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SPACER FITTING MECHANISM FOR HOTLINE MAINTENANCE

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Abstract: In recent days, electrical sector has grown rapidly and also voltage levels at which transmission to be done has also increased from 33KV to 1200KV. This has led to the problem of doing the maintenance work because the work has to be performed on live line. It is undesirable to disconnect heavy loads for maintenance work from grid as it may cause huge loss to the consumer as well as to the Power companies. Currently this work is done by humans by hand with Hotstick method and Bare hand technique but these methods also has drawback. To overcome this we developed a Spacer fitting mechanism to eliminate the need of human hand in Spacer fitting operation. With this mechanism the spacer fitting operation becomes faster and easier. With the help of IR (Infra-Red) sensor and Arduino® Uno microcontroller board with ATMEGA328P controller, the position of conductor is sensed and command is sent to perform fitting of spacer. The position of arms is adjusted by DC motors to perform the operation correctly.

Keywords: ATMEGA328P (Microcontroller), Arduino UNO (board), IR Sensor (InfraRed), Hotlinie.

I. INTRODUCTION

In electrical engineering, maintenance work has to be performed while line is energized. The first techniques for live-line working were developed in the early years of the 20th century, with growth in industrial sector from 19thcentury; it led to problem of maintenance work because it was difficult to perform work without interrupting supply to the consumer. In the 1960s, methods were developed in the laboratory to enable field workers to come into direct contact with high voltage lines. Such methods can be applied to enable safe work at the highest transmission voltage

1.1 MEANING OF HOTLINE MAINTENANCE

"Performing the maintenance work while the line is energized is called as hotline maintenance" the work involves the fitting of spacer, replacement of insulators, inspection of transmission lines and cleaning of insulators. These works are mostly performed by hand with the help of two methods that two methods are as given below:
1) Hot stick method
2) Bare Hand Technique

1.1.1 Hot stick Method

In this method the worker carries a hot stick (Hot stick is a insulated with a high voltage rating) in his hand and perform the maintenance work by keeping his body at ground potential and completely isolated from line potential.

1.1.2 Bare Hand Technique

In this technique worker wears a Faradays suit (which is completely electrically conductive) as well as insulated gloves and shoes. He then reaches closer to transmission line by insulated ladder or insulated floor of helicopter. The worker holds a charge circulating stick on transmission line and draws the potential from transmission line into his body. Based on principle that whenever two same charges are placed together they suffer neither attraction nor repulsion. Hence worker suffers no electrical shock from high voltage line and can perform the work safely.

2. METHODOLOGY

By introducing robot into power sector the risks involved may be minimized, but the robot should fulfill the following requirements:

- It should reduce involvement of human hand.
- It should not make contact between ground potential and line potential.

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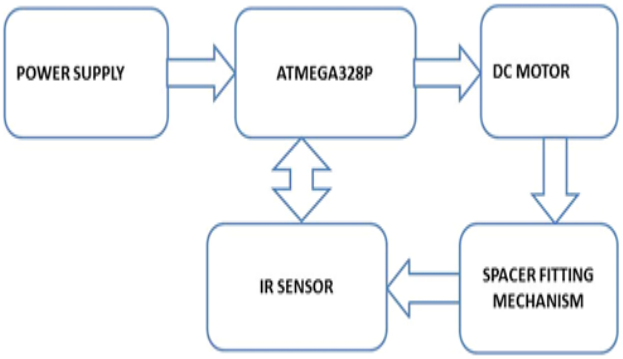
- Robot should be easy to operate.
- Robot should provide maximum safety to operator.
- It should not cause any harm to transmission line.

Spacers fitting operation should be smooth



2.1 Block Diagram of Spacer Fitting Mechanism

Above figure shows the block diagram for hotline maintenance by robot in which the12V DC power supply is feed to microcontroller, microcontroller generates PWM pulses which cause the rotation of dc motor in particular degrees. Due to rotation of DC motor robot arms will move (as the motors are actually fitted in robot-arms to cause movement). There will be a tool arrangement at the end of arm for doing maintenance work. Controlling unit controls the robot arm movement by giving commands to the microcontroller. Sensing unit will detect the position of robot-arm. The torque rating for dc motor is usually 14Kg/m2 to 16Kg/m2 this torque rating is sufficient for robot arm movement, Positional feedback also plays an important role in movement of robot-arm as it improves the stability of operation. The motor driver IC is used to drive the motors using a 5v signal source and can also run the motors in both reverse and forward directions. This IC can also supply the 12V to the dc motors even though the controller voltage is of 5V. The speed of the motors in both forward and reverse direction is controlled using the microcontroller.

3. IMPLEMENTATION

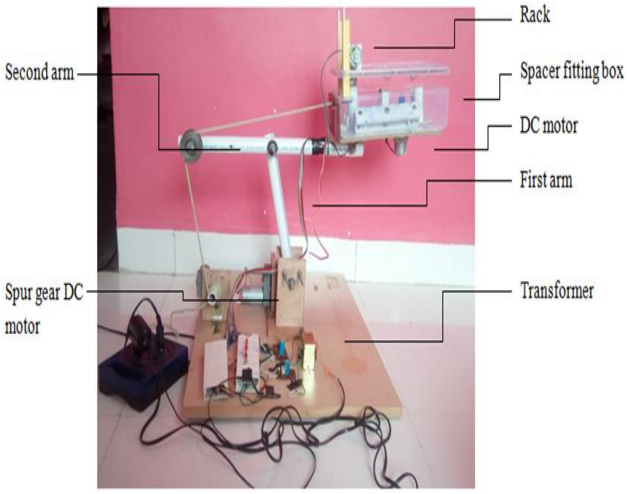


Figure 3.1: Side View of Project Setup

Three different movements have been employed in this system. They can be titled like**:**

1. Waist Movement
2. First Arm Movement
3. Second Arm Movement

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1. Waist Movement

The waist of the robotic arm is controlled by the pulley controlled box. A string is attached to the spacer fitting box and tied to the shaft of motor articulated at the base of setup and middle of the string is attached to the pulley at the centre. By movement of motor the waist also moves.

2. First Arm Movement

Another DC motor is coupled with a worm reducer, which has a reduction ratio of 100:1. The worm reducer will transmit the power to the shaft. This shaft is connected to the first (lower) arm. So if the shaft rotates then the first arm will rotate accordingly.

3. Second Arm Movement

Second arm holds both the pulley on one side and spacer fitting box on the other side. A string is attached to the box at one end and to the motor shaft on the other end through pulley. When the motor purposed for second arm movement is turned 'ON', string gets wounded on motor shaft which results in pulling of spacer fitting box causing upward and downward movement of spacer fitting box.

4. Flowchart for conductor detection program

Figure4.1: Flow Chart For Conductor Detection Program

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Spacer

In case of high voltage transmission line the spacer fitting is important as the conductors are held together as well as they are protected against the high winds. There are many types of spacers. They are mostly classified according to number to conductors they hold. The almost comes in all shapes and sizes according to the requirement of transmission line. The brief classification of these may be given as follows:

1.Two conductor spacer
2. Three conductor spacer
3. Multiple conductor spacers

1. Two conductor spacer

Spacer, who is used to hold two conductors together, is a two conductor spacer. Usually this spacer is employed in high voltage transmission line above 33kv. It is also called as twin spacer.

Figure 4.2: Two Conductor Spacer

Two conductor spacer is as shown in above image, in which it has two parts joined together by bolt and nut arrangement. Its length is 12.5cm. This spacer is fitted to transmission line by worker with hands. In India most of the transmission lines are fitted with two conductor spacer.

For our spacer fitting mechanism we made spacers by ourselves which are made up of fiber material and like spacer shown in above figure it is also joined together by bolt and nut.

Figure 4.3: Specially Made Two Conductor Spacer

Operation of Spacer Fitting Mechanism

Arduino UNO boards are specialized in robotic applications, Hence can be used in almost robotic applications it has special ports for driving up to 4 DC motors. Two ports for driving Servomotors and additional 5 sensors can be connected to the board. It has extra 13 ports for connecting input/output devices. In this project we used it for conductor position detection and screw tightening mechanism (Spacer fitting Mechanism).

The operation of the Spacer fitting mechanism is as follows

- The spacers are fed into the spacer fitting box.
- One part of spacer is set on upper part of box and other part of spacer on the lower part of spacer fitting box.
- The setup is moved close to the transmission line.
- The spacer fitting box is opened.
- The opened box is inserted into the transmission line.
- The sensor set for conductor detection detects the conductor and gives signal to the ATMEGA328P (which means conductors are in position)
- The spacer fitting box is closed and motor placed at the bottom of the box stars rotating which holds a Nut.
- Due to this the spacer gets tightened as both the Nut and bolt gets tightened due to rotation of Nut.
- After successful operation of spacer fitting

5. RESULTS & CONCLUSION

The above work deals with high voltages applications hence it must be insulated properly. The insulation rating for the given spacer fitting setup can be determined as follows

$$V_{rated} = K * V_{transmission}$$

Where,

V_{rate} - Rated voltage for insulation of given setup.

$V_{transmission}$ - Voltage of the transmission line.

K- (2 or 2.5) multiplier constant depending upon the weather condition.

CONCLUSION

In India most of the high voltage lines are fitted with two conductor spacer hence this mechanism is suitable for almost all such type of high voltage lines.Itis concluded from the work that the space fitting operation can be performed safely by eliminating human hand and placing artificial mechanism to perform the task. It also reduces the cost of operation as it reduces number of workers needed for the operation. Operation is easy and require less time for training.

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