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Emergency Motor Stopper Using Ultrasonic Sensor

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Abstract

In order to improve motor safety and operational reliability, this project proposes the design and implementation of an emergency motor stopper that makes use of an ultrasonic sensor. Relays, LED indicators, an Arduino microprocessor, and an ultrasonic sensor are all integrated into the system to provide rapid motor control and real-time motion detection. In order to process detected distances, the ultrasonic sensor connects with the Arduino and continuously scans a 50 cm radius for impediments. A red LED glows to indicate an emergency stop, and the motor automatically stops after a 5-second lag when an obstruction is detected. The technology flashes a green LED and restarts the motor after the obstruction has been removed. In order to assess sensor accuracy and response time, the project technique comprised circuit design, Arduino coding, and iterative hardware testing. The findings show that the system effectively functions within the specified range and consistently stops the motor within 5 seconds after detecting an impediment, guaranteeing safety without completely shutting off the motor's power supply. By offering a user-friendly, automated, and flexible solution appropriate for a range of applications, including industrial machinery and safety systems, this creative design tackles the difficulties associated with dynamic motor safety. The results emphasise the value of automation in reducing accidents and improving maintenance procedures, as well as the necessity of using ultrasonic sensors for accurate obstacle identification. With major ramifications for both personal and industrial safety regulations, this technology offers a scalable and economical approach to vehicle safety.

1. Introduction

The necessity for effective, responsive, and dependable systems that strike a balance between automated decision-making and manual intervention has been highlighted by the growing need for automation in industrial and safety applications. Safety issues arise from conventional automation system frequent inability to dynamically adjust to environmental variables, such as sensing motion and triggering the proper reactions. Using microcontroller-based systems in conjunction with ultrasonic sensors has become a viable way to improve operational efficiency and safety.

Several emergency stop systems have been investigated in the past to increase safety in automation and industrial settings. Fernández-Muñoz et al. [1] demonstrated the significance of electrical safety devices in reducing the dangers associated with machinery by designing an electronic emergency stop device (ESD) linked with supervisory safety systems. In a similar vein, Sammarco [2] carried out a safety analysis on hardwired and

programmable electronic shutdown systems in mining, proving their effectiveness in lowering incidents related to moving machinery. Additionally, an adaptive safety monitoring system for human-robot collaboration was shown by Karagiannis et al. [3], highlighting the importance of dynamic safety zones to guarantee operator protection in cooperative industrial settings.

Even with these developments, existing systems frequently lack scalability and versatility. The majority of solutions are geared towards certain uses, like mining or robotics, and fall short in combining automated motor control, real-time motion detection, and user input into a single, affordable device. Furthermore, the dependence on costly and sophisticated technologies prevents their broad use in a variety of contexts, opening the door for a more flexible and approachable alternative.

By creating an emergency motor stopper with an ultrasonic sensor, this work fills up these gaps. The suggested system offers a dependable and easy-to-use safety mechanism for a range of applications by combining ultrasonic motion detection with LED indicators and motor control based on Arduino.

2. Methodology

Emergency motor stopper use Arduino to receive and sends signal. The Arduino received the power supply to operate. When the Ultrasonic sensor received input, the sensor send signal to the Arduino. Then the Arduino send signal to push button and relay to operate. Figure 1 illustrates a block diagram of how the Arduino received and sends signals.

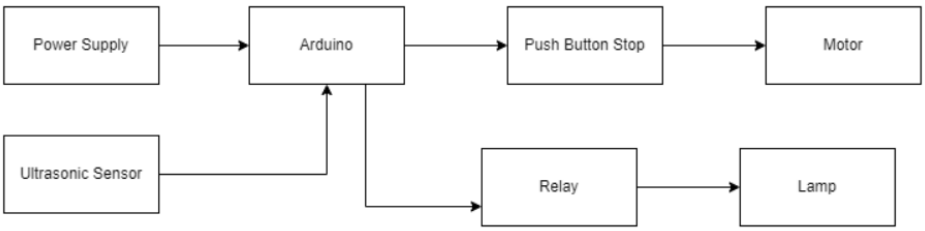

***Fig. 1*:** System block diagram.

Figure 2 shows the flowchart of the emergency motor stopper. The system starts by employing the ultrasonic sensor to detect motion within a 50 cm radius. The Arduino UNO received a signal for processed if motion is detected. Ultrasonic sensor detected motion for 5 second and the red lamp blinked 5 times. After 5 second, the motor stop and the red lamp stay turned ON. When the ultrasonic sensor still detect motion, the red lamp still turned on and motor stop. When the ultrasonic sensor not detected the motion, the red lamp turned OFF and the motor run again.

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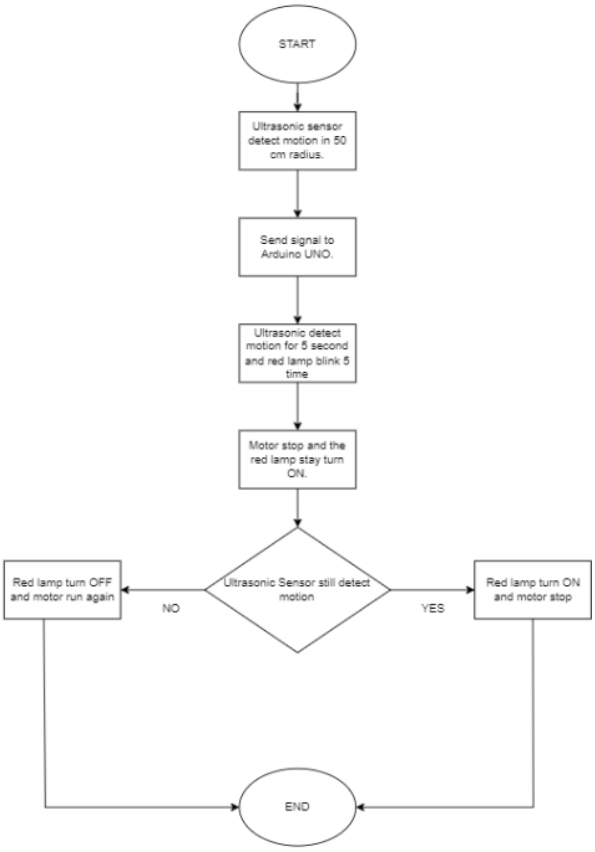


***Fig. 2*:** System flowchart

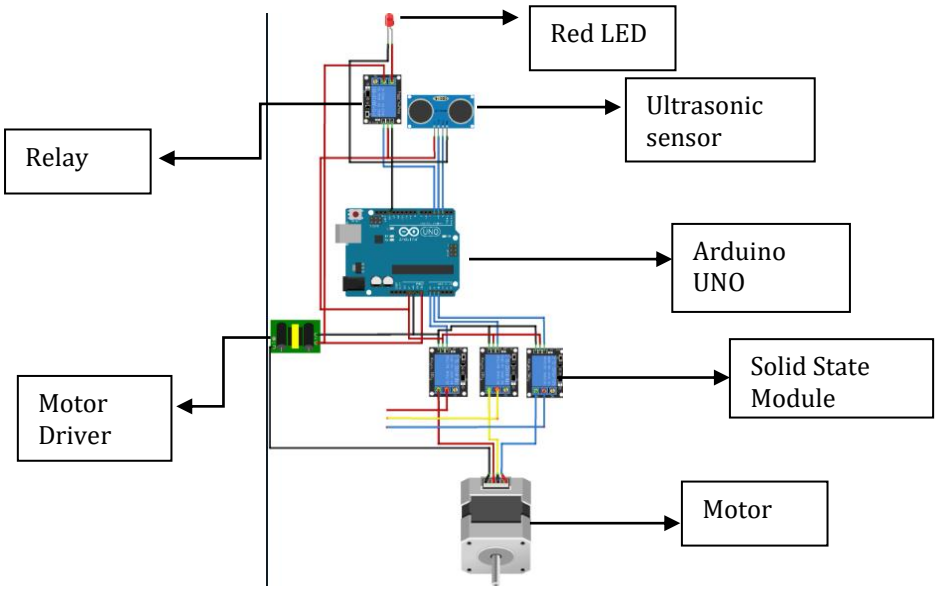


***Fig. 3*:** Circuit Diagram

Figure 3 shows the circuit diagram of the project. The circuit diagram consist of relay, ultrasonic sensor, Arduino UNO, motor drivers, red LED and 3 solid state. The softwarte that being used to develop the circuit is by using Fritzing software.

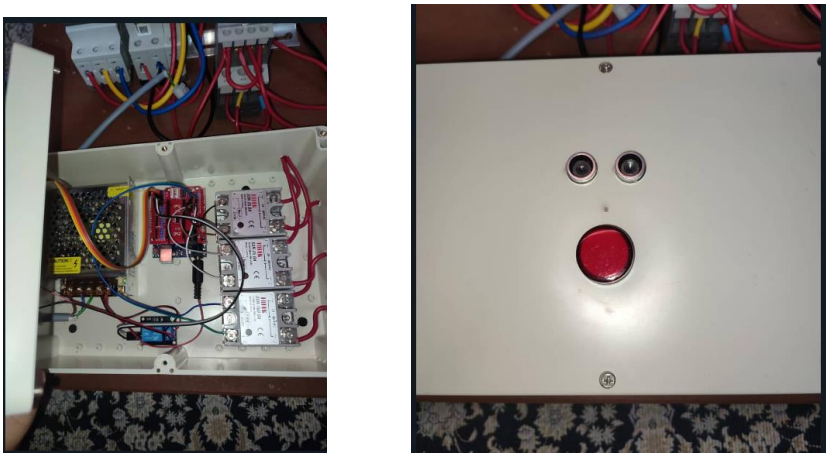
3. Results and Discussions

The project results have been analysed and evaluated through a series of experiments. These experiments focused on testing and functionality of the emergency motor stopper using ultrasonic. The Emergency motor

stopper is connected with 3 phase motor in the lab for testing. This shows that the sensor is not only applicable only for single phase but also three phase motor. The data collected from the experiments is time taken for motor to stop and the distance of object from ultrasonic sensor with the condition of motor.

3.1 Actual Prototype

The prototype consists 2 part of section which is component inside the prototype and component outside the prototype. Figure 4(a) show the hardware inside the prototype. Hardware inside the box consist of relay, AC/DC converter, Arduino UNO, and 3 solid state module. Figure 4(b) shows the component outside the prototype. The hardware are ultrasonic sensor and red pilot lamp.



(a) (b)

***Fig. 4*:** (a) Hardware inside prototype (b) Hardware outside the prototype

3.2 Actual Test

The test of the emergency motor stopper is being tested in a lab with 3 phase motor connection Figure 5(a) shows when the ultrasonic sensor is blocked by hand while Figure 5(b) shows the condition of the motor when being blocked by the hand. When the ultrasonic sensor detected the hand at radius within 50 cm, the red lamp blinked 5 time and after 5 second and the motor stopped.

(a) (b)

***Fig. 5*:** (a) Ultrasonic sensor block (b) Motor stop

Figure 6(a) shows when the ultrasonic sensor is not blocked by hand. When the ultrasonic sensor is not blocked by hand the red lamp turn off. Figure 6(b) shows the motor continued to operate. When sensor detected no motion anymore the motor continued to run and operate as usal.

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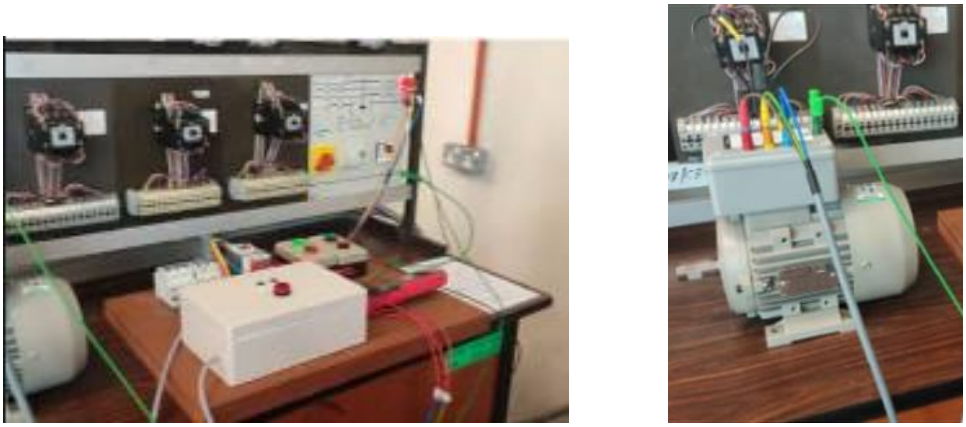

(a) (b)

***Fig. 6*:** (a)Ultrasonic sensor not block (b) motor continue operate

3.3 Data Collection

Several distance measurements needed fulfillment for this test to succeed. We conducted this test to find out the range which the sensor can detect objects so the motor would initiate stopping. The activation point for stopping the motor occurred when objects reached or passed below 50 centimeters in distance. This research tests if ultrasonic sensor activation at 50cm and less effectively stops motor operation. The ultrasonic sensor works without problems when paired with the Arduino Uno. The ultrasonic sensor showed perfect operation with an Arduino Uno connection. The system performed an evaluation of both the ultrasonic sensor's effectiveness and its operational efficiency. The motor operational status demonstrated when it stopped functioned as the evaluation outcome.

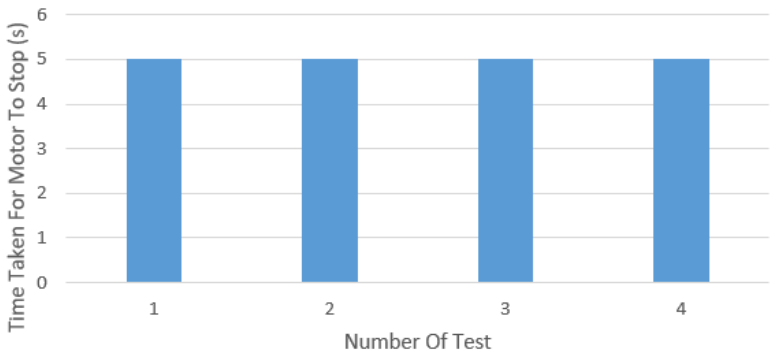

Fig. 7: Time taken for motor to stop

Figure 7 shows the time taken for motor to stop. The test is conducted 4 times to see if the system turn off after 5 second. Test 1, 2 ,3 and 4 conducted and all the test, the motor stops complitly at the same time which is at 5 second when the ultrasonic sensor is blocked by object.

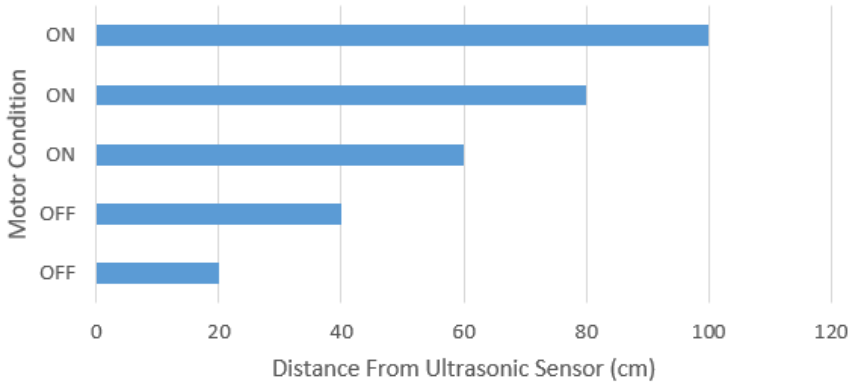

Fig. 8: Motor condition vs distance from ultrasonic sensor

Figure 8 shows the motor condition with different distance from ultrasonic sensor (cm). When the distance of object from the sensor is below 50 cm, the ultrasonic detected the object and send signal to the Arduino to stop the motor. When the distance of object from the sensor is above 50 cm, the ultrasonic sensor not detect the object and the motor continued to operate.

4. Conclusion

The project aimed to design a system that can protect the user from moving part of the motor when there is incident that occur. An efficient and dependable safety device intended to improve motor operation safety is the Emergency Motor Stopper, which uses an ultrasonic sensor. It greatly lowers the chance of mishaps and equipment damage by immediately stopping motor operation when it detects impediments or hazards within a predetermined range. Through accurate distance measurement, the device provides quick response, guaranteeing prompt assistance. Its long-term dependability is enhanced by its non-contact detecting method, which reduces wear and tear. Furthermore, automated safety responses are made possible by the integration of the ultrasonic sensor with motor control systems, which lessens the need for personal intervention. This technology is affordable, simple to use, and adaptable, making it appropriate for a variety of applications, including personal automobiles and industrial machinery. All things considered, the Emergency Motor Stopper exemplifies how important sensor technology is to enhancing automation and security.

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