

# An Efficient Perceptive Fault Detection System using IoT

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**Abstract** Fault detection and isolation are critical factors in the design and development of transmission and distribution systems. Prompt and accurate fault detection safeguards these systems by isolating the faulty section, preventing damage to other components. Effective fault detection and location identification enable service providers to address issues swiftly, minimizing power outages and ensuring uninterrupted service to consumers. This project aims to detect faults and disconnect the faulty segments in real time using AWS cloud technology. The proposed model identifies faults in the transmission line (represented here by a bulb) through a microcontroller, with fault information transmitted to the service provider via IoT. This approach is essential for the protection and maintenance of power systems. Traditional methods, which rely on current and voltage transformers and manual measurements, are expensive and require constant operator presence. The proposed solution offers a more efficient and cost-effective alternative.

**Keywords:** *Fault Detection, Internet of Things (IoT), Power Systems, MOSFET, Sensors, Microcontroller.*

## I. INTRODUCTION

Electrical power systems are getting advanced in all the sectors, which includes the generation, transmission and distribution systems. Safety and reliability play a crucial role in making any system to operate without any malfunctioning [1]. However, faults occur eventually in the system due to various factors such as human error, environmental changes and equipment failure. There are two types of faults, namely the symmetrical and unsymmetrical faults. Symmetrical faults are the most severe form of fault and rarest type of faults are called unsymmetrical faults, it is less severe when compared with the symmetrical faults [2][3]. Further these faults are sub-divided into three types namely, line to line (L-L) fault, line to ground (L-G) fault and double line ground (LL- G) fault. The faults in the system network may also

interrupt the workflow. Hence, the faults should be detected and isolated from healthy section in no time. There are many types of circuit breakers available in the market, which may include the SF6 circuit breaker, oil circuit breaker, vacuum circuit breaker and so on. These circuit breakers can be used for tripping of the circuit whenever a fault is detected in the system [4]. The other protective devices include relays, fuses etc. Whenever a fault is detected in the system it creates a low impedance path for the current flow which results in excessive current being drawn damaging the equipment's associate with it and tripping of the circuit breakers. This project is based on the fault detection using IoT helps in detecting the fault with time reference whereas the manual method is time consuming and needs physical presence to restore the system service. In order to fill in the above mentioned queries we have come up with the fault detection system, which helps in the identification of the faults in no time using IoT [5, 6]. This is a real time application where the faults are detected with an accurate date and time. In addition to this, the lines are disconnected in order to prevent the components or equipment from being damaged due to the occurrence of faults in the system. Fault detection and isolation techniques plays a vital role in safety thereby increasing the reliability of the system. This system focuses on the fault detection and isolation of the faulty section using IoT. The faults are created by two means and detected with the help of IoT, which in turn increases the system reliability and safety of the equipment restored once the faults are cleared by tripping the relay within a short period of time [7].

## II. MATERIALS AND METHODS

### A. RESISTOR

Resistors are used to regulate the current and/or voltage in a circuit. For transistor amplifiers, typical uses include supplying bias potentials and currents, translating

output voltage drops at the collector or emitter, and supplying aspecified attenuation value.

### B. POTENTIAL TRANSFORMERS

Potential transformers are step-down transformers, meaning that the secondary winding has few turns while the main winding has a lot of turns. PT is built with an exceptional high quality core that operates at a lower flux density for a small magnetizing current to minimize load loss.

### C. TEMPERATURE SENSORS

The degree of coolness and heat in an object can be measured using temperature sensors. The operation of a temperature meter is controlled by the voltage applied across the diode. The resistance of the diode directly correlates with the variation in temperature. Resistance will decrease when temperature drops, and vice versa. The resistance across the diode is measured, and the result is translated into temperature units that may be read and presented in numerical form over read out units. The temperature sensor used here is shown in figure 1.



Fig 1: Temperature Sensor

### D. RELAY WITH DRIVER

In industrial electronic systems, relays serve as switching components. Contacts are made or severed as soon as a relay is activated. Relays that manage either dc or ac power. They are employed to manage the flow of events during the operation of many systems, including telephony, welding circuits, electronic heaters, counters, and X-ray machines. Electromagnets are used in magnetic relays, and they produce a magnetic effect when a current flow through its coil. Soft iron relay contact armatures are pulled or pushed by it. The relay with driver used here is shown in figure 2.

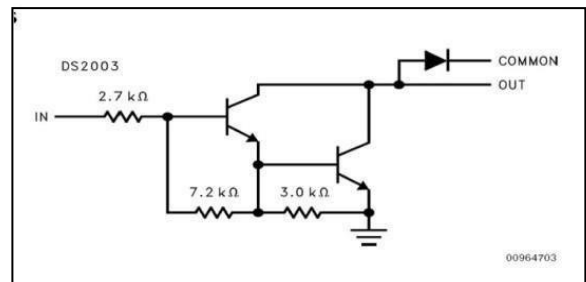


Fig 2: Relay with driver

### E. CURRENT TRANSFORMER

A current transformer delivers a secondary current that is precisely inversely proportional to the source current. r. The power system's current-winding, a core, and a secondary winding are the components of a current transformer; however, some transformers employ an air core.

### F. MOSFET

The ability to regulate the voltage and current flow between the source and drain terminals is the fundamental feature of a MOSFET device. The operating much like a switch. The main component of a MOSFET is a MOS capacitor. By applying either a positive or negative gate voltage, the semiconductor surface at the bottom of the oxide layer, which is situated between the source and drain. MOS capacitor underlies the device's operation, terminal, can be inverted from p-type to n-type. The MOSFET used here is shown in figure 3.



Fig 3 MOSFET

### G. MICROCONTROLLER

In order to simplify the system, a microcontroller is a complete setup of microprocessors built on a single integrated chip has been introduced. We can build whole microprocessor configuration on a single chip, which lowers the cost of creating other straightforward goods that use the same supply as a microprocessor. The microcontroller architecture used here is shown in figure 4.

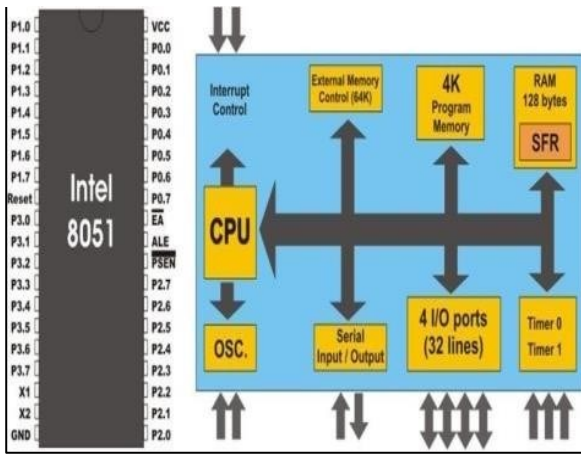


Fig: 4 Microcontroller architecture

### H. INTERNET OF THINGS

The term "Internet of Things" (IoT) describes the network of intelligent devices that are connected to information acquired by embedded sensors and microprocessor system, they are more expensive. Each component has a price tag. The parts needed to build this system should be inexpensive even though the product design merely calls for a rudimentary system [8]. A microcontroller constructed on a single chip was created to address this issue. This kind of setup is called microcomputer, and all the major parts are in the integrated chip. Usually they are called actuators in physical systems and other things. IoT is a new technology that will grow quickly over the coming years. This system will disclose a new dimension of services that increase customers' quality of life and the productivity of businesses, opening up the possibility of a linked life [9].

### III. MODELLING AND ANALYSIS

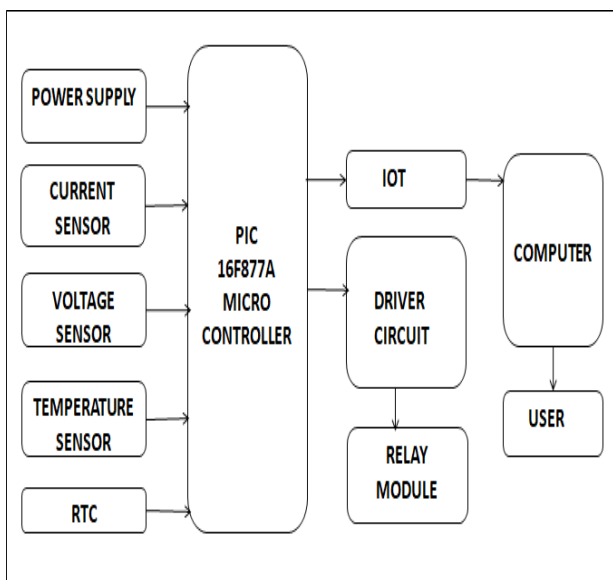


Fig: 5 Proposed Block Diagram

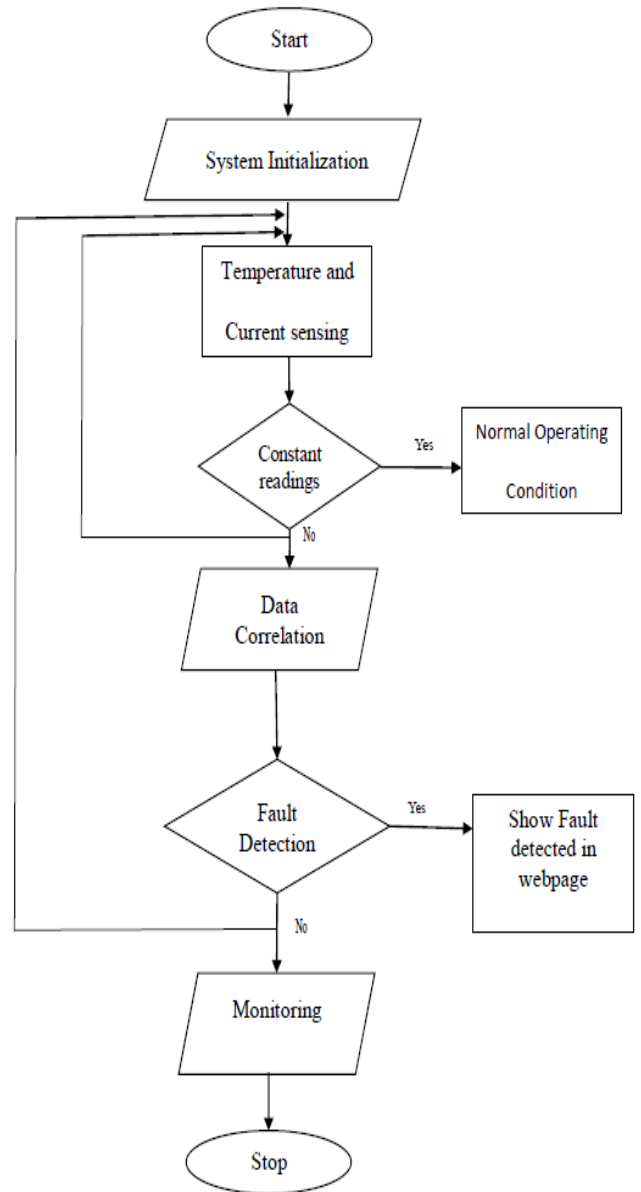


Fig: 6 Proposed Flowchart

As shown in Figures 5 and 6, an AC supply is given to the step-down transformer, which reduces the voltage and feeds it to the bridge rectifier for converting AC into pulsating DC. Further, a capacitor filter and voltage regulators are used for additional conversions as required by the system. A relay driver is also used in the proposed system. The PIC17F877A microcontroller [10] acts as the heart of the system, interfacing with the Wi-Fi module. An RTC (Real-Time Clock) is used for date and real-time reference.

### III. RESULTS & DISCUSSION

This study uses a PIC16F8779 controller with an inbuilt analog-to-digital converter and high program memory to store control algorithms and programs for specific tasks or functions. This system also includes components such as a current sensor, voltage sensor, potential transformer,

temperature sensor, driver circuit, and relay module. When the supply is provided, the microcontroller gets powered and initializes. An ESP module is used for Wi-Fi connectivity. The overview of the implemented hardware module is shown in figure 7.

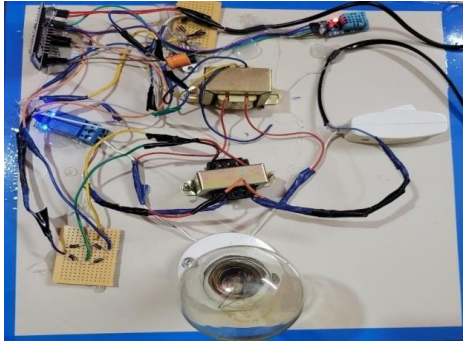


Fig: 7 Hardware Implementation

The fault detection is initiated by creating faults in the system by two means. The first this temperature rise is sensed by the temperature sensor. Further this information is sent to the relay and it is tripped. This information is sent to the micro controller through the driver circuit which is connected with microcontroller. Microcontroller uploads the information about the temperature and the current values with the date and time reference in wi-fi module. This is a real time application where the information is obtained at the instant when the fault is detected with the help of the RTC. The process uses wi-fi for obtaining information. This is followed by a display of the current levels. Another fault is created by short circuiting. The isolation of the faulty section is done by tripping the relay. This process happens whenever the fault is detected and the service is restored.

When the faults are created, the system and the webpage result are shown as follows:

Under the normal operating condition, the system and the webpage indication will be provided as follows: Figure 8 shows the normal operating condition. Figure 9 shows the log of operating conditions in webpage. Figure 10 shows the temperature rise indications. Figure 11 shows the log of fault detection using temperature value in webpage. The other different types of logs by tripping and short circuiting the system are shown in figures 12 and 13.

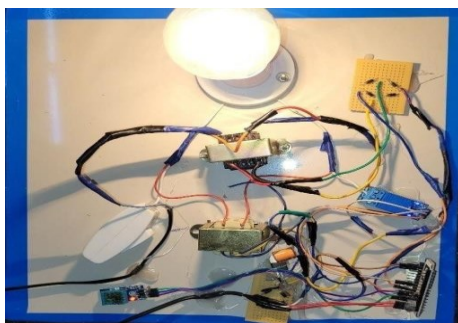


Fig: 8 Normal operating condition(hardware)

34	LOW	HIGH	12:14:42 PM	04/05/2023
35	LOW	HIGH	12:15:01 PM	04/05/2023
36	LOW	HIGH	12:15:10 PM	04/05/2023
37	LOW	HIGH	12:15:18 PM	04/05/2023
38	LOW	HIGH	12:15:25 PM	04/05/2023

Fig: 9 Normal operatingcondition(webpage)

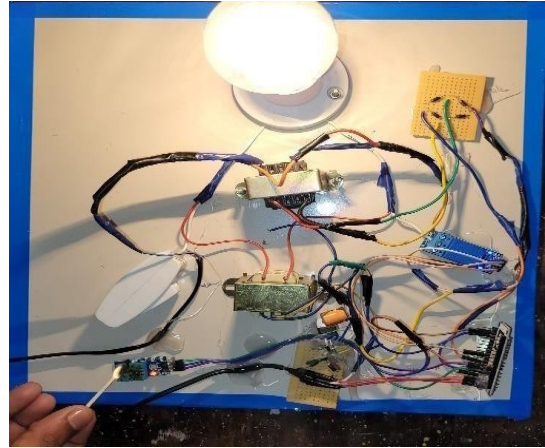


Fig: 10 Temperature rise indication in hardware

ID.NO	Temperature	Current	Time	Date
1	HIGH	HIGH	12:11:26 PM	04/05/2023
2	HIGH	HIGH	12:11:28 PM	04/05/2023
3	HIGH	HIGH	12:11:30 PM	04/05/2023
4	HIGH	HIGH	12:11:31 PM	04/05/2023
5	HIGH	HIGH	12:11:33 PM	04/05/2023
6	HIGH	HIGH	12:11:35 PM	04/05/2023
7	HIGH	HIGH	12:11:37 PM	04/05/2023
8	HIGH	HIGH	12:11:40 PM	04/05/2023
9	HIGH	HIGH	12:11:41 PM	04/05/2023
10	HIGH	HIGH	12:11:44 PM	04/05/2023

Fig: 11 Fault detection log in webpage

#### IV. CONCLUSION

45	LOW	LOW	12:16:20 PM	04/05/2023
46	LOW	LOW	12:16:28 PM	04/05/2023
47	LOW	LOW	12:16:36 PM	04/05/2023
48	LOW	LOW	12:16:44 PM	04/05/2023
49	LOW	LOW	12:16:52 PM	04/05/2023
50	LOW	LOW	12:16:59 PM	04/05/2023
51	LOW	LOW	12:17:07 PM	04/05/2023

Fig: 12 Fault detection

#### IOT BASED FAULT DETECTION

ID.NO	Temperature	Current	Time	Date
1	LOW	HIGH	6:47:47 PM	24/04/2023
2	LOW	HIGH	6:47:49 PM	24/04/2023
3	LOW	HIGH	6:47:50 PM	24/04/2023
4	LOW	HIGH	6:47:52 PM	24/04/2023
5	LOW	HIGH	6:47:54 PM	24/04/2023
6	LOW	HIGH	6:47:56 PM	24/04/2023
7	LOW	HIGH	6:47:58 PM	24/04/2023
8	LOW	HIGH	6:48:01 PM	24/04/2023
9	LOW	HIGH	6:48:03 PM	24/04/2023
10	LOW	HIGH	6:48:05 PM	24/04/2023
11	LOW	HIGH	6:48:07 PM	24/04/2023
12	LOW	HIGH	6:48:12 PM	24/04/2023
13	LOW	HIGH	6:48:14 PM	24/04/2023
14	LOW	HIGH	6:48:17 PM	24/04/2023
15	LOW	HIGH	6:48:19 PM	24/04/2023
16	LOW	HIGH	6:48:22 PM	24/04/2023
17	LOW	HIGH	6:48:24 PM	24/04/2023
18	LOW	HIGH	6:48:27 PM	24/04/2023
19	LOW	HIGH	6:48:30 PM	24/04/2023
20	LOW	HIGH	6:48:33 PM	24/04/2023
21	LOW	HIGH	6:48:36 PM	24/04/2023
22	LOW	HIGH	6:48:38 PM	24/04/2023
23	LOW	HIGH	6:48:41 PM	24/04/2023
24	LOW	HIGH	6:48:44 PM	24/04/2023
25	LOW	HIGH	6:48:47 PM	24/04/2023
26	LOW	HIGH	6:48:55 PM	24/04/2023
27	LOW	HIGH	6:48:58 PM	24/04/2023
28	LOW	HIGH	6:49:01 PM	24/04/2023
29	LOW	HIGH	6:49:04 PM	24/04/2023
30	LOW	HIGH	6:49:12 PM	24/04/2023
31	LOW	HIGH	6:49:15 PM	24/04/2023
32	LOW	HIGH	6:49:23 PM	24/04/2023
33	LOW	HIGH	6:49:26 PM	24/04/2023
34	LOW	HIGH	6:49:30 PM	24/04/2023
35	LOW	HIGH	6:49:33 PM	24/04/2023
36	LOW	HIGH	6:49:41 PM	24/04/2023
37	LOW	HIGH	6:49:50 PM	24/04/2023
38	LOW	HIGH	6:49:58 PM	24/04/2023
39	LOW	HIGH	6:50:02 PM	24/04/2023
40	LOW	HIGH	6:50:10 PM	24/04/2023
41	LOW	HIGH	6:50:13 PM	24/04/2023
42	LOW	HIGH	6:50:21 PM	24/04/2023
43	LOW	HIGH	6:50:26 PM	24/04/2023
44	LOW	HIGH	6:50:34 PM	24/04/2023
45	LOW	LOW	6:50:43 PM	24/04/2023
46	LOW	LOW	6:50:51 PM	24/04/2023
47	LOW	LOW	6:50:59 PM	24/04/2023
48	LOW	LOW	6:51:07 PM	24/04/2023
49	LOW	LOW	6:51:16 PM	24/04/2023
50	LOW	LOW	6:51:24 PM	24/04/2023
51	LOW	LOW	6:51:32 PM	24/04/2023
52	LOW	LOW	6:51:40 PM	24/04/2023
53	LOW	LOW	6:51:48 PM	24/04/2023
54	LOW	LOW	6:51:58 PM	24/04/2023
55	LOW	LOW	6:52:06 PM	24/04/2023
56	LOW	LOW	6:52:14 PM	24/04/2023
57	LOW	LOW	6:52:23 PM	24/04/2023
58	LOW	LOW	6:52:32 PM	24/04/2023
59	LOW	LOW	6:52:40 PM	24/04/2023
60	LOW	LOW	6:52:49 PM	24/04/2023
61	LOW	LOW	6:52:58 PM	24/04/2023
62	LOW	LOW	6:53:06 PM	24/04/2023
63	LOW	LOW	6:53:14 PM	24/04/2023
64	LOW	LOW	6:53:23 PM	24/04/2023
65	LOW	LOW	6:53:31 PM	24/04/2023
66	LOW	LOW	6:53:38 PM	24/04/2023
67	LOW	LOW	6:53:48 PM	24/04/2023
68	HIGH	LOW	6:53:57 PM	24/04/2023
69	HIGH	HIGH	6:54:05 PM	24/04/2023

Fig :13 IoT based Fault Detection

The short circuit fault and the fault due to temperature rise in a particular place in the system is detected and the faulty section is isolated i.e., disconnected using IoT. The Real Time Clock (RTC) is used in this system to detect the fault with accurate date and time reference. The system displays the temperature, current values, date and time when the fault is detected which is accomplished with the microcontroller and IoT webpage. The main pros of this system is the improvement of the system reliability and the fast detection and instant disconnection of the faulty section with the intimation from IoT.

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