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Design and Fabrication of Pneumatic Robot for Drilling Blockage in Borewell

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ABSTRACT

The advancement in the field of automation along with the mechanical design has a great impact on the society. Theobjective of the project is to design and construct a "Pneumatic Robot for Drilling in Blockage in Bore well". The light weight servo motors were implemented for the machine operations. A long range digital camera was placed to find the stone position. This machine is a human controlled computerized machine system. The complicated manual process makes 70% of the motor damage. The project design is based on studying different type of stone and their specification and driller material to drill the stones in bore well pipe with drilling parameter with calculations and contain designing and fabrication of pneumatic robot.Our robot design constitutes a best ergonomic design and performs safest operation. And use for the drilling a stone inside the bore well which can help us to free the bore well and use it again for water supply.

Keywords: Computerized control, Digital camera, Pneumatic cylinder, Robot design, Rock analysis.

I INTRODUCTION

Today's major problem faced by human is water scarcity, which leads to a large number of bore wells being sunk.Bores which generate water and subsequently got strucked with some obstacles such as stone material in some depth in pipe stops the operation of borewell.So the farmer faces huge problem due to water scarcity for farming and other purposes. In some cases they try to remove the obstructions manually but do not succeed and the operation fails. Moreover it is very long duration operation and costs high.Heavy expenses have also reportedly obtain in most cases. It is pertinent to mention that proper technical solution for such situation is needed. More so in times of technical advancements and continuous research, technician should take responsibility to find an easy way out. It is an issue of everyone using borewells and early deep in the way of developing an instrument for the cases desirable.Aiming to that problem in the present era, robotic technologies combined with rapid advances in electronics, controls, vision and other forms of sensing, and computing have been widely recognized for their potential applications in almost all areas.After studying all the cases we found a serious issue to do, to make such machine which can go through the borewell in lest minimum time with suitable support of pneumatic arm and fix the device provide with proximity sensor, LED and camera attached

with it which helps in locating the stone and drill it to break the stone strucked in the borewell pipe and free the borewell and supply the water regularly and we called that machine as "Pneumatic bore well drilling robot system"

II PROTOTYPE

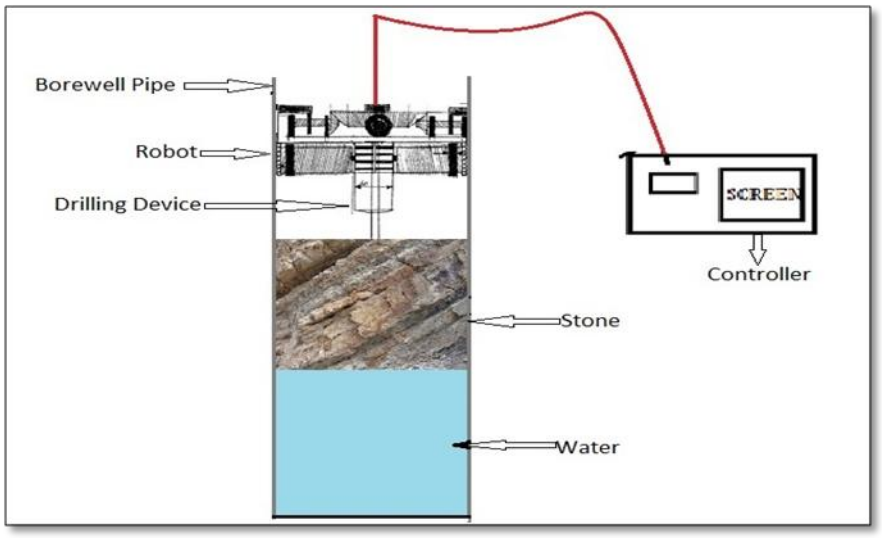

Fig.2: Prototype

2.1 CATIA

MODEL:

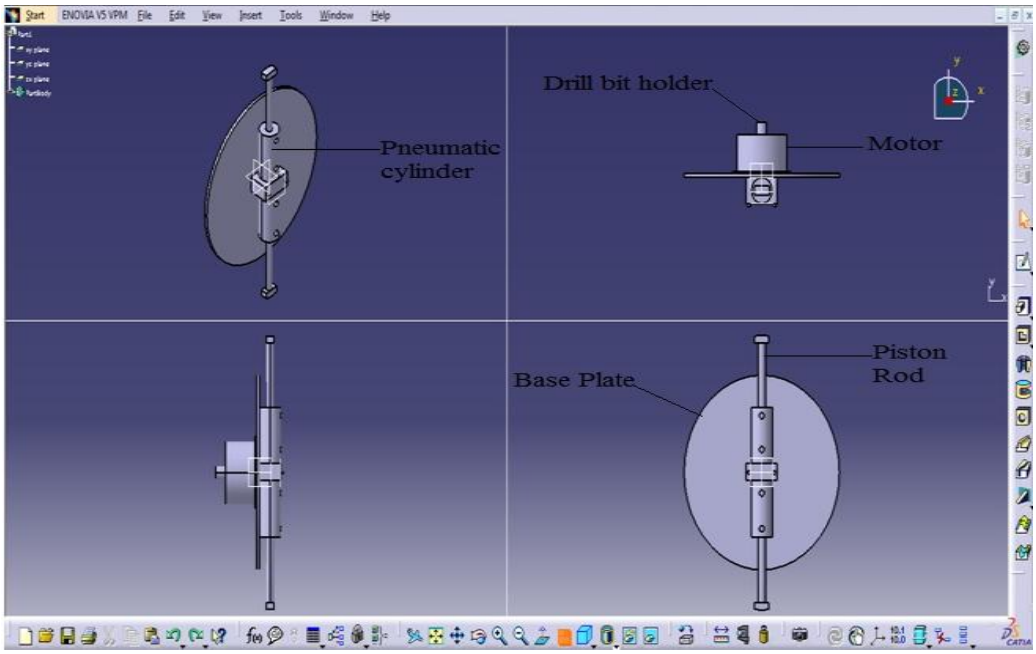

Fig.2: Catia Model of Pneumatic Robot

2.2 COMPONENT

1. ALTITUDE SENSOR:

a. HC SRO4 is a low cost, high accuracy altitude sensor. Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

b. Using IO trigger for at least 10us high level signal,

c. The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.

d. If the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.

e. Test distance = (high level time × velocity of sound (340M/S) / 2

2. CAMERA:

a. Closed-circuit television (CCTV), also known as video surveillance, is the use of video cameras to transmit a signal to a specific place, on a limited set of monitors. It differs from broadcast television in that the signal is not openly transmitted, though it may employ point to point (P2P), point to multipoint, or mesh wireless links. In industrial plants, CCTV equipment may be used to observe parts of a process from a central control room.

3. LED

a. A LED is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron-holes within the device, releasing energy in the form of photons. LEDs are just tiny light bulbs that fit easily into an electrical circuit. But unlike ordinary incandescent bulbs,. The lifespan of an LED surpasses the short life of an incandescent bulb by thousands of hours.

4. DC Motor

a. A DC motor uses electrical energy to produce mechanical energy, very typically through the interaction of magnetic fields and current-carrying conductors. The reverse process,producing electrical energy from mechanical energy, is accomplished by an alternator, generator or dynamo. Manytypes of electric motors can be run as generators, and vice versa. The input of a DC motor is current/voltage and itsoutput is torque (speed).The DC motor has two basic parts: the rotating part that is called the armature and the stationary part that includes coils of wire called the field coils. The stationary part is also called the stator.

2.3 ANALSYS FOR ROCKS PRESENT INSIDE:

A. Drillability of Rock and Its Classification

The purpose of studying the drillability of rock is for:

1. Choosing a suitable drilling method, equipment, and technology to achieve best results on project progress and economy;
2. Estimation of the drilling rate and working life of the drilling tools to offer the basic data of project planning;
3. Offering reliable data of rock performance for design and improvement ofdrilling machines.

B. NTNU/SINTEF Method and Classification of Rock Drillability

SINTEF Rock and Soil Mechanics and NTNU Department of Geology have developed a test procedure for evaluating rock drillability. The method includes measuring three indices:

• Drilling rate index (DRI);

• Bit wear index (BWI); and

• Cutter life index (CLI).

C. Rock Drillability Classification Using the Method of Impact Penetrate.

Concept of impact penetrate-specific work (IPSW).The work consumed for impacts penetrate on a unit volume of rock is called"impact penetrate-specific work (IPSW)." It is the basic physical quantity for the percussion (rotary-percussion) drilling of rock.

The IPSW, a, can be calculated using the following formula:

$$a=\frac{A}{V}=\frac{n\times A_0}{\frac{\pi}{4}\times d^2\times H}=\frac{480\times 39.2}{\frac{\pi}{4}\times 4.1^2\times\frac{H}{10}}=\frac{14252}{H}$$

Where, a = impact penetrate-specific work (IPSW), J/cm3;

A= total impact work of 480 J;

V =rock volume to be broken after 480 impacts, cm3;

N =total impact times, n = 480;

A0 =work of single impact, A0 = 39.2 J;

D =actual hole diameter after drilling, d = 41 mm

(Bit diameter = 40 mm); and

H =net depth, mm

D. Classification of rock drillability.

Rock drillability classification by impact penetrant-specific work index "a". [4]

Class	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Drillability	Very Easy	Easy	Fair Easy	Fair difficult	Difficult	Very Difficult	ExtremelyDifficult
IPSW "a" (kgm/cm3)	≤19	20-29	30-39	40-49	50-59	60-69	≥70

E. Mini-drillgauge (MDG)

For convenience of test the rock drillability, the WZ-1 type of mini-drillgauge (MDG) was designed by the same research group of Northeast University in 1991. In fact the mini-drillgauge is a reformed electric mini-impact drill and a special designed drill bit.

For testing the rock drillability, the working parameters of WK-1 MDG are determined as follows:

Working voltage: 220 V,

Motor speed: 1000 r/min,

Single impact work: 2.6 J, Impact frequency: 3800/min

I-type bit diameter: 14 ± 0.5 mm, Insert angle: 110°.

Drilling time for each test is set to 1 min. The impact penetrant-specific work measured by the WZ-1 MDG is calculated with the following formula:

$$a_w = \frac{A}{V} = \frac{n \times A_W}{\frac{\pi}{4} \times D^2 \times \frac{H}{10}} = \frac{360 * 2.6 * 10}{\frac{\pi}{4} \times 1.5^2 \times H} = \frac{55909}{H}$$

Where

N =impact frequency, n = 3800/min;

Aw= single impact work, Aw = 2.6 J

D =drillhole diameter, D = 1.5 cm (bit diameter: 1.4 ± 05 cm);

H =net depth of drilled hole

F. Rock drillability classification by impact penetrant-specific work (IPSW) index.[4]

Class	IPSW(J/cm^3)		Drillabiliy	Representative rock
	IPA "a"	WZ-I MDG"a_w"		
1	≤186	≤400	Very Easy	Shale,coal,tuff
2	187-284	401-650	Easy	Lime stone,sandshale,peridoite,greenclay,amphibolites,mica quartz
3	285-382	651-900	Fair Easy	Granite,limestone,olive,schist,bauxite,magnite
4	383-480	901-1150	Fair Difficult	Granite,siliceous,limestone,gabbro,porphyrite,magnite quartzite
5	481-578	1151-1350	Difficult	Marteite,magnetic quartzite (Nan Fen),cangshangnesis,finegranide granite
6	579-676	1351-1550	Very Difficult	Martite(Gushal), lamprophyre, magnetite quartzite(Nan Fen 1st and 2nd layer iron ore), dense skam

III TYPES OF DRILLS BITS AND ITS MATERIAL

1] A masonry bit drills into tough materials such as concrete, brick and other stone material.

2] Cobalt Drill bit is extremely hard dissipating heat quickly. They are mostly used for boring in aluminium and tough metal such as stainless steel.

3] Black Oxide coated HSS drill bit has finished designed to help resist corrosion and increase durability. They last longer than basic HSS BIT and work well variety of material, including metal hard wood, softwood, PVC, fibreglass

4] Titanium coated HSS drill bit produce less friction they are tougher than basic HSS bit and stay sharp longer. They work for drilling wood, metal, fibreglass and PVC.

IV CALCULATION

Double acting pneumatic cylinder :-

Given data: Cylinder: 20*25

a) **Volume of air exhaust = Stroke *Area of piston**

$=50*(\pi/4)*20^{\wedge 2}$

$= 15707.96\ m^{\wedge 3}$

b) **Area of piston = $(\pi/4)*20^{\wedge 2}$**

$= 314.15\ mm^{\wedge 2}$

c) **Outstroke force (F) = Pressure *Area of cylinder**

$= 0.4*314.15$

$= 125.66$ N

d) **Piston rod area (A1) = $(\pi/4)*d^{\wedge 2}$**

$= (\pi/4)*7^{\wedge 2}$

$=38.48mm^{\wedge 2}$

e) **Effective area = Piston area - Piston rod area**

$= 314.15-38.48$

$= 275.66\ mm^{\wedge 2}$

f) **Instroke force = P*A**

$= 0.4*275.66$

$= 110.26$ N

❑ **Forces to break the stone =**

$$a = \frac{A}{V} = \frac{NAo}{\frac{\pi}{4}D^2H} = \frac{200 \times 39.2}{\frac{\pi}{4} \times 10^2 \times \frac{H}{10}} = \frac{998.2}{H} J/cm^2$$

Taking,

1) H=2cm, a=499.10 J/cm^2.

2) H=3cm, a=332.73 J/cm^2.

3) H=4cm, a=249.55 J/cm^2.

where:

a = Impact penetrate-specific work (IPSW), J/cm3;

A= Total impact work of, J;

V= Rock volume to be broken after , cm3;

N= Total impact times,

A_0= Work of single impact, A_0 = 39.2 J;

D= Actual hole diameter after drilling, d = 1 cm (bit diameter = 10 mm);

H= Net depth, mm.

V ADVANTAGES OF THIS MODEL:

1. The robot is computerized Digital control system.
2. The camera used is highly advanced as mentioned earlier.
3. The operation time is minimal.

4. The motor used in this process are computer controlled. So high precision of control is obtained.
5. The rope used is an international standardized.

VI CONCLUSION

The proposed system of drillingoperation was better than ordinary reboreoperation. The proposed machine has several devices to do specified work which will make the robot more efficient and in safety manner. This project is used to reduce human efforts for clearing blockage operations in the bore well. It performs operations in very less time as compared to traditional methods. Thus, it has been designed keeping the entire obstacle in mind that may arise during the operation. It can do the pipeline inspection which is beyond of human reach.

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