Arduino based Short Circuit Protection System using various sensors

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Abstract - This paper contains a short circuit protection system using sensor systems and Arduino module with wireless communication. In many industries and M.S.M.E. there are cases of fire and the major cause is short circuit which mostly occurs due to moisture level increase in plant or increase in heat and temperature in the plant and circuits. So to overcome this we have developed a short circuit protection system using Arduino ,GSM module, heat sensor, temperature sensor, relay and alarm. It is easy to implement and can be used in various sectors and industries by changing certain parameters.

Key Words: Arduino, DS18B20, GSM module, Industrial Automation, Sensor, Sim800A

1.INTRODUCTION

Electric power is generated, transmitted and distributed through large interconnected power systems. The electric power is generated in various types of power plants. Then the voltage level of the power will be step up by the transformer before the power is transmitted. Since electric power is the product of voltage and current, high voltage is used in transmission in order to reduce the line currents then the power transmission losses is reduced that is copper loss. The primary objective of all power systems is to avoid the load shading. However, lightning or other natural events like wind and ice, physical accidents, equipment failure, and other unpredictable events may cause a short circuit between the phase wires of the transmission line or from the phase wires to ground, which is called a fault. Then the short circuit current is produced and the value of the short circuit current is very much greater than the normal operating current. So if there is a fault persists, there is a severe damage shown in the electrical equipments. In order to reduce such an accident, it is necessary to disconnect the faulted part from the healthy system as soon as possible. This is done by the circuit breaker and protective relay.

2. LITERATURE REVIEW

KV Baoze Wei in his paper demonstrated that, in order to prevent working accidents by electrocution in high voltage systems, the main safety measure consists in connecting the earthing devices, on the both sides of working area. In any of these three cases, if the earthing devices are chosen and placed correctly, in the working area, as we expected, the drop voltage, is limited to a safety value. The worker on the console can touch one phase at a maximum distance of 2 m, and the voltage does not exceed 1 V, for 10 of the earth dispersion resistance.[1]

Rakesh Maisuriya in simulation of short circuit condition and fault analysis in power system [2] From the discussion of IEEE 14 bus power system Mat-Lab model we can conclude that in an interconnected electrical power system if there is a fault occurs in any of the subsystem , all the system voltages and system currents are affected and must be improved otherwise it will creates fault of circuit parameters to other lines. This paper presents the Research literature work and the Review about the Short Circuit Analysis of a large Power System Network. Survey and lot of research papers have been presented for the improvement and new methods to analyze the Short Circuit Calculation in a Power System. The Aim of this Review Paper is to propose a calculation method in effortless technique for Short Circuit Analysis. The analysis of the most serious short-circuit fault provides a very high inrush current which is very dangerous for the system so to chop out this heavy current, a suitable step should be taken so that the dangerous effects of symmetrical faults can diminish and making the system more reliable. If we will not improve or disconnected faulty lines or area from healthy lines or area then huge crisis of power will be occurred, even blackouts. So instability, transient stability, fault analysis are very important in power network.

Sharthak Munasib in Short-Circuit Protection for Low-Voltage DC Distribution Systems Based on Solid-State Circuit Breakers [8] The work presented in this thesis addressed some important issues regarding the short-circuit protection of low-voltage dc distribution systems. The following conclusions and contributions are drawn from the results presented and analyzed in the thesis: The RB-IGCT seems the best semiconductor device for implementing a 1-kVdc SSCB since it has the short-circuit capability of a thyristor (~ 3 kA), extremely low on-state voltage drop (~1.25 V) during normal SSCB operation, and blocks voltages in forward and reverse directions but conducts current only in the forward direction. It has low thermal resistance, assisted by double-sided cooling and hermetic sealing resulting from its hockey-puck, thyristor-type package. All of these attributes should result in increased efficiency, compactness and reliability when compared to other controllable devices. ⌟ Compared to the standardized opening time of 35-40 ms during a fault for electromechanical circuit breakers, the SSCB containing RB-IGCT as the semiconductor switch would exhibit an opening time of around 40 μs. ⌞

Unavoidable controller delays require that additional devices be connected in parallel to sustain higher limiting fault currents.

Main power circuit based hardware protection or combined with modified algorithm control method: In some other literatures, the protection methods are based on modifying the main power circuit by adding auxiliary protection circuit or using different control method in the software under fault condition. The concept of the protection in [5] is using an auxiliary switch, connected along with driving circuit, between the positive rail of the DC bus capacitors and the collector/drain terminal of the upper switching transistor. The disadvantage is that the complexity of the circuit is increased given that auxiliary drive circuit need to be incorporated for switching the protecting transistor [5]. Also, in [5], it proposed another protection method called linear current protection method, which contains more auxiliary switches and resistors for the protection circuit. This method will increase the cost and the volume of the system; also will increase the power loss because of the auxiliary components.

Algorithm based overload or short circuit protection method : The over current control strategy in [7] is based on generating new current reference according to a current limit function, an auxiliary control loop, and a look up table is used to store the original current reference. In [8], a current limiting method was proposed based on a hysteresis comparator circuit and switched to current controlled mode after over current happens. The main disadvantage of this control method is complexity of the auxiliary current control mode, and it has a longer response time as the authors mentioned in [8] and it need to design a hysteresis comparator circuit for each phase.

3.CIRCUIT DESIGN

3.1 Block Diagram

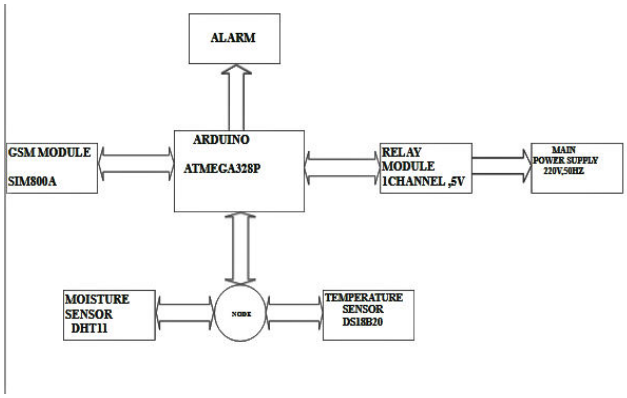

FIG.1 BLOCK DIAGRAM OF SYSTEM

The signals detected by the sensors are passed through a signal conditioning circuit for further processing and to convert the analog signals into digital values. The Analog-to-Digital convertor is defined by its bandwidth and signal-to-noise ratio.

The microcontroller which is used is ATmega328 interfaced using an Arduino Uno kit.

The system we are connecting with the Arduino via Gsm using RS232 serial communication modem. RS232 protocol is commonly used in embedded systems. In this, data is combined into a packet and sent bit by bit on a single wire between two communicating devices. This requires less maintenance and costly implementation. However, synchronization between communicating devices is necessary. Sometimes separate wires are required for two-way communication. This approach is widely used for long distance, high speed and reliable communication. This kind of communication can be used at home as well as in the hospitals for central monitoring systems.

Arduino Uno is interfaced with all the above sensors and gsm module and all the data is stored in an ERP database(enterprise resource planning)

All the three sensors detect the heat, temperature and moisture content in the plant and as soon as the level exceed the optimum level a warning message is sent to the respective department of the industry as well as the system provider using gsm module and the reason for increase in the level of moisture heat and temperature is determined and rectified in time to prevent any mishap.

3.2 CIRCUIT PIN DIAGRAM

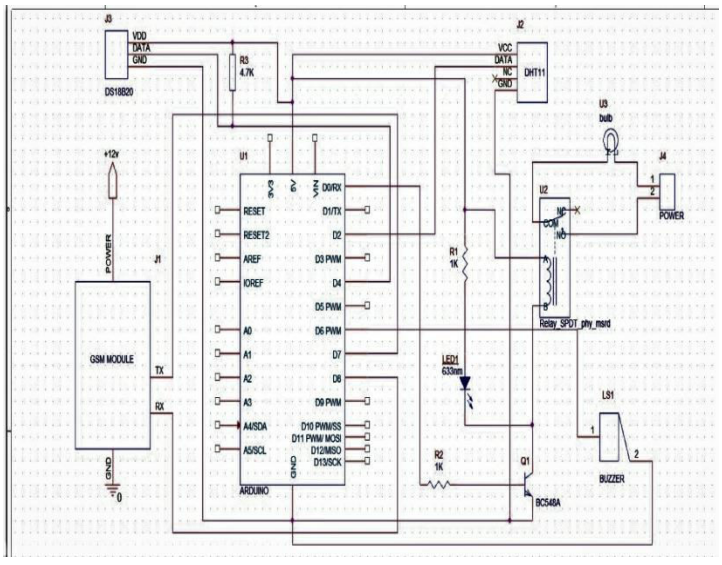

FIG.2 CIRCUIT DIAGRAM WITH PIN CONFIGURATION

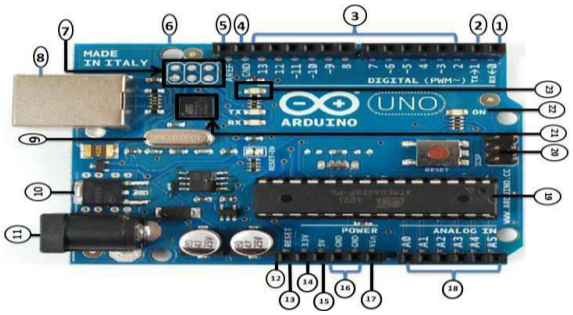

FIG. 3 ARDUINO LAYOUT

TABLE 1:ARDUINO LAYOUT COMPONENTS

NO.	NAME	PIN DESCRIPTION
1	Serial output(TX)	
2	Serial input(RX)	
3	Digital input/output Pins(2-13)	The input/output voltage to the Arduino Uno board when it is using an external power source
4	GND	Ground pin for digital
5	AREF pin	Reference voltage for the analog inputs, Used with analog reference
6	Reset button	Move this line low to reset the microcontroller, and use to add a reset button to shields which block the one on the board.
7	ICSP for AT mega 16U2	
8	USP plug	
9	AT mega 16U2 microcontroller	Memory
10	Voltage Regulator	Regulate the voltage to 5V
11	External power supply plug	Can supply voltage through it by the power jack
12	IOREF pin	Provides the voltage reference with which the microcontroller operates
13	Reset pin	Bring this line to reset the microcontroller
14	3.3V pin	3.3V supply generated by the board regulator. Maximum current on the board 50 mA
15	5V pin	The outputs 5V on the board
16	GND	Ground pins for analog
17	Voltage in pin	The Vin pin of board(7-12V) supply voltage via 5V or 3.3V
18	Analog inputs pins(0-5)	Read the analog data
19	AT mega 328 microcontroller	Memory has 32 KB
20	ICSP for AT mega 328	
21	TX, RX Led	
22	Power LED indicator	
23	On-board LED	

4.RESULT AND EVALUATION

4.1 PRACTICAL CIRCUIT IMPLEMENTATION

A practical circuit implementation of the proposed Short Circuit Protection System using Arduino Controller and various sensor is shown in FIG.2. For Arduino power is given using the USB slot.

DS18B20 Temperature sensor which senses the temperature of the surrounding environment of the wire and circuit placed in the industrial setting is interfaced to Arduino board using D4 pin which establish data communication and sequentially the observed value is being fed to the relay and GSM module.

DHT11 Humidity sensor which senses the humidity level in the surrounding is interfaced to the Arduino board using D2 pin to establish data communication between sensor and Arduino board and the observed value is fed to the relay and GSM module.

SIM800A GSM module which receives the data from DHT11 and DS18B20 sensor sends the data to the user and receives the command back from them and implements it. It is interfaced to Arduino using D7 pin for transmission function and its receiving and implementation function is achieved using alarm and Arduino command.

1 Channel, 5V relay is used to shut the power of the plant when the temperature and humidity content in the surrounding exceeds the safe and previously pre fed value. It is connected through GSM module and alarm to cut the power supply to prevent short circuit.

Alarm is connected to D6 PWM pin of the Arduino which when the temperature and humidity exceeds the pre fed values is raised and send the data to relay as well as GSM to prevent Fire due to short circuit.

4.2 EXPERIMENTAL OBSERVATION

***NORMAL VALUES(Room condition):-**
1.DS18B20 - 0-45 Degree Celsius
2.DHT11- 0-45 %

***WARNING LEVEL(Room condition):-**
1.DS18B20 - 46-50 Degree Celsius
2.DHT11- 46-55 %

***HAZARDOUS LEVEL(Room Condition):-**
1.DS18B20 - >50 Degree Celsius
2.DHT11 - >55%

TABLE 2 : EXPERIMENTAL OBSERVATION

NO.	DS18B20	DHT11	ACTION
1	38 deg	30%	Normal value observed for temperature and moisture, No action needed, Value stored in database
2	42 deg	38%	Normal value observed for both sensor, Value stored in database
3	47 deg	42%	Warning level for temperature and normal for moisture, Warning message sent to user through GSM Module.
4	48 deg	48%	Warning level for both temperature and moisture content, Warning message given to user through GSM Module, Relay Passing current
5	52 deg	50%	Hazardous level for temperature ,Alarm raised, and SOS message sent to user and Relay cut-off the power supply
6	56 deg	60%	Hazardous level for both temperature and moisture, Alarm raised and SOS message given to user and Relay cut off power supply

5. CONCLUSIONS

We have made a short circuit protection system using Arduino and various sensor. This system provides several advantages in compared to the traditional method.

Apart from the sensors we have proposed, more parameters can also be integrated and each sensor can be connected to a processing board via a wireless module. Our proposed multi-sensor system can also be implemented in the various industries as proposed and it can also be used in automobile industry for maintenance purposes by changing sensors which is quite easier.

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