatic Borewell Feet Calculator and Indicator

In the proposed model, the system is designed such that it continuously indicates the feet drilled by the borewell unit and automatically inserting the spanner to hold the drilled rod. Initially the rod is placed in the rotation motor and its presence is detected and it is given to microcontroller. This in turn gives signal to optoelectronic distance measurement sensor. Hence, the optoelectronic distance measurement sensor continuously measures the distance between the rotation motor and the bed of the master. The value in feet is calculated using the embedded program and displayed in the LCD screen. In this model, a limit switch is placed at the end of the master. When the rotation

motor reaches the lower end of master, the limit switch is actuated and the signal is given to the microcontroller. Then the value of feet drilled is changed into constant and it is stored. After storing, the gear motors are actuated for inserting the spanner. Once the spanner is inserted the rotation motor has to be disconnected from the drilled rod and taken to top of the master. The top of the next rod is connected to the rotation motor and its bottom is connected to the drilled rod. After connecting, the presence of rod is detected and this process continues. The new value is added to the constant value and then updated in the LCD display. This proposed model has lots of pros like time saving, online feet measurement, reduces human power etc. Thus the proposed model helps in overcoming the cons faced in the existing system.

2.1 Block Diagram of Automatic Borewell Feet Calculator and Indicator

The controller used in this project is Peripheral Interface Controller (PIC) 16F877A and the distance measurement sensor used here is optoelectronic type sensor which has an interlock of proximity sensor. The sensor measures the distance between the rotation motor and bed of master in the prototype. This measurement is given as an input signal to Analog-to-Digital Convertor (ADC) present in PIC16F877A microcontroller which is programmed to convert this analog signal into corresponding digital signal. The block diagram of automatic borewell feet calculating and indicating system is shown in Figure 2.

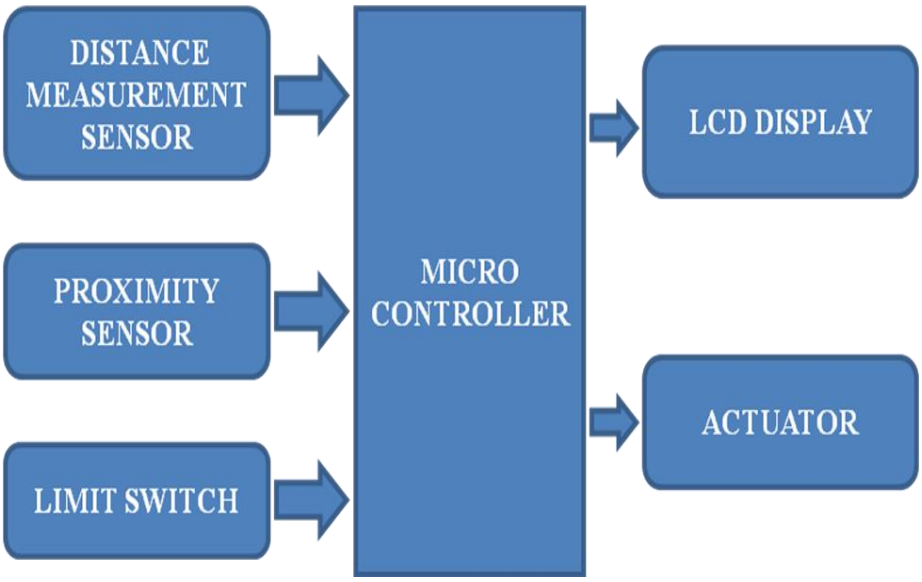

Figure 2 Block Diagram of Automatic Borewell Feet Calculator and Indicator

The corresponding distance measurements are used to calculate the feet drilled and to display in the LCD display. The signal from limit switch, which is given to the microcontroller, is used for actuating the Gear motor, which in turn inserts the spanner to hold the drilled rod.

2.2 Circuit Diagram of Automatic Borewell Feet Calculator and Indicator

The circuit diagram of automatic borewell feet calculator system is shown in Figure 3. The optoelectronic distance measurement sensor is interfaced with the port A of PIC microcontroller 16F877A.

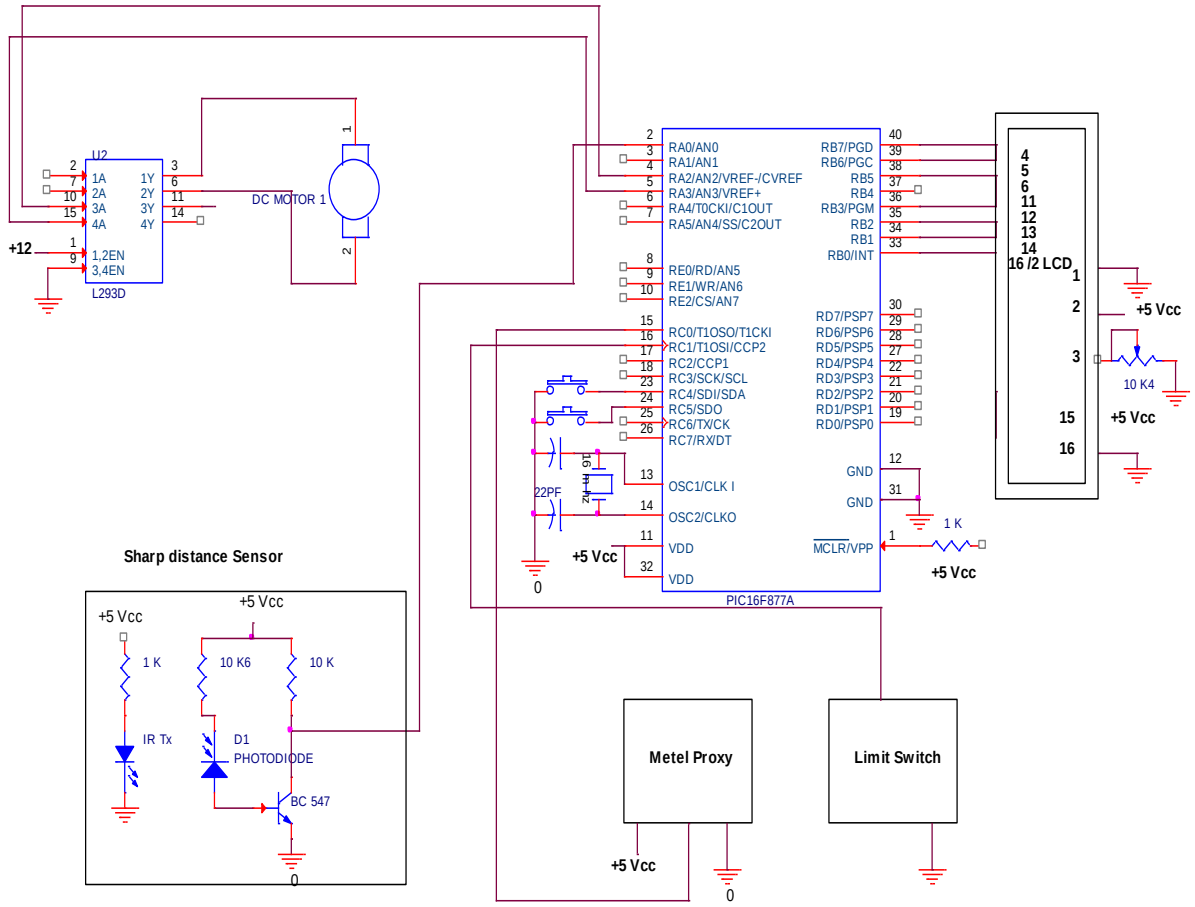

Figure 3. Circuit Diagram of Automatic Borewell Feet Calculator and Indicator

The distance measurement signal act as analog inputs to the microcontroller which is connected to first pin of port A. Port A being ADC converts the analog signal to corresponding digital signal. The limit switches and metal proxy which is used in this project is connected to the 16th and 17th pin of microcontroller. The L293D H drive circuit is connected to the 5th and 6th pin of microcontroller. Three push button switches are connected to the 23rd, 24th and 25th pin of microcontroller. The LCD section is connected to the port C pins in the method of 4 bit data transfer. A 20MHz crystal is connected externally for providing the external clock pulse. This crystal is connected to the 13th and 14th pin of PIC microcontroller.

2.3 Microcontroller and Interfacing Circuit

Hardware interfacing circuits of the proposed model is depicted in figure 4. It consists of the following components.
PIC controller is chosen since this is the only controller with lot of advantages. Some of the advantages of PIC 16F877A is given below as follows:

- High performance and cost effective
- Provides field programmable embedded control solutions

- Wide application area
- Reduced Instruction Set Computer Architecture enables easy programming

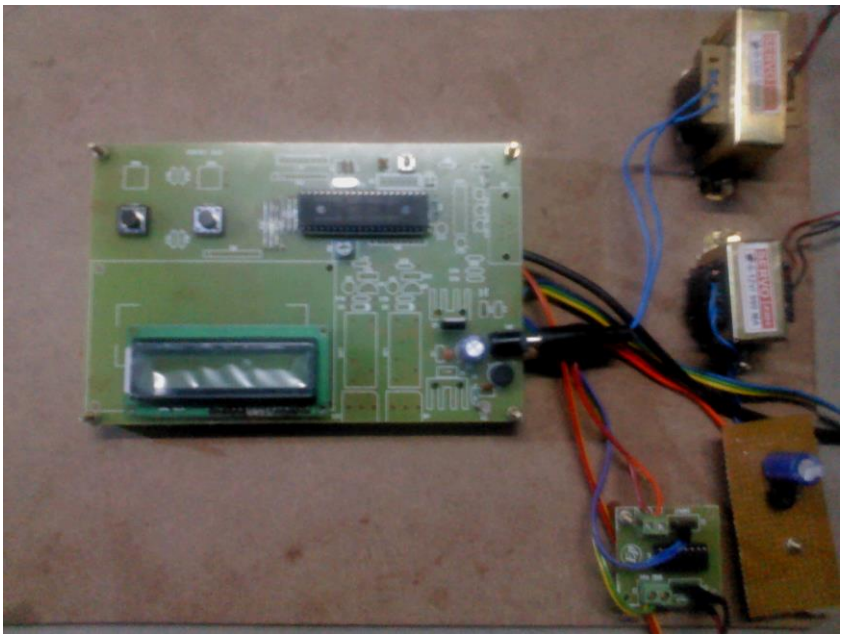

Figure 4 Microcontroller and Interfacing Circuit

2.4 Optoelectronic Distance Measurement Sensor

The optoelectronic distance measurement sensor which is used in this project is to detect the feet drilled by the borewell unit. Thus the sensor is placed in the rotation motor so that the distance between the rotation motor and the bed of the borewell master is continuously monitored and given to the microcontroller. The sensor is actuated only after the rod detected by the proximity sensor.

2.5 Inductive Type

Inductive proximity sensors switch in the presence of metal. These sensors take 5 to 30V DC and have a normally-closed NPN-type output. The sensor has a 12 mm diameter threaded body and the rear of the sensor lights up when the sensor is triggered, allowing easy mounting and adjustment 4 mm sensing distance. Specification of the Inductive type sensor is specified in table 1

Table 1 Specifications of inductive type proximity sensor

PARAMETERS	**RANGE**
Supply voltage	5 to 30 V DC
Dimensions	12 mm, 40 mm Long
Secure sensing distance	3.2 mm
Ingress protection	IP67

Maximum output current	150 mA
Output switch voltage drop	≤1.5 V
Operating frequency	600 Hz
Operating temperature	-20 to 70 °C
Operating humidity	35 o 95% RH

2.7 Limit switch

Limit Switch is a switch operated by the motion of a machine part or presence of an object. In this project, the limit switch is used to find whether the rotation motor reached the lower limit of the master or not. When the rotation motor comes into contact with the actuator, the device operates the contacts to make an electrical connection to ground. The switching action acts as an input signal to the microcontroller.

2.8 Helical Gear Motor and Its Drivers

The helical gear motor used in this prototype is to automate the spanner system. The rotation motion of the helical gear motor is converted into linear motion. So the spanner is inserted while rotating in the clockwise direction and removed when the direction is in anti-clockwise direction.
A motor driver used here will drive the DC gear motor according to the input from microcontroller signal. The driver used here can drive two motors at a time. It has a capability to drive 30 volt motor. When the microcontroller sends 1 0 as signal the motor rotates in clock wise direction. And when it sends 0 1 as signal the motor rotates in anti-clockwise direction.

2.9 Implementation in PIC Microcontroller

Hardware has to be interfaced with the microcontroller in order to execute the actual instructions given by the designer. Software used for programming the code is depicted in this content.

2.10 Analog – Digital – Convertor

The PIC 16F877A contains inbuilt 10 bit ADC. The analog port A consists of 8 channels. The signals from 3 temperature elements are given to the 8 pins as inputs. An n-bit ADC has a resolution of one part in 2n. For example, a 12-bit ADC has a resolution of one part in 4,096, where 212 = 4,096. Thus, a 12-bit ADC with a maximum input of 10 VDC can resolve the measurement into 10 VDC/4096 = 0.00244 VDC = 2.44 mV. Similarly, for the same 0 to 10 VDC range, a 16-bit ADC resolution is 10/216 = 10/65,536 = 0.153 mV. The resolution is usually specified with respect to the full-range reading of the ADC, not with respect to the measured value at any particular instant.

2.11 Software Used

The name of the software's used in this project for programming purpose is given below:

- CCS C Compiler
- Proteus ISIS

3. Results and Discussions

This section analyses the results of the project. The prototype model of the real time system present in the borewell industry has been done as shown in the Figure 5. The Output Characteristics of Distance Measurement Sensor is shown in Table 2. This table shows the output voltage signal of the sensor according to the distance which is sensed by the distance sensing element.

Table 2 Output Characteristics of Distance Measurement Sensor

Distance (cm)	Output voltage(V)
9	2.60
10	2.40
14	1.87
18	1.52
20	1.40
28	1.15
30	1.03
40	0.85
50	0.70
60	0.55
80	0.40

The analog input is given to the microcontroller, the ADC unit converts the corresponding analog voltage to digital signal and displays in the LCD unit as shown in Figure 6. The limit switch input controls the spanner insertion which is used to hold the rod. This mechanism is automated by using a microcontroller that calculates the feet drilled more accurately than the conventional system. In addition to this, the spanner system is also automated which reduces human power. In this project a miniature model of the borewell drilling unit has been done which can be used in various borewell trucks.

The corresponding distance measurements are used to calculate the feet drilled and to display in the LCD display. The signal from limit switch which is given to the microcontroller is used for actuating the Gear motor which in turn inserts the spanner to hold the drilled rod.

Optoelectronic distance measurement sensor is used for detecting the feet drilled by the rods in the borewell unit. In microcontroller, Embedded C programming is done such that depending upon the rotation motor movement in the borewell master the feet drilled is calculated. According to the change in displacement of the rotation motor the distance measurement sensor gives input to the microcontroller.

The Spanner system is being operated with the help of a gear motor. The Spanner system works when the rotation motor touches the limit switch and the limit switch triggers the gear motor for the insertion of the spanner system and the removal of the spanner system is operated using a push button by the borewell operator.

This hardware is simple and cost effective is given in Figure 5. The software used here is user friendly. It is very easy to handle the proposed system in the bore well units since it reduces human effort to great extent by indicating the drilled feet online and doing the spanner operation automatically. The prototype model of the real time system present in the borewell industry has been done. This method reduces the complexity in calculation and rectifies the error that occurs due to manual calculation. Hence the exact amount of

feet drilled is displayed in the LCD Display in Figure 6. This system is beneficial for both customers as well as borewell workers.

Figure 5 The prototype model of the real time system present in the borewell industry

Figure 6 LCD Output of the max feet drilled

CONCLUSION

The Automatic Borewell Feet Calculator, and Indicator finds wider application in the bore well drilling industries for online indication of the feet drilled and automation of spanner system. The prototype model of the proposed method has the minimum distance 9cm to maximum of 80 cm. the corresponding voltage obtained is 0.4v. The insertion and removal of spanner is operated manually. Based on the rotation of the shaft of the motor the feet calculation is done automatically while drilling itself as an online process that shows exact feet drilled, which is done using an embedded program.

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References

[1]. *Biernat. A, Kompa. G. (1998) 'Special Issue of Journal of Optics on Optoelectronic Distance / Displacement Measurements and Applications', IOP Publishing, Vol. 29, no.3(1998).*

[2]. *Danny Causey, Muhammad Ali Mazidi and Rolind D. Mckinlay. 'PIC Microcontroller and Embedded Systems Using Assembly and C for PIC18' Pearson Education, South Asia, (2008)*

[3]. *Jack Ganssle, 'Art of Programming Embedded Systems', Academic Press, San Diego, (1992)*

[4]. *John B.Peatman 'Design with PIC Microcontrollers', Pearson Education, Sixth Edition,(2004)*

[5]. *Ayob Johari, Mohd Helmy, "Tank water level monitoring using GSM network", International Journal of Computer Science and Information Technologies, Vol. 2,no. 3,(2011).*

[6]. *Saraswati, Made & Kuantama, Endrowednes & Mardjoko, Pono. (2012). "Design and Construction of Water Level Measurement System Accessible through SMS", Proceedings of the Sixth UK Sim/AMSS European Symposium on Conference: Computer Modeling and Simulation (EMS), Europe (2012) pp. 48-53.*

[7]. *Constantin Daniel Oancea, GSM Infrastructure Used for Data Transmission", Proceedings of the 7th International Symposium on Advanced Topics in Electrical Engineering (ATEE), Romania (2011), May 12-14.*

[8]. *Samuel C. Irubor , John Igimoh, "Design and Implementation of a GSM Based Tank Water Level Control System", American Journal of Engineering Research (AJER), Vol.6, Issue.11,(2017), pp-54-60*

[9]. *N. Jineshkumar, U. Krishnan., T. Kalavathi Devi, "Estimation of Water Quality using Wireless Sensor Networks", International Journal for Research in Applied Science & Engineering Technology, Vol.6, Issue II, (2018), pp.1101-1106.*

[10]. *T. Kalavathi Devi, P.Sakthivel, "Monitoring and Analysis of Water Quality Parameters for Diagnosis of Safe Drinking Purpose using Wireless Sensor Network", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol.9 Issue-2, (2019),pp.1478-82.*