A Low-Cost Indoor Service for Human Recognition

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Abstract—**Human recognition systems typically require expensive computational resources and digital equipment. In this demo, we show that a low-cost indoor service can be implemented using simple everyday cameras, small computers (e.g., Raspberry Pi or smartphone). A registration list of people is maintained. The camera captures faces of people that appear in the room. For every detected human face the fact is derived, either the person is registered (recognized) or not. More advanced features can be implemented using the smart space approach for extending this demo. For instance, the registration list is augmented with semantics that describe the context and relate the people with other video-recognized facts.**

The aim of this demo is to show how small onboard computer can be used in conjunction with an ordinary camera (wired or remote) to create service that will detect how many people are in area. This area may be a room in office or some production room. We expect that such services can be effectively applied in many problem domains where it is important to detect how many people are in a room. The use of cheap and widespread devices makes our solution promising for deploying in practical areas for everyday use [1].

The high-level view on the service architecture and system scope is shown in Fig. 1. The service is implemented as a prototype for experimental study. The elements for local installation are as follows.

1) The camera is connected directly via a wire or remotely via a router to the Raspberry Pi. The service works most quickly in the local network;
2) On the Raspberry Pi those entities rises:
    a) SIB for interpreting and storing semantics (who exactly is in a room with more detailed information, for how long, what she/he has)
    b) Video server for uploading / uploading images / video when interacting with the camera
    c) Service the presence of people in the room. One example of low-cost services that runs on a small onboard computer.

The service scenario consists of the following steps.

1) Agents (people who will be inside the indoor area) fix the face in front of the camera.
2) In case of successful face recognition (if it is in the face template), the name of the person will appear in the information system.
    a) In addition, such a person can, through recognition, for example, obtain additional privileges (access to third-party resources, opening / closing doors).
    b) Additional information about a person appears in the information system, including (photo, age, gender, rights).
3) In case of unsuccessful face recognition, the name of the person will not appear in the information system, however, information will remain about the unsuccessful attempt.
    a) Including the person will not get access to resources within the indoor area (e.g., room, office).
4) Information system agents can see who is inside the area / office, read brief information about them.
5) If a person wants to leave the area, she/he should appear again in front of the camera, in which case her/his departure will be recorded.

Each user has access to the information system of the service when passing the face recognition test. Access to the information system is made using a mobile device. Thus, mobile clients can interact within the information system and among themselves through a mobile application. In this case, mobile applications to access the service are typically based on Android or iOS platforms.

The service can be extended with more advanced functionality. In particular, in [2] (demo part) we considered the service of motion detection and face recognition. A similar principle applies in our studied case. Moreover, mainly concerns the distribution of resources within the region. For example, a person who fails the face recognition test is not provided with access to the area. Or she/he has access while the use of some devices is restricted or prohibited. A possible option is to restrict access to the lockers (electronic lock).

Such restrictions can act not only at the access level, but also within the information system. For example, the staff with the most privileges is able to view full information about agents located inside the office, and staff with the least privileges is able to view only short information (e.g., name) of other agents.

In [3] the Through-The-Wall (TTW) sensing is used, which is based on Wi-Fi abilities. Such case uses ultrawideband systems for detecting human presence by using radio frequency. Similar solutions were applied in the SmartRoom system to analyze the activity of collaborative work activity [4]. Experimental setup shows how to detect human between Wi-Fi AP and Wi-Fi Receiver. Thus, a low-cost system can be used to help detecting humans but using another way with Raspberry Pi.

In [5] the authors discussed a video camera surveillance system with face recognition functionality. They applied such

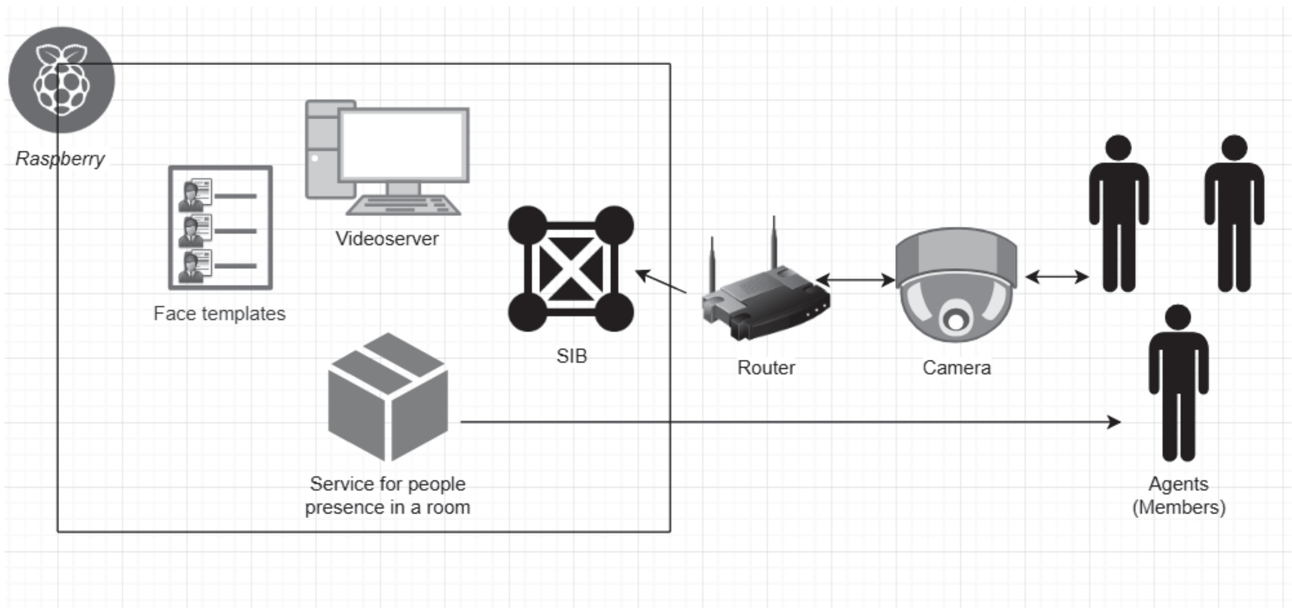

Fig. 1. Prototype architecture with main Raspberry Pi component

well-known detection algorithms as AdaBoost and Haar-cascade features. Mostly the Haar-like functionality can be used in our case to build a low-cost system, which can be realized on such low-capacity devices as Raspberry Pi. Our demo shows that such time-efficient face recognition algorithms can be effectively used. The algorithms are implemented in the OpenCV software with Python programming language.

Based on the Internet of Things (IoT) technology, more advanced systems can be developed, as we showed in our previous work [6]. One interesting IoT-enabled option is to involve some user devices to the service construction process. For example, the user can use her/his own camera and interact with many clients in the indoor area.

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References

[1] D. Korzun and S. Balandin, “Personalizing the Internet of Things using mobile information services,” in *UBICOMM 2016 : The Tenth International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies*, 2016, pp. 184–189.

[2] N. Bazhenov, D. Korzun, and S. Balandin, “Smartphone-oriented development of video data based services,” in *Proc. 23rd Conf. Open Innovations Association FRUCT*, Nov. 2019, pp. 62–68.

[3] S. D. Domenico, M. D. Sanctis, E. Cianca, and M. Ruggieri, “Wifi-based through-the-wall presence detection of stationary and moving humans analyzing the doppler spectrum,” *IEEE Aerospace and Electronic Systems Magazine*, vol. 33, no. 5-6, pp. 14–19, May 2018.

[4] S. Marchenkov and D. Korzun, “User presence detection based on tracking network activity in smartroom,” in *Proc. 16th Conf. of Open Innovations Association FRUCT*, Oct. 2014, pp. 45–50.

[5] R. Hu, J. Zhang, H. Yu, and Y. Liu, “Design and implementation of a surveillance camera system with face recognition functionality,” in *2014 IEEE International Conference on Electron Devices and Solid-State Circuits*, Jun. 2014, pp. 1–2.

[6] N. A. Bazhenov and D. G. Korzun, “Use of everyday mobile video cameras in IoT applications,” in *Proc. 22nd Conf. Open Innovations Association FRUCT*, May 2018, pp. 344–350.