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BORE-WELL RESCUE ROBOT

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Abstract:

The advancement in the field of automation along with the mechanical design has a great impact on the society. The objective of the project is to design and construct a "Bore-well rescue robot" (i.e. to rescue a trapped baby from bore-well). This project includes series of process development from hand drawn sketches to computer generated design. The modern equipment's were implemented for various parts of the machine, since the machine performs a life rescue activity. The light weight servo motors were implemented for the machine operations. A safety balloon was introduced in order to provide extra safety. A long range CCTV camera was placed to find the baby position. An additional fork system was implemented for the perfect positioning. This machine is a human controlled computerized machine system with additional safety devices.

***Keywords**:* Robot design, Digital camera, computerized control, oxygen concentrator, pressure sensors, Infrared thermometer, safety balloon.

I. INTRODUCTION

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. There were so many child deaths due to the open bore-wells. The children fell into the open bore-wells and the rescue operation was almost end with failure. In the present what we do is dig a new well of the same depth next to the bore well and then make a tunnel connecting the two. This is a time consuming and costly process. It may take hours or even days to dig new well. In India there were frequent bore-well deaths. Approximately 20 children were felt in the bore-well and only 2 were alive. To overcome these hurdles, we have designed a bore-well recue robot with advanced equipment and devices.

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II. IMPORTANT COMPONENTS OF PROPOSAL MODEL

TABLE 1.
COMPONENT DETAILS:

S.No	COMPONENTS	FUNCTIONS
1	Digital integrated camera	To detect and handle the positioning of the baby
2	Digital oxygen supply system	To supply oxygen to baby from the surface
3	Advanced materials for different parts of robot	Special materials for different parts of robot
4	Advanced small sized servo motors	To run the gears for robot control
5	Advanced strain measuring pressure sensors	To measure the strain pressure in robot hands
6	Carpenter's levelling equipment	To ensuring exact centre of the robot through rope at the surface
7	Digital infrared thermometer	To measure temperature of the baby and baby trapped surroundings
8	Fork screw system	To make the robot immovable during rescue.
9	Gears	To control all the movements of robot action by different gears
10	International standardized rope and pulley	To carry and support the robot and equipment.
11	Safety balloon	To provide extra support to the baby
12	Digital pressure cage	To measure gas pressure during inflating the safety balloon under the baby.
13	Safety balloon filling equipment	To inflate and deflate the safety balloon
14	Fully computerized control system.	To integrate all electrical device controls in the computer

III. ADVANCED DIGITAL INTEGRATED CAMERA:

Figure1: 500 meter wireless range Digital CCTV camera.

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Closed-circuit television (CCTV) is more suitable for live-monitoring purposes. CCTV (closed-circuit television) is a TV system in which signals are not publicly distributed but are monitored, primarily for surveillance and security purposes.

The special features of the CCTV camera are mentioned in the table 2.

TABLE 2:

ADVANCED FEATURES OF THIS CAMERA.

	
	
	
	
	

IV. ADVANCED DIGITAL OXYGEN SUPPLY SYSTEM:

- The respiration of human beings will difficult, if the percentage of oxygen in air becomes less than 18%.so, we need a device to supply proper oxygen to the baby at the rescue process.

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- An oxygen concentrator is placed on the surface of the bore-well. It will automatically sense the defect of oxygen at the rescue region and it supplies the required oxygen. For this purpose, we included oxygen concentrator.
- An oxygen tube of 200 meter is placed on the surface.
- The tube is sent along with the robot to supply emergency oxygen to baby.
- The figures 2 and 3 show the oxygen concentrator and oxygen hoses.

Figure2. Oxygen concentrator.

Figure3. Oxygen hose

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V. ADVANCED STRAIN MEASURING PRESSURE SENSORS IN ROBOT HANDS:

- A pressure sensor measures pressure, typically of gases or liquids. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. Signal is electrical.
- This is typical open-cell polyurethane foam that can slightly conduct electricity because it is impregnated with carbon. Interestingly, it works as a pressure sensor.
- The figure 4 shows a foam pressure sensor model.

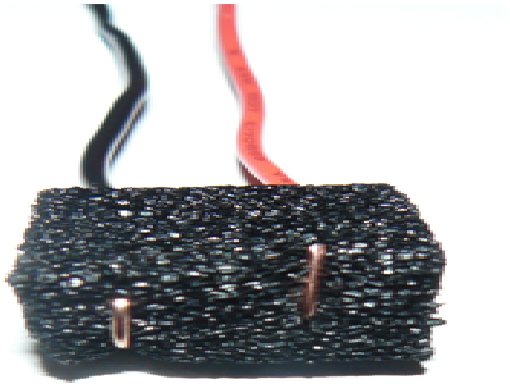

Figure4. A foam pressure sensor.

- The table 4 shows the specification of the foam used in pressure sensor.

TABLE 3.
PROPERTIES OF FOAM USED.

S.NO	PROPETY	RANGE
1	Density	5 lb/cu ft
2	Material	Open Cell Polyurethane
3	Tensile Strength	25 PSI
4	Heat Resistance	Stable at 121^{o} C

- The figure 5 shows the pressure sensor setup and its sensing when pressure given by finger.

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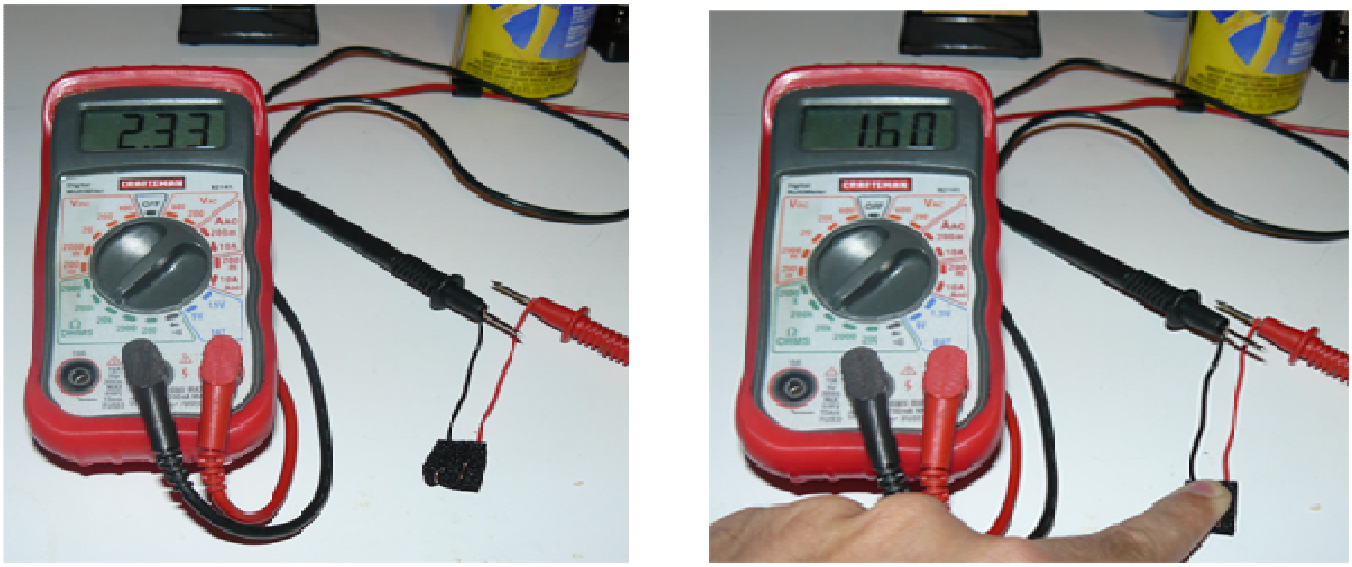

Figure5. Pressure sensor setup and working.

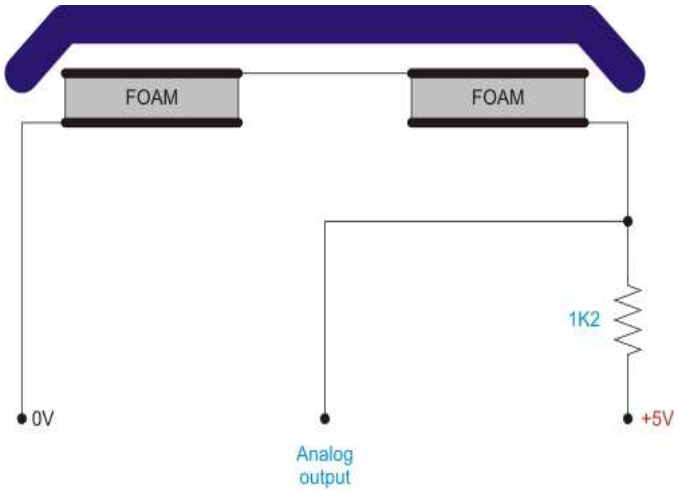

Figure6. Pressure sensor arrangement in foam.

VI. CARPENTER'S LEVEL:

- Embedded in the middle of the spirit level is a small window where the bubble and the tube are mounted. Two notches (or rings) designate where the bubble should be if the surface was level. Often an indicator for a 45 degree inclination is included.
- It is used to make sure of perfect leveling of the stand on the surface so that the complete robot arrangement is entering the bore-well in exact center.

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Figure7. Carpenter's sprit level.

VII. ADVANCED MATERIALS FOR DIFFERENT PARTS OF ROBOT:

TABLE 4.

MATERIALS AND ITS APPLICATION IN THE PROJECT.

S.NO	MATERIAL	WEIGHT (Kg/m^3)	IMPORTANT PROPERTIES	ACTUAL APPLICATIONS	PART OF OUR PROPOSAL
1	Stainless steel	7480-8000	High oxidation resistance	• Underwater materials • Architecture • Bridges	Plates Hollow cylinder Fork setup
2	Micro melt A 11 tool steel	7450	Extremely strong	• Propeller blades • Nozzles • Punches	Bellow tube and nozzle
3	Beryllium copper	8100-8250	1.non-magnetic 2.non-sparking 3.ductile 4.weldable 5.machinable	• springs • spring wire	Robot hand
4	Aluminium	2020.75	1.spark proof 2.silent operation 3.smoother running	• Gears, • Cook wares	Gears

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VIII. ADVANCED SMALL SIZED SERVO MOTORS:

TABLE 5.

TYPE OF MOTORS AND ITS APPLICATION IN THE PROJECT.

S.NO	MOTOR POWER	FUNCTION	APPLICATION
1	Servo motor [1/2 H.P]	To run the bevel gear setup	It helps the forks connected in bevel gears to penetrate the bore-well side walls
2	Servo motor [1/2 H.P]	To rotate the lower plate	It helps to rotate hands which are connected to lower plate to desired positions
3	Servo motor [1/4 H.P]	To run the rack and pinion set	It helps to do up and down movements of gas tube connected to mechanical bellow
4	Servo motor [1/4 H.P]	To rotate robot hand screw	It help to forward and backward movements of the robot hand to a desired position
5	Servo motor [1/4 H.P]	To rotate robot hand screw	It help to forward and backward movements of the robot hand to a desired position
6.	Servo motor [1 H.P]	To rotate the largest pulley	It is used to move the robot up and down using the rope and pulley setup.

IX. DIGITAL TEMPERATURE MEASURING EQUIPMENT:

- An infrared thermometer is a thermometer which infers temperature from a portion of the thermal radiation sometimes called blackbody radiation emitted by the object being measured. By knowing the amount of infrared energy emitted by the object and its emissivity, the object's temperature can often be determined. Infrared thermometers are a subset of devices known as "thermal radiation thermometers".
- Temperature measuring device is attached in the robot to measure the temperature level of the baby. It will helps medical team to make treatment planning before the child reaches the surface.

Figure8. Digital infrared thermometer.

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X. GEARS:

The table 6 gives various gears used in this project and their applications.

TABLE 6.

VARIOUS TYPES OF GEARS AND ITS APPLICATION IN THE ROBOT.

S.NO	GEAR TYPE	QTY	APPLICATION
1	Nut and screw type	6	To Control robot hands [2], To control fork setup [4]
2	Rack and pinion gears	1	To Controlling of height safety balloon setup
3	Bevel gears [large+small]	[1+4]	To ensure the stability of the robot

XI. ROPE:

- UIAA (Union Internationale des Associations d'Alpinisme)
- According to UIAA standards, required type of rope is selected.

Workhorse Singles rope:

- It is good for routes with rough rock and edges.
- It is used to down the robot inside the bore-well to desired depth where rescue operation to be done.
- This rope is flexible and easy to handle.
- The table 8 gives the specifications of the rope according to the international level..

TABLE 7.

PROPERTIES OF THE ROPE.

S.NO	PROPETY	RANGE/NAME
1	Diameter (mm)	15-25
2	Weight (g/m)	250

3	Break load (Kg)	11200
4	UIAA Fall Rating	15-25

XII. PULLEY:

- A pulley is a wheel on an axle that is designed to support movement of a cable or belt along its circumference.[1] Pulleys are used in a variety of ways to lift loads, apply forces, and to transmit power.
- We use three movable pulleys to pass the rope.
- A movable pulley has an axle in a movable block. A single movable pulley is supported by two parts of the same rope and has a mechanical advantage of two.

Applications of pulleys:

The application of various pulleys is listed in the table 9.

TABLE 8.

VARIOUS PULLIES AND ITS APPLICATION IN THE PROJECT.

S.NO	**PULLEY DIAMETER (mm)**	**APPLICATION**
1	1000	To roll up entire rope
2	150	To guide as intermediate pulley
3	100	To down the robot at bore-well centre using rope along with oxygen, balloon gas hoses, motor wires and signal cables

Figure9. Pulley model.

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XIII. SAFETY BALLOON:

- The safety disc is an air-filled disc that has a unique dome-shaped top.
- The safety balloon disc is 12" in maximum diameter.

Figure10. Safety baloon(mechanical bellow)

- It is initially in the deflated condition fitted with the nozzle.
- It is inflated, when this safety balloon is in right position under the baby.
- It is used to provide support to the baby.

XIV. ADVANCED DIGITAL PRESSURE GAUGE:

- This Digital pressure gauge is used to find the pressure from the gas cylinder which is connected to the safety balloon.
- It helps us to maintain exact range of pressure over the balloon.

Figure11. Digital pressure gauge.

XV. SAFETY BALLOON FILLING SMALL TYPE AIR COMPRESSOR:

- Using small type air compressor on surface, we fill air in the safety balloon at lower the baby for extra safety. Pressure gauge is inbuilt with this compressor. It will help us to know the pressure of air flow from compressor.
- 7 gallon (27 liter) air tank, ideal for small applications.
- It can deliver 125 maximum PSI
- A gas tube of 200 meter is placed on the surface, so that depending on the depth of rescue, the tube is lowered.

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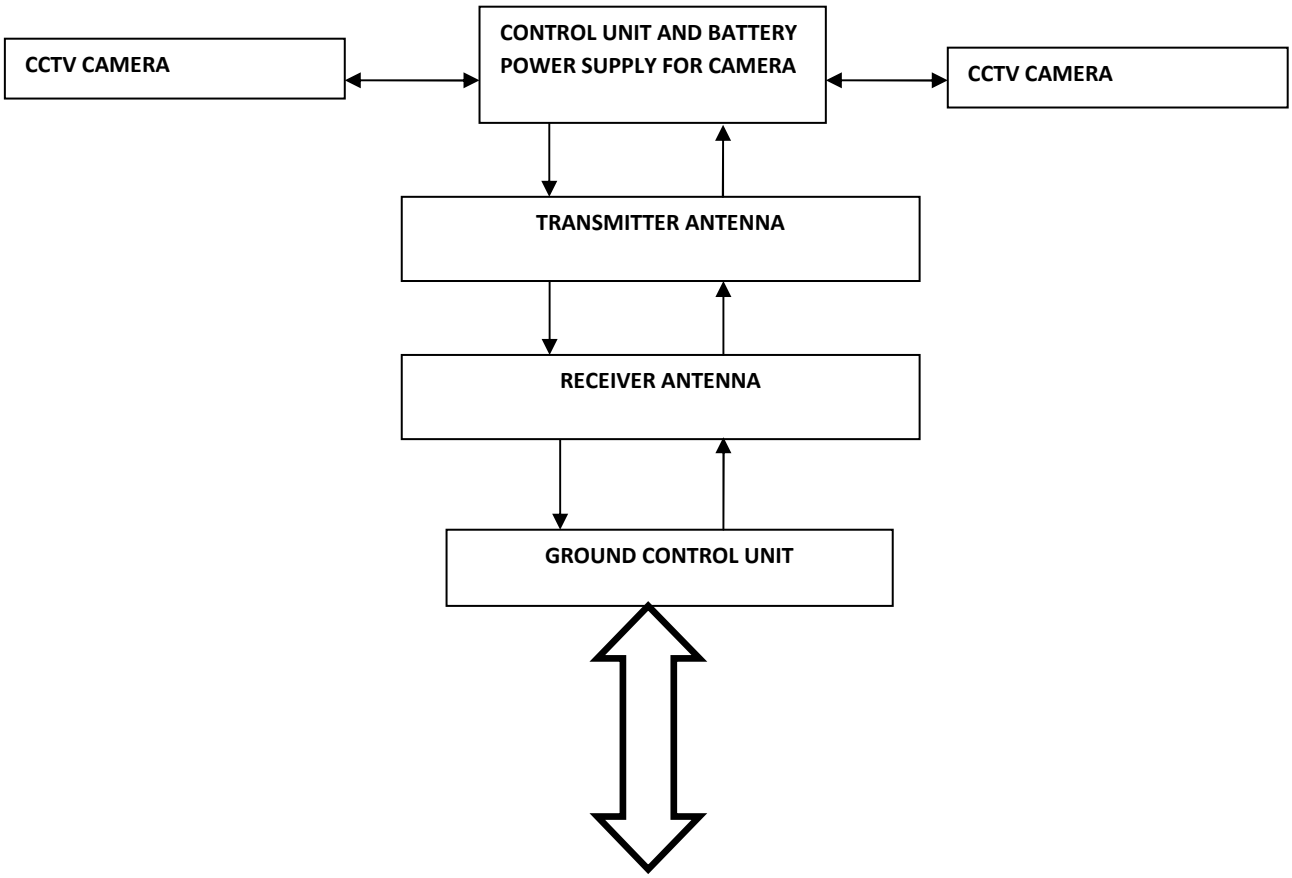
Figure12. Compact size air compressor

XVI. FULLY COMPUTERIZED CONTROL SYSTEM:

Flow chart 1.

Layout of all computer controlled devices in this project.



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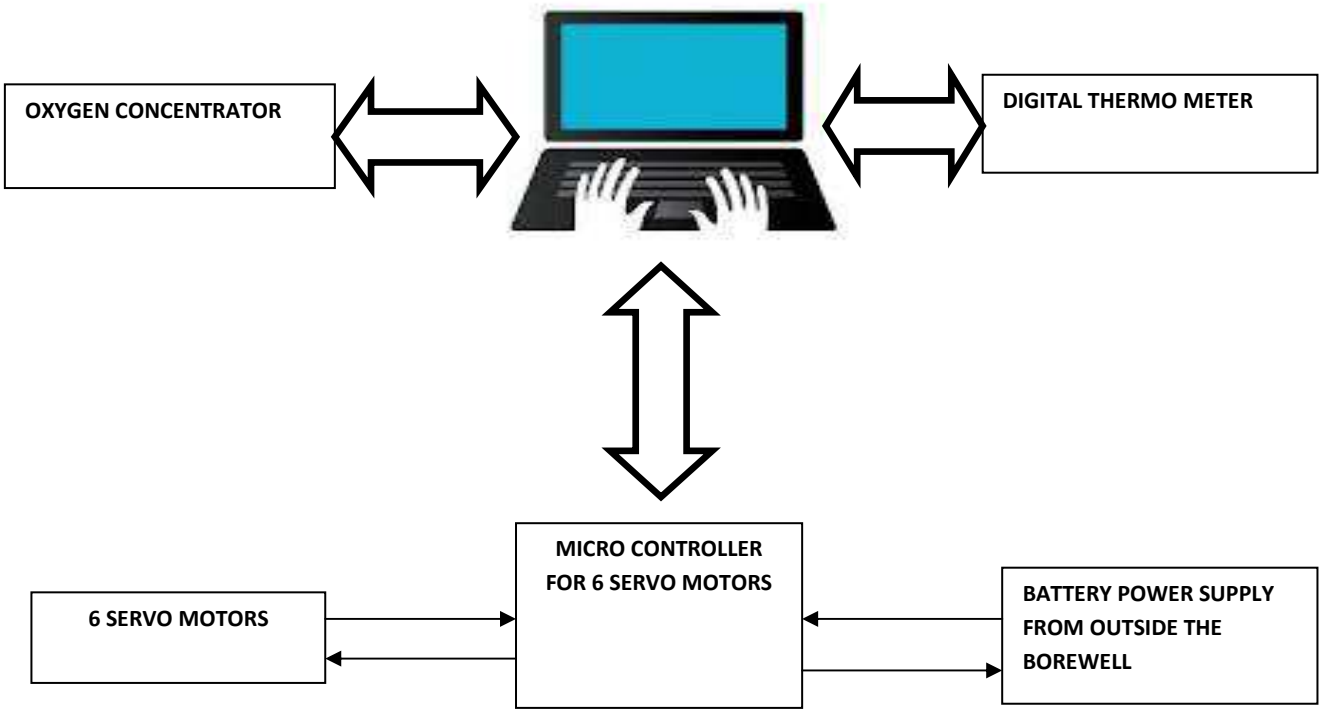

XVII. HAND DRAWN SKETCH OF OUR PROPOSAL:

- We have drawn the sketch of the advanced bore-well rescue robot on the basis of engineering graphics before the designing done in the designing software.
- It helps us to design the robot with our model idea and in exact dimensions.
- The three chain arrangement on the upper plate where the meeting junction of chains is used to tie the rope is not shown in hand drawings in order to maintain the legibility of the hand drawing and to avoid confusions in sketch.
- We have hard copy of drawings in A3 sheet with us.
- We attached a one view in figure 14.

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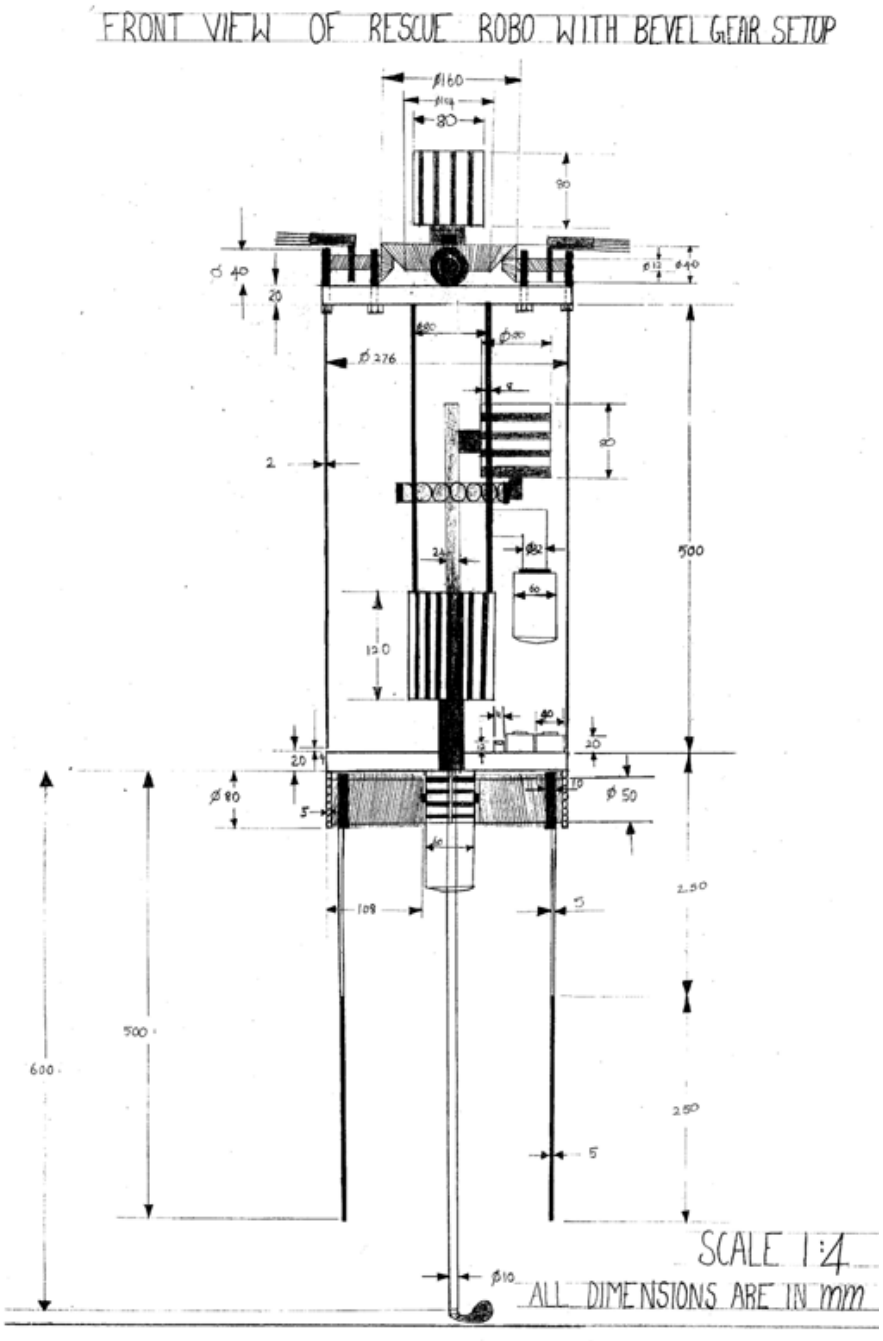

Figure13. Hand drawn front view of our model.

XVIII. COMPUTER DRAWING MODEL OF OUR PROPOSAL:

- We used Pro-e wildfire 5 software to draw the complete 3D model of our rescue robot.
- These three chain setups on the upper plate are shown in computerized drawings.
- The figure 15 shows the 3d drawing.

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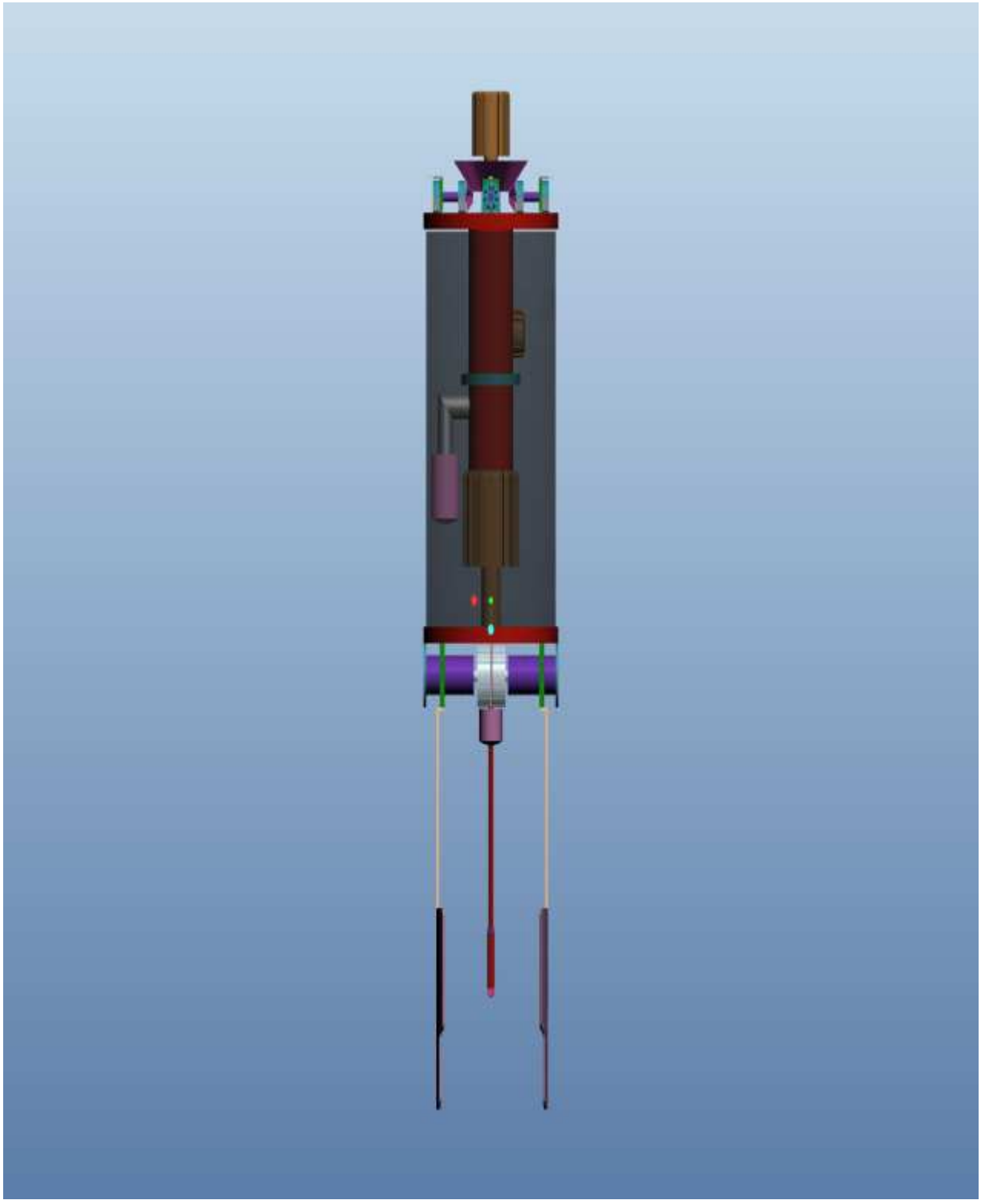

Figure14.Front view of robot design in pro-e software.

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XIX. PRECAUTIONARY STEPS:

- When baby accidently felt into the bore-well, first inform to the rescue team in fire station.
- The people should not do anything in the bore-well hole.
- It will help in preventing foreign bodies entering into the bore-well hole like soil, small stones, wooden pieces.etc.,
- The people can help the rescue team by removing obstacles around 5 meter of bore-well without disturbing the bore-well hole as said in previous step.
- They must prevent the people entering bore-well area around 10 meter diameter in order to prevent the disturbances during rescue operation.

XX. WORKING PROCEDURES OF OUR PROPOSED MODEL:

Step 1: The stand and pulley setup is placed exactly in centre of bore-well hole using carpenter's level.

Step 2: The rope is connected to the top of robot.

Step 3: As the robot is sent into the bore-well hole, electric wires for the motor from the control unit chip is attached along the rope.

Step 4: The oxygen hose is fixed to the upper plate of robot. Depending on the robot movement, the hose length is adjusted from outside the bore-well.

Step 5: The gas hose from the compressor is connected to the gas box located on the lower plate through the hole in upper plate. The gas box act as an intermediate gas transmitter.

Step 6: Depending on the robot motion, the rope is sent into the bore-well hole by a 3 pulley control system. The largest pulley is connected to motor shaft. Using this, the rope is pulled or pushed from the hole.

Step 7: Using the motion detector and other special features of camera, the baby position is seen through computer.

Step 8: At the appropriate position, the fork will punch into the bore-well wall using the motor connected to the bevel gear setup on the upper plate.

Case 1: If the baby is trapped in the middle of bore-well, the following steps should be done.

a) Using the motor connected at lower end of the hollow tube, the lower plate is rotated in such a way the safety balloon gas tube is in the gap between bore-well and the baby.
b) Initially the gas tube is above the end of robot hands.
c) It will avoid stabbing of gas tube on the baby.
d) Using the motor connected to the pinion, the rack is moved lower than the robot hands.
e) Then the robot is moved down in such a way that the robot hands free to hold the baby head or middle of the body.
f) Then using the individually working screw type gear system under the lower plate, the hands of robot are moved depending on the baby posture.
g) During holding, the strain pressure of the baby is measured using the pressure sensor connected the robot hands.
h) The pressure sensor output of each hand is shown in the separate multimeter.
i) The multimeter is placed on the lower plate in convenient to see the pressure changes through the other camera connected in middle of the hollow tube.
j) Now the baby is safer in between the robot hands.

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k) Then the temperature of the baby and surroundings is measured through the Digital thermometer which is controlled in the computer.
l) The display of the thermometer is also placed under the upper camera along with the multimeter.
m) Then the safety balloon is inflated by using the air compressor through gas box. The air pressure is measured in analog pressure gauge connected to the compressor.
n) For extra safety, a Digital pressure gauge is connected at the junction of the rack, safety balloon filling pipe and the hose from the gas box.
o) The Digital display is placed below the upper camera.
p) After the safety balloon reached the exact pressure, the compressor is cut off.
q) Then the safety balloon is moved upward using motor connected to the rack and pinion setup till the safety balloon completely supports the baby.
r) Now the baby is completely in robot control.
s) The baby movements are seen through the lower camera and other data readings are seen through upper camera.
t) The two way audio communication will help us to know the stipulations of the baby.
u) Then slowly, the baby is moved upward by pulling the rope using the pulley control system.
v) The medical team will be able to prepare for the treatment depending on the already seen temperature of the baby.
w) When the robot is pulled out, the rope is cut off.
x) The robot is taken outside carefully from the stand.
y) The hands are loosening by the motor control and the baby is taken for treatment.
z) Thus the baby is rescued within 30 minutes with full advanced robot system.

Case 2: If the baby is at the end of the bore-well, the following steps should be done.

a) It is similar to the above method with one step alternation.
b) The gas tube is above the robot hands as like the above procedure.
c) But the first rescue step is to hold the baby and lift the baby to at least 30 centimeter.
d) Then the gas tube is lowered using rack and pinion setup.
e) Then all the procedures are similar to the above case

XXI. PROJECT COST ESTIMATION AND ANALYSIS:

TABLE 9.

COST ESTIMATION IN INDIAN CURRENCY.

S.NO	COMPONENTS	QTY	COST/QTY	COST
1	ADVANCED DIGITAL PRESSURE GAUGE	1	2,000	2,000
2	BEARINGS	10	50	500
3	BEVEL GEAR SET[LARGE+SMALL]	[1+4]	[200,100]	600
4	DIGITAL CAMERA SET WITH CONTROL UNIT	1	42,000	42,000
5	FOAM USED IN PRESSURE SENSOR	2	200	400
6	FORK SETUP	4	250	1,000

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7	GAS FILLING HOSES (200 m)	1	40/1m	8,000
8	HOLLOW CYLINDER (9.6cm outer,8cm inner)	1	250	250
9	MULTIMETER	2	500	1,000
10	OXYGEN CONCENTRATOR	1	4,000	4,000
11	OXYGEN HOSES(200 m)	1	25/1m	5,000
12	PLATES (DIA 28CM,29CM,BOTH 1CM THICK)	2	250	500
13	SMALL TYPE AIR COMPRESSOR	1	4,000	4,000
14	WOODEN PULLEY [1000 mm]	1	1,000	1,000
15	STEEL PULLEY [150 mm]	1	200	200
16	STEEL PULLEY [100 mm]	1	150	150
17	RACK AND PINION	1	1,000	1,000
18	ROPE (200 m)	1	15/m	3,000
19	SAFETY BALLOON	1	1,500	1,500
20	SCREW TYPE GEAR	2	150	300
21	SERVO MOTOR (1/2 H.P)	3	8,000	24,000
22	SERVO MOTOR (1/4 H.P)	2	6,000	18,000
23	SERVO MOTOR (1 H.P)	1	10,000	10,000
24	ELECTRICAL CONTROLS FOR 6 MOTORS	6	3,000	3,000
24	BATTERY	1	10,000	10,000
25	MANUFACTURING COST (WELDING,DRILLING,ETC.,)	_	600	600
26	LABOUR COST	_	1,000	1,000
27	COMPUTER AND EXTERNAL DEVICES	1	40,000	40,000
GRAND TOTAL		40		1,83,000

XXII. ADVANTAGES OF THIS MODEL:

1) The robot is computerized Digital control system.
2) The camera used is highly advanced as mentioned earlier.
3) The thermometer setup will more useful in the pre planning of medical team.
4) The safety balloon is more safety in case of avoiding further falling of baby during the rescue operation.
5) The pressure sensor will help us to give correct movement of hands on the baby.
6) The fork setup will fix the robot at desired position and it will not allow further rotational or longitudinal movement of the robot.
7) The operation time is minimal.
8) The artificial oxygen concentrator will help in supplying required oxygen to the baby.
9) The motor used in this process are computer controlled. So high precision of control is obtained.
10) The rope used is an international standardized
11) This robot can also able to use as a obstacle remover in the bore-well, if the components used are changed into heavier and high power motors.

XXIII. FUTURE DEVELOPMENTS:

1) The cost of robot is high. But comparing to current military rescue operation, cost is less.
2) The rescue operation may be declined in case of foreign bodies over the baby.
3) There are 5 motors used in this rescue robot. It will make the rescue little tough.
4) As for long distanced operation, there may be possibilities of breaking of the gas hose or oxygen hose.
5) The power transmission through wires along the rope makes the rope bulkier and it may delay the operation.

We still research on these thinks to eradicate and develop the design of robot and the rescue operation.

XXIV.**CONCLUSION:**

- Thus we tried our level best to create a successful bore-well rescue robot. Since the actual robot cost is high, we designed in computer and we made it as model with few features excluded from the original proposed robot.
- The proposed system of rescue operation was better than ordinary rescue operation.
- The proposed machine has several devices to do specified work which will make the robot more efficient and in safety manner.
- If we get sponsor from government or private organization, we will make the actual robot.
- Since the proposed model has only few modifications and more advantages, it surely improves the rescue operation with less time.
- We still working on this project to include few modifications and to produce 100 % efficient bore-well rescue robot to the society.

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Biography:

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