Design and implementation of two way safety enabled smart stove with gas leakage detection and age verification using machine learning

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Abstract: *Smart embedded systems are playing major role in nowadays and it has been core component in the latest technologies. Internet of Things (IoT) is an integration of the Sensor, Embedded, Computing, and Communication technologies.[1] The trendiest field is IoT based embedded system and it is prominently used in the research area. A stove could cause an accident at any time. As a result, a two-way IoT based smart stove is created with a child lock mechanism and a gas leakage detection feature that open and closes the window. The Smart Stove will attempt to assure safety and will use real-time video streaming to determine age. The child would be unable to switch on the stove. In addition, the stove can provide safety through a gas detection alert. Automatic gas booking system is provided when load cell reads the value less than threshold. For the hardware implementation, an Arduino Uno, a Gas Detection Module with a buzzer, a Weight Measurement Module, and a Wi-Fi module were used. Haar Cascade and Caffe framework is used for the system execution. The stove is IoT-based, stove is ensuring safety remotely as well as manually which will try to prevent accidental occurrences.*

Keywords - *IoT, Smart Embedded System, Load cell, Child lock system, Age Detection, Gas leakage detection.*

I. Introduction

One of the primary emerging fields that have the potential to impact people's daily lives is the IoT and embedded systems. The goal of embedded devices is to create a one-of-a-kind computing system. Internet-connected embedded gadgets can communicate with other network devices, which provide safety features to the user. Through IoT (Internet of Things) characteristics, people may remotely control and monitor their equipment. An IoT-based smart stove is developed. The stove will include two sorts of safety features: real-time age recognition for kid lock and gas leak protection. Both a manual and an electric stove are used. An IoT-based smart system that will embody the notion of smart stove in this work. An Arduino Uno microcontroller is utilized for the system. The Arduino Uno is used to interface with other essential sensors, modules, and apparatus.

Overview of the system

Gas detection module:

A gas sensor (MQ6) module is used to detect the gas leakage. It can handle H2, LPG, and CH4. When the value measured by the gas sensor exceeds the threshold, an instruction is sent to the microcontroller (Arduino Uno) to open and close the windows automatically to remove the gas that has spilled. As a result, there is less of a danger of catching fire in the kitchen and mishaps from the stove. If a fire occurs, our system includes a fire sensor (LM35) that provides protection by pumping water when the temperature rises over a certain level. In addition, when the user forgets to switch off the gas, smart stove system uses a relay module to automatically regulate the flow of gas.

Child lock system:

The major emphasis of the study is that child will be unable to turn on the gas, ensuring the safety of the smart stove using an age verification mechanism based on machine learning. The Haar cascade method is used to recognize objects in live video streaming captured using a PC camera with an open CV. The approach employs a deep convolutional neural network to recognize faces and extract various facial attributes. Also, the age of the individual is anticipated using the Haar cascade algorithm, which controls ignition of the stove when

child under the age of 12 tries to turn it on.

Load cell:

A load cell device is employed to detect the weight of a gas cylinder and alert the user to book the cylinder anytime the gadget reads a value less than the threshold. A load cell is a device that measures the weight of a substance and then returns the weight to the Arduino in lbs using particular functions and calibration factors. This function allows for automatic gas refills.

Wi-Fi module:

Wi-Fi module is used to alert the user by sending SMS. It alerts the user regarding gas leakage, fire detection, gas booking and child detection near the stove. This feature acts as the application of the system. In this study, Node MCU Wi-Fi module is used to connect to the arduino and the desired messages are sent to the user via telegram application.

Proposed methodology

In intelligent applications such as access control, human-computer interaction, enforcement, marketing intelligence, and visual surveillance, age estimation from a single face is a critical problem. The human face contains important features that can be used by vision-based automated systems in order to identify and recognize individuals. [2] The main goal of this project is to create an algorithm that accurately calculates a person's age. Haar cascade is one of the most extensively utilized approaches. With the help of Haar Cascade, a model is proposed that can anticipate a person's age and manage the ignition of stove in this project. The model used different male and female photos as positive and negative images to train the classifier. Face features are retrieved in several ways. The Deep Convolution neural network was used. Even with insufficient data, it performs well. The project uses the caffe deep learning framework for the age approximation challenge. It has a flexible design and code that may be extended.

The proposed system consists of gas sensors, load cell unit, relay module for automatic control of gas. If the user forgets to switch off the gas, the system will do so automatically. It also consists of LCD to display the results and different sensor values. The weight of the load cell unit is used to automatically refill the gas tank. Gas leaks can be detected using gas sensors, leaked gas is evacuated using the automatic open and close window operation performed by the arduino and also it will alert the user via IoT connection. By detecting an unneeded flame in the gas stove, the device also identifies gas waste. Fire catch is also detected using the fire sensor and performs pumping of water to nullify the fire. Through the age estimation provided using haar cascade algorithm and deep convolution neural network, the system provides child lock feature to control the ignition of gas.

Hardware implementation

Components required:
- Arduino Uno
- Gas Sensor
- Load Cell
- Fire Sensor
- Relay
- DC motor
- H-Bridge
- Power Supply
- Buzzer
- Wi-Fi module
- Water pump
- HX711 driver
- LCD
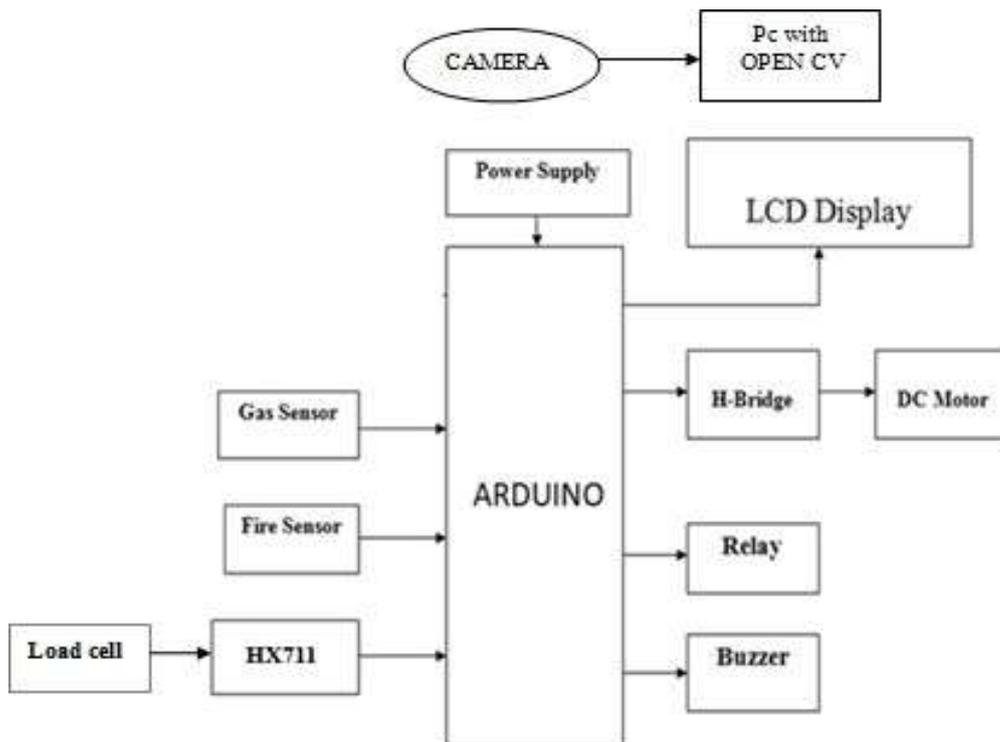
Figure 1: system architecture

Above Fig.1 depicts the block diagram of the system. It includes an Arduino microcontroller, a lap camera, and other embedded systems, is shown above. This gadget is mounted to the stove, which provides the necessary safety measures. Also, users can monitor it from anywhere using any internet- connected smart device, such as a smart phone, tablet, or PC.

Software implementation
Specifications required:
- Arduino IDE
- Embedded C
- Python
- Open CV

Below Fig.2 illustrates the flowchart of the system. It begins with the initialization of the fire and the gas sensors, and processing of the sensors data takes place. It checks for the condition of gas leakage, if yes, then it notifies the user with a message. Along with the user notification, buzzer goes on and automatic window opening and closing operations take place. It inspects the presence of fire, if it goes less than the threshold then, the fire is detected and the user is alerted with a message, also the buzzer goes on for the water pumping operation to extinguish the fire. It examines the load cell, if it goes less than 10 lbs, message is notified to the user to direct the bookings. It then checks for the age verification, if age is less than 12 years, child lock is enabled to prevent any child to get access to our system. If age is not less than 12 years then the child lock is not enabled.
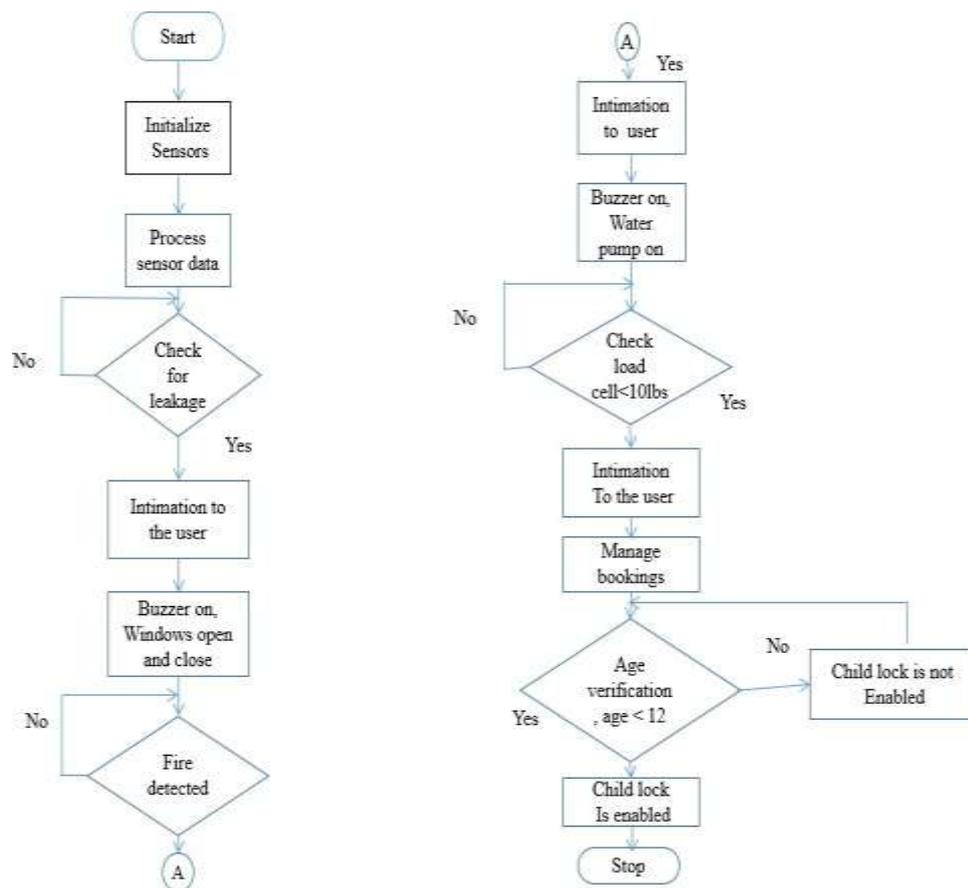
Figure 2: flowchart

II.   Results

Below fig 3 consists of the hardware setup with fire, gas values and the load value displayed in the lcd. Also it displays the message 'please book your gas cylinder' if the weight is below the given threshold to the user.
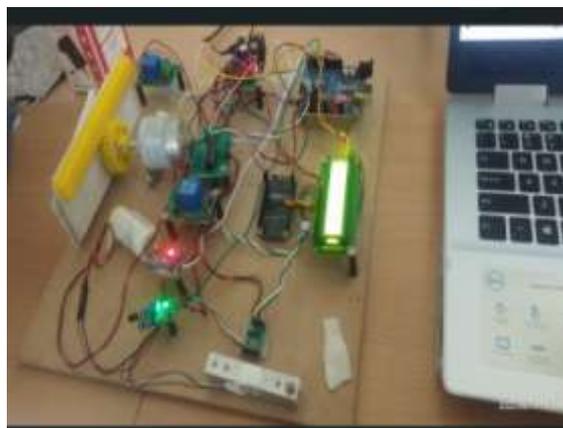
figure 3: hardware setup

Age verification

Fig 4.1 and 4.2 are the outputs of the age verification with case1: child detection and case 2: adult detection respectively.

Figure 4.1: case1- child detection

Figure 4.2: case 2-adult detection

III.   Conclusion

In the smart stove, Age detection and gas-leakage detection are used as security measurements. It is incorporated with protective features like the inclusion of a child lock and alerts the user if there is any accidental gas leakage. This stove is connected to the internet so that it can be monitored from afar to ensure safety. If the gas leakage happens, window opening and closing operations take place which ensures that the gas gets evacuated. The system continuously monitors the weight of the cylinder and alerts the user if the weight is less than the threshold to book a new cylinder. The system's flaw is that the algorithm for age detection is only 70% accurate.

References

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