Real Time Face Recognition based Smart Lab for Energy Conservation

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Abstract

Home automation offers a good solution to help conserve our natural resources in a time when we are all becoming more environmentally conscious. Home automation systems can reduce power consumption and when they are not in use automatically turn off lights and appliances. With home automation, many repetitive tasks can be performed automatically or with fewer steps. For example, each time the person gets out of his computer desk, for instance, the fan and the lights need to be turned off and switched on when he comes back to the computer desk. This is a repetitive task, and failure to do so leads to a waste of energy. This paper proposes a security/energy saving system based on face recognition to monitor the fan and lights depending on the presence or absence of the authenticated user. Initially, the authenticated faces/users LBPH (Local Binary Pattern Histogram) features were extracted and modelled using SVM to construct the face profile of all authenticated users. The webcam catches the user's picture before the PC and the Haar-cascade classifier, a profound learning object identification technique is used to identify face objects from the background. The facial recognition techniques were implemented with python and linked to the cloud environment of Ada-Fruit in order to enable or disable the light and fan on the desk. The relay status is transmitted from Ada Fruit Cloud to Arduino Esp8266 using the MQTT Protocol. If the unidentified user in the webcam is detected by this device, the information in the cloud will be set to ' off ' status, allowing light and fan to be switched off. Although Passive Infrared Sensor (PIR) is widely used in home automation systems, PIR sensors detect heat traces in a room, so

they are not very sensitive when the room itself is hot. Therefore, in some countries such as INDIA, PIR sensors are unable to detect human beings in the summer. This system is an alternative to commonly used PIR sensors in the home automation process.

Keywords

LBPH, Haar-cascade, Ada-Fruit, Ardunio ESP8266, Face Recognition.

Introduction

Home automation applies to smart homes where almost everything is connected to a remotely controllable network, including lighting, electrical and electronic appliances. This also includes the alarm system, security cameras, as well as any other devices connected to it from the standpoint of home security.

The network's capacity to set up and schedule activities refers to Automation. The programs may include instructions related to time, such as switching on or off your lights at particular times each day. It may also involve unplanned incidents, such as turning on all the lights in your home if your security alarm is activated. The Internet of Things has enabled home automation to become a reality today. The Internet of Thing applies to everything that can be tracked and accessed remotely, such as sensors, devices that are given an IP address.

As manufacturers are constantly creating more and more "smart" devices and appliances, home automation possibilities are virtually limitless. Each developer has a different understanding of how these devices can be associated and regulated.

Even though you might have a "smart" television, washing machine, refrigerator, induction hob, espresso machine or any of the other web-ready home appliances on the market, the actual reality is probably a multiple-input mechanism for each device.

Home automation can be standardized in the near future so that we can really reap the benefits of all these new possibilities. Home automation systems are currently focusing on more crucial and beneficial aspects of home, including home automation and intelligent security systems.

Literature Survey

A face book profile picture [1] is used as authentication to control the home appliances using raspberry pi 3.Sensors information is monitored at home to communicate with the social networking page to help the user to track the information. A face recognition method is used as a security in smart homes and cities [2] to detect the movement in the specific area using a PIR sensor. The captured Pictures are recognized and send it to the Smartphone as notification to alert the user whether the intruder entered or not using telegram application. The author proposed that Real-time Face recognition can be achieved using LBP features [3] is light weight and more efficient feature for KNN classifier to detect the human face accurately. Discrimination rates are good for LBP feature extraction. In the thermal Picture, the hair-cascade classifier is used to detect humans [4]. Haar is a two-dimensional function is used to detect the object. Many cascade classifiers are often used to determine the properties and classify the object. Real-time embedded face Recognition for smart home [5] proposed the module presented in the home devices to detect the human faces accurately using cascaded discriminant analysis. Generally, a PIR sensor is used to detect the motion of the object to turn on the home appliances leads to a lack of security. In this work, the author used a PIR sensor for the home automation system.[6].The vehicle detection system is developed for traffic surveillance systems to monitor the real-time traffic and to make communication with moving vehicles with the help of the Haar Feature-Based Classifier. It detects the movement of the car and tells about the intensity of traffic in the lane [7]. IoT based door access control using face recognition is to unlock the door at home. The captured Picture is sent to the authorized persons through the mail for safety purposes[8]. Enhancing home security in IoT proposed the Bluetooth speech recognition on the entry door and fingerprint scanner to control the smart home equipment [9]. Instead of the password-based system that can be hacked with the help of phishing attacks home equipment can be hacked. Body gestures and eye scanners can be used to enhance the security of the home appliances [9].

Proposed Methodology

The proposed real-time office automation system consists of two main modules: User Recognition Module and Automation Module as shown in Fig. 1.

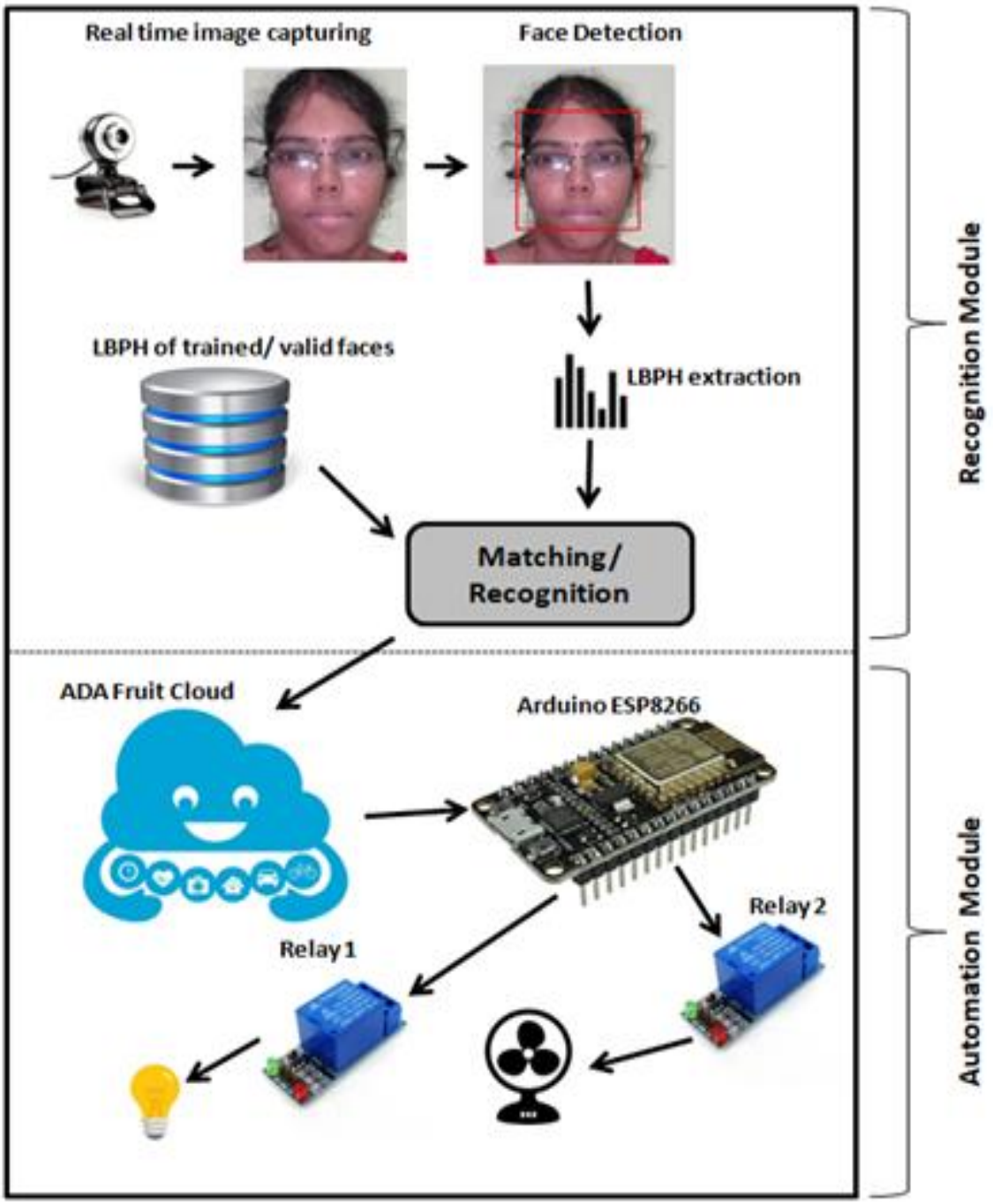

Figure 1 The proposed real-time office automation system

Recognition Module

The training and recognition phases involved in the recognition module are given in Fig. 2. The training phase involves dataset creation, face detection, and LBPH extraction.

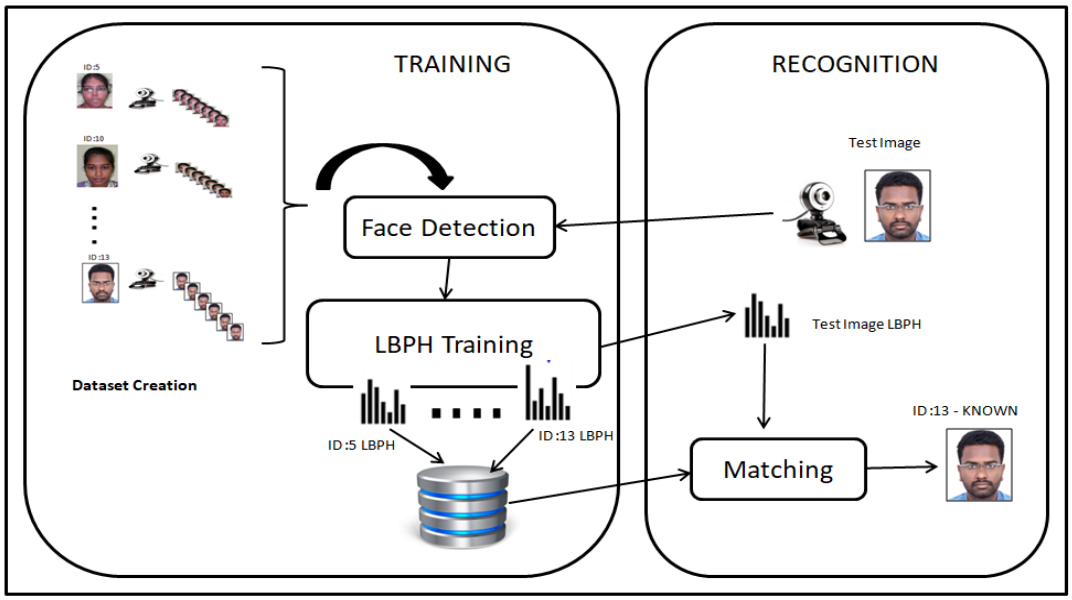

Figure 2 The Block diagram of the Recognition Module

Dataset Creation

To create the training data, the users who have access to the computer should be first decided. Then a set of gray scale Pictures is obtained for each designated user. Ten Pictures of each user are acquired in this work. We also have to set an ID to each picture (it can be a number or the name of the individual), therefore this data is used by the algorithm to identify an input Picture provide an output. The same individual's pictures should have the same identity (ID). Fig. 3 Display the user 13 dataset.

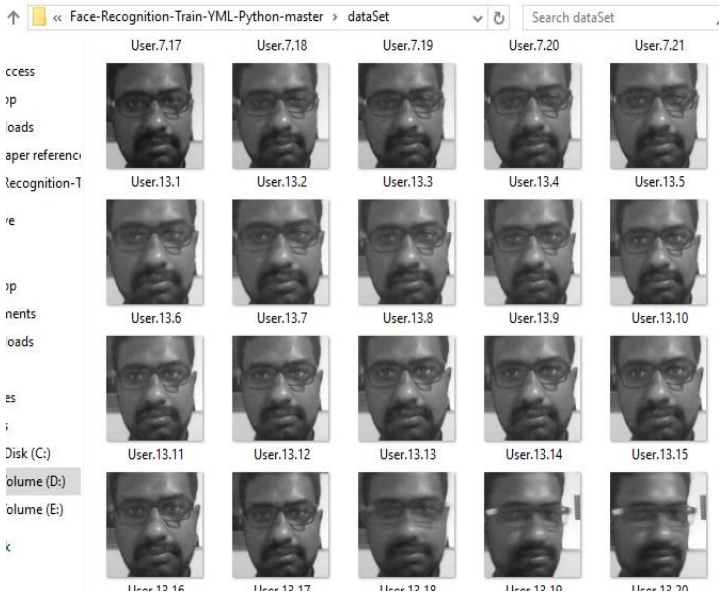

Figure 3 Dataset created for User ID: 13

Face Detection

The Haar Cascade Classifier is used in the background of each gray Picture to identify the human face. Object Detection An optimal way to detect objects proposed by Michael Jones and Paul Viola is to use haar-based feature cascade classifiers. It is a learning method based on a machine that trains a cascade function from several positive and negative pictures.

Feature Extraction and Training

These detected facial regions will be used to train using the features of the local binary pattern histogram (LBPH). Local Binary Pattern (LBP) is an easy but very powerful texture operator that tags the pixel Picture by thresholding the neighbourhood of each pixel and declares the outcome as just a binary number. Using the LBP in conjunction with histograms, we use a simple data vector to depict the pictures of the face. The face recognition tasks can also be used as LBP is a visual descriptor.

The very first computing step of the LBPH is to develop an intermediate picture that accurately describes the actual Picture by outlining the facial features. To do just that, as shown in Fig 4, the algorithm explores the idea of the sliding window. The threshold of central value for each neighbour in Fig. 4(c): 90, we set 1 values equivalent or above the threshold, and 0 values underneath the threshold, and we get a Fig. 4(d).The central value is then replaced by the decimal equivalent of the binary, that is, the gray value 133 as shown in Fig.4(e).

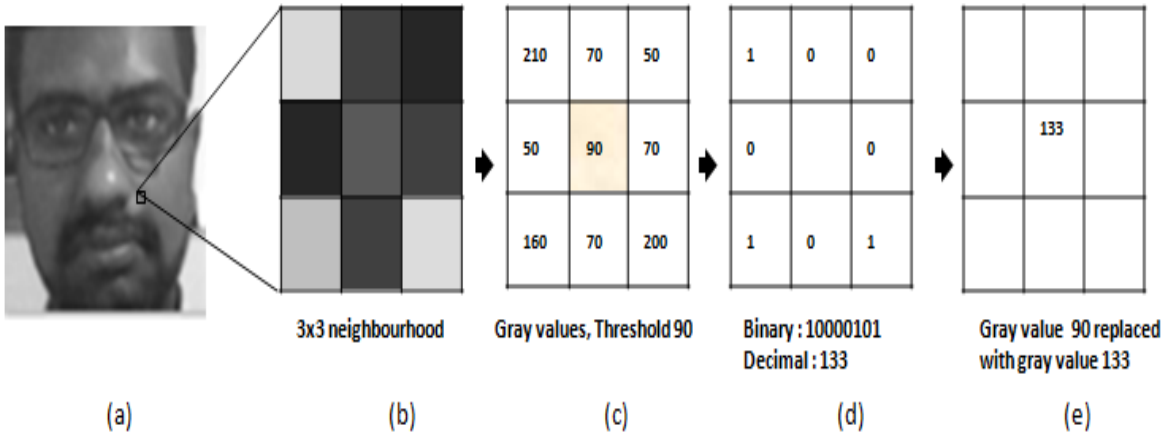

Figure 4 The Block diagram of the Automation Module

We have a new Picture at the end of this method (LBP procedure) that better reflects the original Picture characteristics as shown in Fig.5. The resulting new face Picture is split

into 8 x 8 cells and the histogram is extracted from each of the cells. Then, the histograms of all these cells are concatenated to create a new and larger histogram, which represents the characteristics of the original Picture. Each histogram thus created is used to represent each user in the training dataset.

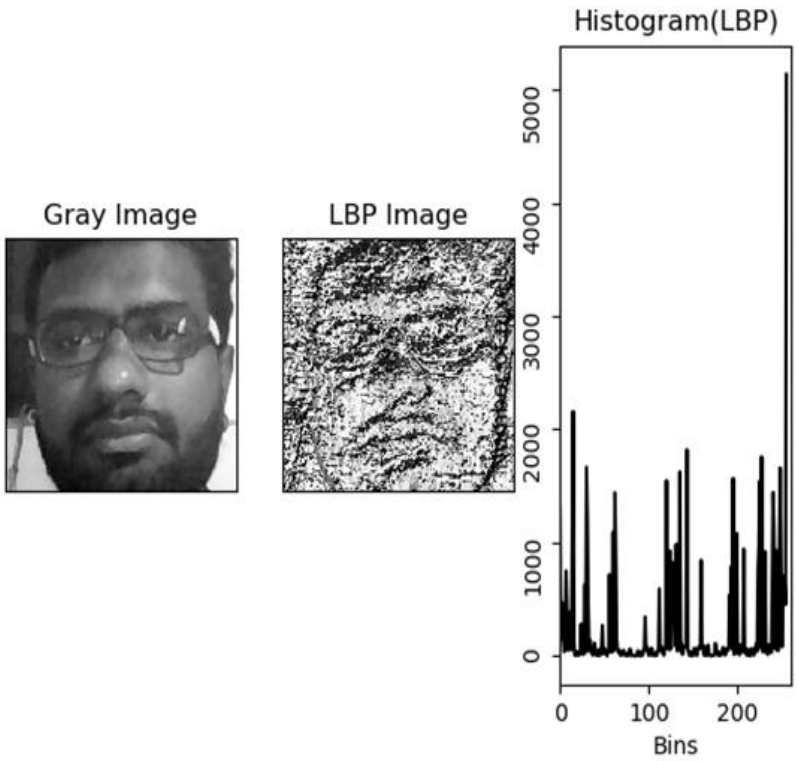

Figure 5 The Block diagram of the Automation Module

Recognition

The web camera captures the video of the person sitting in front of the computer in order to recognize the given input Picture. Each captured frame is converted to 256 X 256 resolution gray scale Picture. The same steps are performed and a histogram is created for this test Picture. This histogram is compared to the histograms of faces that have already been trained, and if it matches the user is recognized as otherwise known as unknown. Euclidean distance metric is used to measure the histograms.

Automation Module

This work uses IoT and face recognition to automate fan and light operation at the computer desk.

Initially, a collection of computer system authenticated users are defined and the LBPH features are used to create a database of these. Using Adafriut cloud, MQTT and nodeMCUESP8266, the system is designed to turn on the lights and fans in the presence of an authenticated user (face Picture captured through webcam) and switch them off when detecting an unauthorized user face. The facial detection and recognition module is explained in the previous section. Adafruit.io is a cloud service primarily for storing and retrieving data.Adafruit.io can manage and visualize multiple data feeds are the core of Adafruit IO. They hold both uploaded data and meta-data about the data sent to Adafruit IO. For example, the date and time it was uploaded, or the GPS coordinates the data from which it originated.

MQTT is a device communication protocol supported by Adafruit IO. You can publish and subscribe to a feed using an MQTT library or client to send and receive feed data. It is lightweight, transparent, concise and easily implemented. Such features make it ideal to be used in multiple scenarios, especially in restricted environments including interaction from Machine to Machine (M2M) and Internet of Things (IoT) contexts where a minimal software footprint and/or premium network bandwidth are needed.

The nodeMCUESP8266 Wi-Fi module is a self-contained SOC with such an integrated TCP / IP protocol stack that allows any microcontroller to link to your Wi-Fi network. The module ESP8266 is an extremely cost-effective board with an ever-growing community. This module has an on-board storage and processing capability which allows it to be incorporated with sensors as well as other app-specific devices with minimal upfront layout and limited run time loading via its GPIOs. The higher degree of integration with an on-chip empowers limited external circuitry including the front-end module, intended to cover minimal PCB space.

Initially two feeds are created in the Adafruit cloud, one for fan and one for light. The webcam continually captures the Picture of the person sitting in front of the computer system and classifies the recognized face as known or unknown. Such data are sent to the Adafruit cloud which uses the MQTT protocol to publish the data to the ardunio MCU ESP8266.

Depending on the received input ESP8266, the relay allows the authenticated user to turn on the fan and light and disables the relay to turn off the light and fan for the unauthorized user. Fig.4 Displays the mechanism involved in an automated face recognition system for offices that monitor fan and light use in real-time.

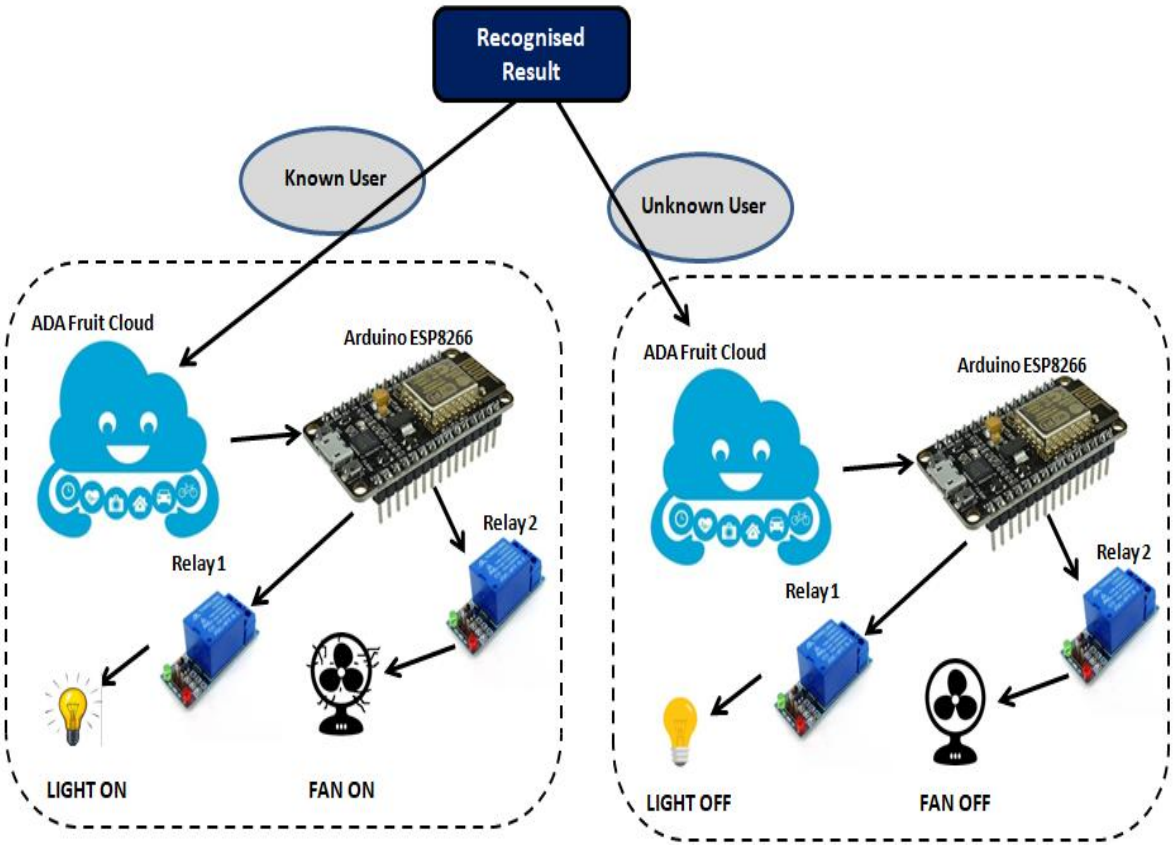

Figure 6 The Block diagram of the Automation Module

Conclusion

A face recognition based home automation is implemented in this work to enhance security at home/office, only an authenticated person to use the electrical appliances by capturing the face. It also offers the solution to replace the PIR detector to detect object motion, whereas it is not capable of detecting humans alone.

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