Design of IOT Based Protection System for Distribution Breakers Using Arduino

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Abstract

Protection of installed electrical system is globally controlled and monitored through the centralized internet communication medium to make system more reliable. This study focuses on protection of the Line man from electrical Hazards that occur in the system. To protect a lineman an automatic password-based circuit breaker has been designed. This provides and ensures the safety of lineman via designed model. Furthermore, the detection of the fault in the installed electric line is also acknowledged, by lineman to operate the substation by entering the reference password. Along these lines, the proposed method improved the working capability of a lineman and helps to reduces the chance of mishaps and provides additional security measures in the system.

Keywords—Arduino, Breaker, Communication, Lineman, Password, Protection, Safety

1 Introduction

In Pakistan 80 to 85% electricity consumers depend on distribution companies. It is very difficult to provide protection to lineman from bulk Electric power. It is noticed that accidental and fatal ratio increases due to lack of complete information and miscommunication during maintenance and repairing of the electrical system. [1]. This study is aimed to provide the solution in the power system which ensures the safety of maintenance staff. As the life of lineman is at risk due to proper communication between staff members. This situation is not only in Pakistan but also in rest of the world, almost all the linemen are considered in the list of top ten most dangerous jobs. As per statistical data there are approximately twenty one lineman deaths per one hundred thousand workers [2]. Line man's deal with bulk power network system and undefined fault location as well as power network electrical equipment's [1][3].

During the electrical fault or short circuit, the power network suffers from high stress of fault current in them which may harm the equipment permanently. For conserving the power networks and equipment, the fault current should be reduced as soon as possible. For this purpose, intelligent micro controller for various control mechanism is used. Secure and reliable electrical system is the prime concern in our daily life [4][5]. Everyone needs proper, secure and reliable system for working. In this In this research, the password-based circuit breaker has been designed and proposed for the safety of electric lineman. System is designed to control and protect lineman and reduces the chances of accidents due to miscommunication [5-8]. If the lineman detects the fault in the system, he can enter the password and the staff working in the substation will be able to know that, there is a fault and can easily isolate the faulty portion. After removing the fault the password is entered by the lineman or he can communicate to substation staff to normalize the healthy circuit [9]. This method provides the proper projection and gives the solution to the problem and ensures the safety of a lineman [10]. Through this password based ON and OFF Control system, performance of the power system is enhanced [11][12].

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Now, if there is any fault in the system, then the lineman will switch off the power supply line by entering password and comfortably repair the electrical faulty area. After coming back to the substation, lineman can switch on the supply to the particular line by entering the password [13]. Separate passwords are assigned for each electrical line [14]. This paper contains four sections. The proposed method for password-based circuit breaker is in section 2, section 3 contains brief description of Hardware and Software. The conclusion and future work has been described in section 4.

2 Proposed Methodology

This project is based on internet of things which provides the access to only specified password to control the circuit breaker [15]. The system is controlled by the Arduino and ESP8266 microcontroller that communicates on serial communication. It has 32KB and 128KB of read only memory for the programming. An Internet of thing cloud is interfaced to the microcontroller to enter the password. Whereas, there is a MCCB circuit breaker to disconnect by disconnecting power supply of (UVR) under voltage relay or operating of shunt operating relay. The complete circuit is built with different equipment on board along with step down transformer of 230/9v [16][17]. The working voltage are around 9V in alternating current (AC). Then bridge rectifier converts the direct current, and the ripples are removed using a capacitive filter and it is then regulated to 3.3V using a voltage regulator. The 5V microcontroller for output is controlled by the interposing relay via stepping up 5V to 12V interposing relay. This disconnects the breaker with the help of shunt operating. The under voltage relays is used to avoid breaker opening without password. And IOT webpage is also utilized for breaker ON/OFF indication to verify the exact status of one breaker form other breaker location and is used for password display [11][18][19]. As the lineman has to deal with live wires very often, the chances of critical accidents are already very high.However, with the right amount of coordination among lineman and substation, a lot of these types of accidents can be avoided. The project of flow chart is shown in Figure 1.

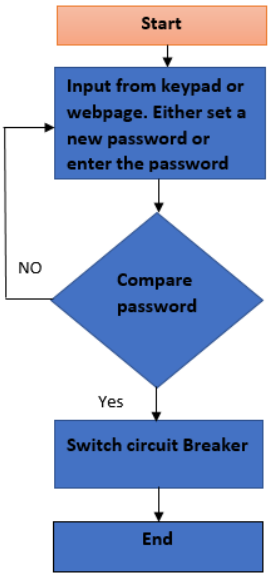

Fig. 1: Shows the flow chart of proposed method

3 Research Methodology

3.1 Software Requirement

3.1.1 Installing Software

The first step follow the instruction of PC and install Arduino software [20]. Specification of components are shows in Table 1.

3.1.2 Programming of Arduino

There are three individual programming connected which are as under.

1) Arduino board
2) Node MCU ESp826board
3) For web page, Arduino Programming

The above individual units are as shown in Figure 2.

3.1.3 ESP8266 Board Programming

ESP8266 WIFI board have total 30pins in which have 17 GPIO [18, 21] and we can utilize 4pins. Programming step to step shows in Figure 3.

3.2 Hardware Requirements

The parameters used in hardware are shown in list of components Figure 4. This shows the internal structure of the model.

3.3 Breaker Turn ON / OFF Procedure

Following steps follows to breaker on condition. The below steps follow for status of breaker on in webpage. Figure 5 shows the breaker 1 and breaker 2 in ON condition and Figure 6 and 7 show the breaker off condition.

1) 220VAC powered up the 9 OR 12 DC power supply as well powered up 5vdc relay auxiliary contacts
2) Password command given by IOT web page toESP8266
3) ESP8266 checking entered password to Programmed password when password correct then establish communication with Arduino.

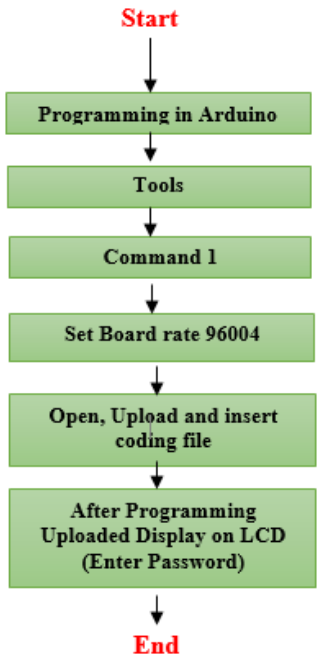

Fig. 2: Block diagram of Arduino programming

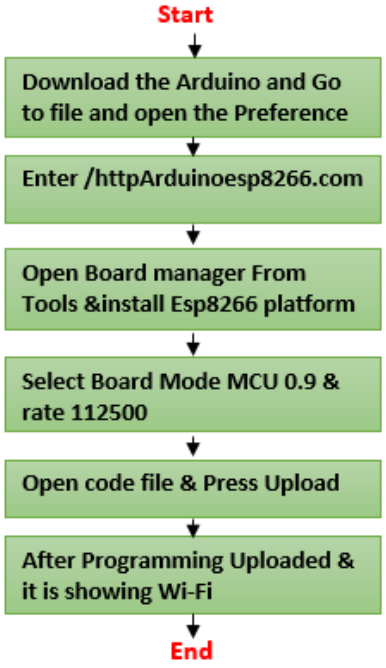

Fig. 3: Shows the block diagram of ESP8266 programming

S.NO	Components	Features	Specification
1	Arduino	Operating Voltage	9v
		Input Voltage	7-20V
		Digital Input /output Pins	14
		Analog Input /output Pins	6
		Dc current input pins	13 (11 pins are used)
		Clock speed	16MHZ
		USB cable	Type B
		Flash memory	32KB 128KB for ROM
2	MCU ESP8266 (WIFI)	Pins	30 in which 17 General purpose input output and we are using 4 Pins
3	Relay	Operating current	5 A
		Operating Voltage	5V DC (220V)
		Frequency	50 HZ
4	Resistor	-	5k Ω
5	Keypad	-	4 x 4 matrix
6	LCD display	-	(16x 2)
7	Power supply	-	230VAC – 12VDC
8	Potentiometer	-	10 Ω
9	Circuit breaker	Simple and motorized	100 A
10	Voltage regulator	AMS 117	3.3 V
11	Switches	Selector	-

TABLE 1: Specification of components and its features functions

Fig. 4: Shows the internal structure of model

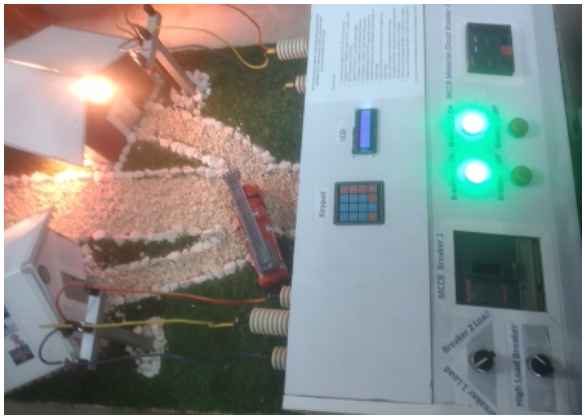

Fig. 5: Breaker 1 and breaker 2 ON Condition.

Fig. 6: Shows the breaker # 1 is off

4) When 5vdc Relay energizes it's NO contacts become NC then 220V AC pass from the contacts and energized /Deenergized the UVC (Under Voltage Coil) to Energized / deenergized the Breaker.
5) Arduino given output 5V start which energized the relay Arduino given output 5V start which energized the relay

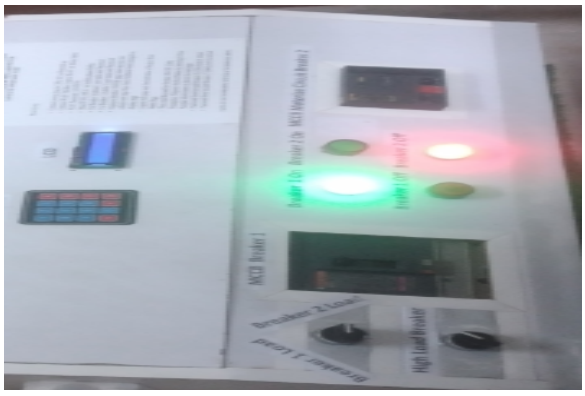

Fig. 7: Shows the breaker # 2 is off

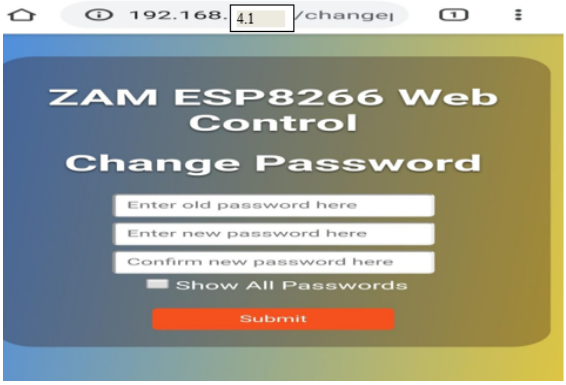

Fig. 8: The password change web page

3.3.1 Emergency protocol procedure for breaker ON and OF condition

If any case Webpage access device faulty or ESP8266 become faulty in that case Arduino able to work individually.

1) 220VAC powered up the 12Vdc power supply as well powered up 5vdc relay auxiliary contacts
2) Password command given by Keypad direct to Arduino.
3) Arduino checks entered password to Programmed password when password is correct then Arduino gives output 5V start Stop which energizes/deenergizes the relay.
4) When 5vdc Relay energizes it's NO contacts become NC then 220V AC pass from the contacts and energized the SOR (Shunt operating relay) to deenergized Breaker or When 5vdc Relay deenergized it's NC contacts become NO then 220V AC stop from the contacts and deenergized the SOR (Shunt operating relay) to energized Breaker.

3.4 Keypad Only Used in Case of Emergency

Only the specific person will be able to see entered password on LCD as well as breaker status. In case of any password security, this will allow the change of password show in figure 8.

3.5 Working Parameter Connection

The circuit consists of microcontroller, keypad (four by four), Liquid crystal display, Shunt and overload relays and two loads. Liquid Crystal display data pins are D 84, 85, 86, 87 connected to UNO board A2, A3, AA/SDA, AS/SCL control pins, respectively. The keypad pins are C1, C2, C3 C4 connected to (D4, D5 PWM, D6, PWMD7) while R1, R2, R3 R4 connected to (D8, D9 PWM, D10 PWM/SS, D11 PWM/MOSI) of the microcontroller while the Liquid

crystal display is used to display the information. In addition, the lamp and motor are connected to P3.0 and P3.1 through the relays. These are used to indicate circuit breaker state. Moreover, ESP 8266 Pins TX RX connected with Arduino at pins D1/TX D0/RX, ESP 8266 two pins D2 and D7 are used for breaker feedback system. In Arduino pins D2 and D3 are used to operate the relays where 5V relays are used t for the AC loads. While giving the connections, there is no common connection for AC and DC supplies. The 12V power supply is used for regulating 3.3 V. for ESP8266 Powered up and feedback system [22]. While other 5V to drive the relay is Arduino board itself regulated voltages.

3.5.1 Working Parameters Process

Following steps show the step by step working according to research.

1) First connect 220VAC Plug or Receptacle into power socket
2) Check and verify all equipment working normal
3) Then Open any Wi-Fi connecting device and connect device Wi-Fi name ‘’
4) Then enter IP:192.168.4.1 into browser search item
5) Then enter username ‘Admin1’
6) Then used password ‘Admin1’
7) Select breaker ‘One or Two’ let us take breaker ‘One’
8) Check status if shown Lock means breaker ‘OFF’
9) Check current status if shown Unlock mean breaker ‘ON’
10) When status shown ‘Unlock’ so switch ‘OFF’ the breaker and verify physically.
11) Then ‘Changed password’ for e.g., Admin3 after changing logout
12) Then try to login with old password for e.g. Admin1 that time login not access if its access on same old password its means that password not changed properly
13) Then check ‘Status’ of Breaker from web page or manual
14) After Maintained activity excess same IP :192.168.4.1 webpage Login in web page with same username and changed password
15) Then Switch ‘ON’ the breaker but status not changed from lock to unlock until breaker not Physically Open Manually (Only apply on Manual Breaker)
16) Now in case access not possible or any connecting device issue or Wi-Fi card not working then that time used keypad (keypad only used in emergency purpose)
17) Enter ‘1234’ for Breaker1 ON and OFF
18) Enter ‘2002’ for Breaker2 ON and OFF
19) After activity switch OFF the power supply and removed plug from power socket and put in safely manner.

4 Conclusion & Future Work

This project model is for reducing uncertainty of fatal accidents with the help of internet of things, for repairing the electric lines. As the safety plays a major role as the technology is ruling in the world. Therefore, this proposed work provides the safety of line man and expensive electrical equipment. The project has been completed as per the requirements. The main aim of the project is to avoid the fatal incident for lineman which are working on live electric power. The proposed work is based on single secured password. In future SCADA and other programming software can also work on this system to ensure the safety, reliably of electrical network.

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