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Arduino Based Adaptive Power Shielding System

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ABSTRACT

A poor quality power source can often cause power surges, spikes, and voltage variations that can lead to flickering lights, broken household equipment, problems with TV reception, and other issues. For this problem, the protective system is desperately needed. Without it, electrical devices might cease to function and be helpful. Given this, this paper shows a prototype of an Arduino based safety system that may be able to prevent under- or over-voltage issues from causing voltage fluctuations in household devices.A DC power source plus the actual protection device comprise the protection device. Since the RMS value is the primary factor in this situation, the AC power source is downscaled into DC voltage, which powers the protection device and gets the Arduino ready to send a signal to the LCD to display the voltage and load values. The NO-NC relay will then "cutoff" the load in the event that an abnormal circumstance arises. The prototype rapidly simulates the volatility of the AC supply after it has been rectified by using a DC variable regulator. There are two sections to the DC voltage protection range: 5 V to 10 V and 15 V to 20 V respectively. Since this prototype lacks a battery, it cannot adequately protect the gadget in an unfavorable situation such as a blackout. These two ranges have also been determined as the typical voltage rates because this prototype can be modified to function as an automatic multi-battery charger.

Keywords: Arduino UNO, Voltage Fluctuations, Blackout, Protection system, Voltage sensor, Current sensor, Relay, Buzzer.

I. INTRODUCTION

Maintaining suitable voltage levels is advised in order to ensure that all electrical and electronic equipment operates as intended. Variations in voltage are one of the main causes of disruptions in the quality of the power supply, which in turn causes malfunctions and breakdowns in a number of electrical devices [1, 2]. Voltage for 220 V varies by + 10% in compliance with ANSI C84.1, as stated in references [3, 4]. Overload may be the cause of these voltage fluctuations, which can be either over or under voltage. Overvoltage, defined as voltage higher than the recommended or normal values, can cause a brief circuit and damage to the insulation of electrical appliances. Along the same lines, low voltage leads to equipment overloading, which results in bulb flickering and inefficient operation of the of the equipment [5]. Most people have installed circuit breakers in their houses to protect their electrical appliances and devices. Users need to manually flip on the circuit breaker, which will automatically cut off the energy, in order to deliver power to the devices. One approach to get past these is to use a device that can turn on and off automatically when there is a voltage fluctuation; the purpose of this study is to identify the requirements that must be fulfilled.

One of their goals is to develop a protection system prototype using the Arduino UNO, specifically for applications involving household equipment, to prevent against voltage variations in electrical equipment that focus on under and excess voltage. Using a DC power source at a specific DC voltage, this process works to ascertain whether or not the protection mechanism can turn the device off. This is the format for the rest of the paper. In Chapter 2, the essential idea underlying the prototype is briefly discussed and some noteworthy literature is surveyed, including a comparison of the authors' studies with some prior pertinent papers. Chapter 3 describes the design and part specifications needed to construct the prototype.

II. BASIC PRINCIPLE AND LITERATURE REVIEW

A protective relay is a type of relay used in electrical engineering that trips a circuit breaker upon fault detection. Electromagnetic devices were the earliest safety relays; they detected anomalous of operations like over current, overvoltage, reverse power, flow, over frequency, and so on using coils that ran on moving parts. The author's focus in this study is on protecting electrical devices against under- and over voltage, over voltage can be defined as a situation in which the circuit's voltage rises faster than usual will damage the electricity or the electrical device. When a main voltage was higher than 120% of its own nominal voltage root-mean-square(VRMS) for longer than one minute [6]. it was considered overvoltage. Although less frequent than under voltage, overvoltage can also result from system, flaws. A single line to ground fault may result in overvoltage, which will boost the voltage of the other phases. The primary cause of overvoltage is the capacitor bank's energization. It may also be produced by an abrupt reduction in load. Overvoltage has greater detrimental effects. High voltage can lead to overheating, which can cause electrical equipment to malfunction. This is especially true for sensitive equipment like electronics.

An abrupt reduction in VRMS below 70% of its average value is referred to as under-voltage, and the residual voltage is typically used to identify it [6]. Short RMS values can primarily result in large motor startup, short circuits, and equipment malfunctions. Under voltage can occur by starting the motor to balance the electrical system, flicking the circuit breaker, or malfunctioning electrical equipment, three-phase, as a result of transformer energizing, equipment failure from heating or insulation breakdown, where power lines are covered in salt, and construction activities that involve digging for building foundation work that can harm subterranean cables and result in under voltage.

Based on extensive prior study, we have determined that the majority of their voltage-fluctuation-protecting devices mostly use AC voltage, although in this case Since our prototype is very basic, we convert the AC source into DC voltage as our primary supply. It is well known that AC voltage, not DC voltage, is what a protective device should be employing. Unfortunately, we have to simplify this job since we lack experimental equipment, becomes a research shortcoming. Furthermore, we continued to compare the literature designs of three magazines with our own design. Table1 will display the comparison between these designs.

Note that we only used the low voltage ranges of protection in our studies because this is still a prototype. Due to Arduino's limited voltage range operation, this constraint occurs.

Comparing a few studies conducted in this field is shown in Table 1.

Parameter/Group	Joni's Group[2]	Ahmed's Group[3]	Sourin's Group[4]	Our design work
AC/DC supply	DC power supply	AC power supply	AC Power supply	AC to DC power supply
Types of protection	Over voltage and Under voltage	Over voltage and Under voltage	Over voltage and Over current	Over voltage and Under voltage
Range of Protection	3V to 5V 10V to 15V	230V to 250V	9V to 12V	5V to 10v 15 to 20V
Controller	IC LT1083	Arduino UNO	Arduino UNO	Arduino UNO

III.PROPOSED METHOD AND SPECIICATION

The protective device and the AC to DC power source are the two key components needed for this prototype. An AC to DC power source is the first component. It includes elements like the step down transformer, digital voltmeter module, LT-1083 (0–30V) variable voltage regulator, 10V and 15V voltage regulators. The power supply was initially AC voltage, however because of Arduino's limitations, the voltage needs to be converted into DC and stepped down using a transformer. Three paths the variable voltage regulator, the 10V voltage regulator, and the 15V voltage regulator are linked in parallel to the final DC supply. Because the variable voltage regulator is simply adjustable and can become the input voltage, it is used to imitate voltage fluctuation. Because it is easily adjustable and can become the input voltage, the variable voltage regulator is used to imitate voltage fluctuation. At the output of the variable voltage regulator is a digital voltmeter. The relay's VCC is represented by the regulated 15V.Protection device components make up the second section. The Arduino UNO, LCD (liquid crystal display) with I2C (inter-integrated circuit), and make up this protective gadget.

The NO (Normally-Open) - NC (Normally-Close) relay itself, as well as the 5V voltage regulator. In order to identify any potential voltage loss, the Arduino is connected to an I6C LCD display, which functions as a voltage comparison with a digital voltmeter to compare the voltage value between the output of the variable voltage regulator and at the Arduino input port. The 10V voltage regulator feeds its output to a 5V voltage regulator, whose regulated 5V powers the Arduino, LCD, and relay. The analog signal from the Arduino UNO is transferred to the LCD to show the voltage and the load's ON/OFF status, as well as to the NO-NC relay to switch the load off. The suggested prototype's basic block diagram is in below figure.

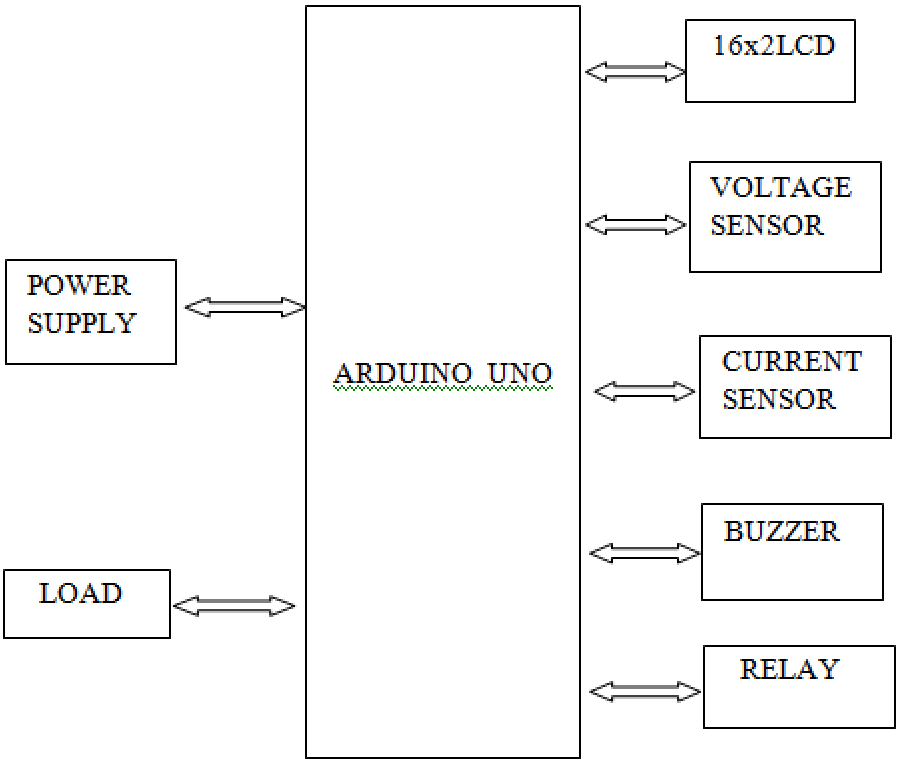

Figure1: Block diagram of the proposed system.

The general schematics are constructed from a few minor circuits, which are all displayed on Figures 2, 3, 4, and 5, correspondingly.

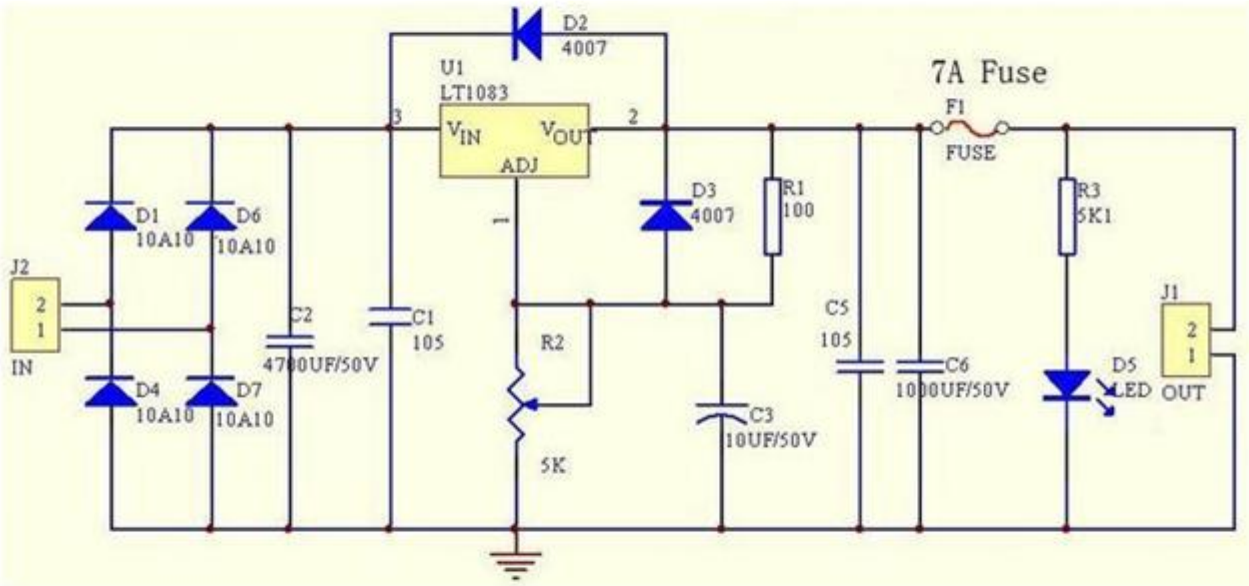

Figure 2: Schematic of the LT1083 Variable Voltage Regulator.

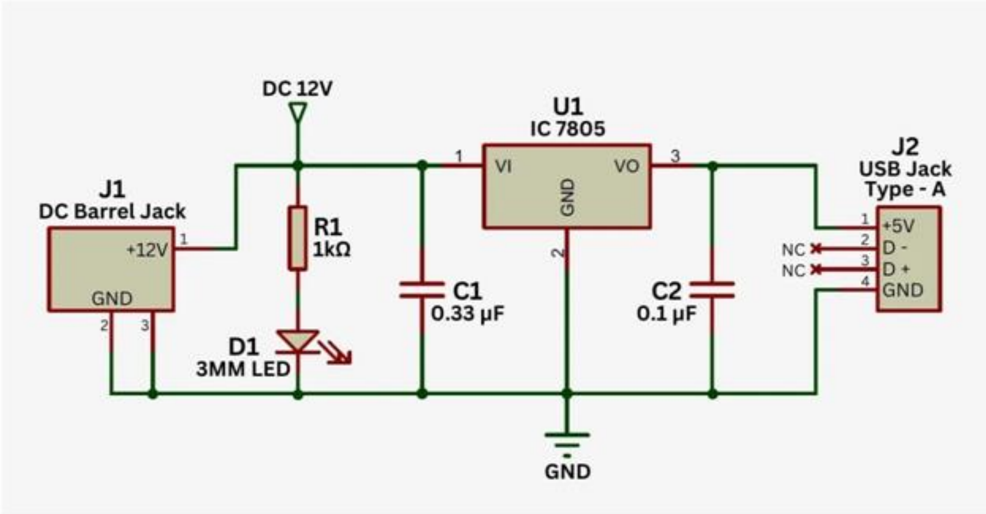

Figure 3: Schematic of the 5V Voltage Regulator.

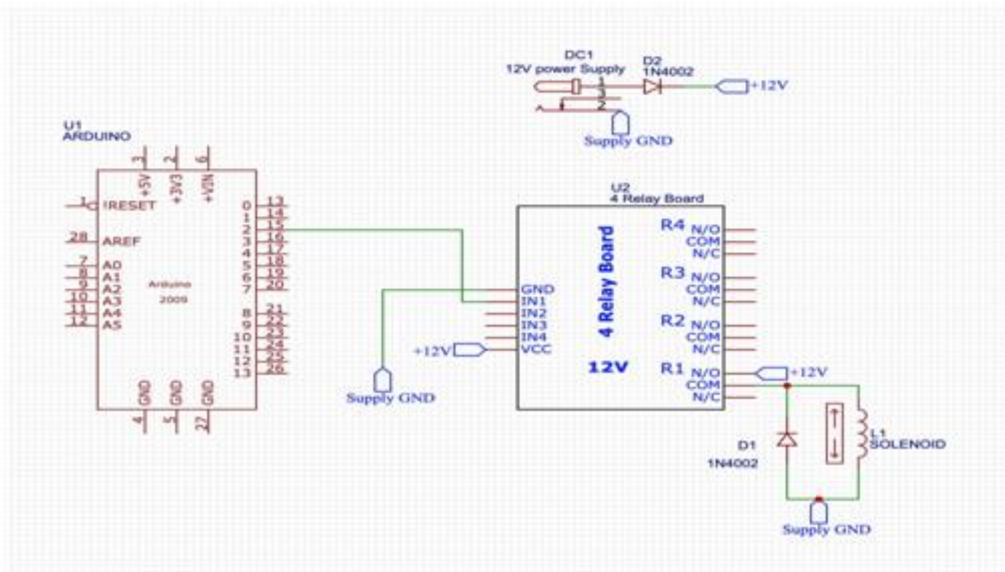

Figure 4: Schematic of Arduino UNO and Relay.

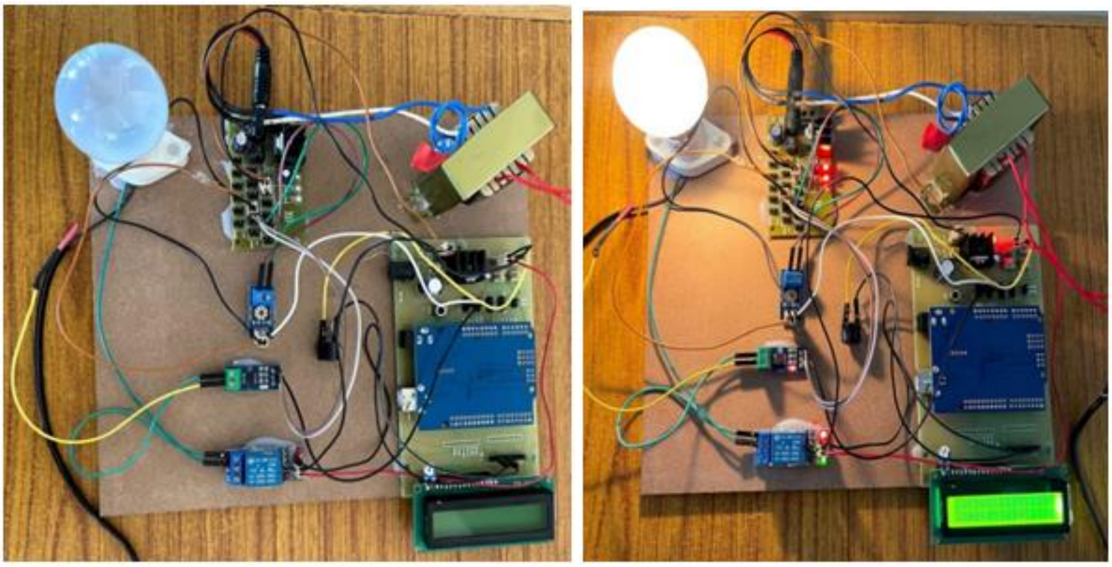

Figure 5: Practical design of Hardware System.

IV. RESULTS AND ANALYSIS

Following a series of trials, we reported the findings for the voltage measurement parameters of 5V to 10V and 15V to 20V, respectively, on Tables 2 and 3. The output voltage from the power source is seen on the computer voltmeter, and the protective device's input voltage is as shown on an 16C LCD.

Table 2: Results from the voltage range of 5V to 10V

Output voltage from power supply (V)	Input voltage to protection device (V)	Load Status
1.0	0.85	Off
2.0	1.65	Off
4.0	3.72	Off
5.0	**4.52**	**On**
6.0	**5.35**	**On**
7.0	**6.23**	**On**
9.0	**8.62**	**On**
10.0	**9.79**	**On**
10.5	10.00	Off

Table 3: Results from the voltage range of 15V to 20V

Output voltage from power supply (V)	Input voltage to protection device (V)	Load Status
12.0	11.24	Off
13.0	12.15	Off
15.0	**14.78**	**On**
16.0	**15.23**	**On**
17.0	**16.57**	**On**
19.0	**18.56**	**On**
20.0	**19.05**	**On**
20.5	19.47	Off
21.0	20.00	Off

Table 2 displays the first set of results, which are those obtained using the measurements range of 5V to 10V (normal condition).Table 2 provides the status of the protection device's input voltage (0.85V to 3.72V) for values below 5V. It displays the situation where the relay will stand by to cut off the load from the ON to the OFF state when the applied voltage is below the condition, also known as under voltage. The typical range is between 5V and 10V. The load may display the typical state, which is in state of ON (9.79V). However, the state of the applied voltage over the input voltage of the protective device (12.8V) above 10V. This condition, known as over voltage, occurs when the relay switches the load from the ON to the OFF state.

The second set of data, which are displayed in Table 3are those that we obtained from the measurement range of 15V to 20V (15.76V - normal state). The load will be shut off, as indicated by the table, if the applied voltage is either over 20V (21.65) or below 15V.Additionally, an exceptional voltage loss between the input voltage at the relay and the output voltage of the LT-1083 is noted, and this voltage loss is present at all voltage levels. This demise but Arduino coding may be used to evaluate and calibrate it.

V. CONCLUSION

This work has achieved the goal of designing and building an Arduino UNO-based under voltage and overvoltage safety system device. In the prototype, an Arduino UNO was used as the controller for the LCD and NO-NC relay. Code was also implemented for the Arduino UNO to display the input voltage value and LCD load status. Users have successfully tested this prototype, which detects fluctuations and cuts off the load. Future developments could lead to the following enhancements: (a) a smart system that is implemented that allows users to see the status of their electronic devices whether they are at home or away and, if needed, turn them on or off using their mobile phones ,(b) the use of batteries that improve performance, particularly in unfavorable circumstances like blackouts. This can be accomplished by turning the prototype into an automated charger, which will safeguard and charge the battery automatically.

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