Identifying Medicine Bottles by Incorporating RFID and Video Analysis

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Abstract

In this paper, we present a new framework of identifying medicine bottles using a combination of a video camera and Radio Frequency Identification (RFID) sensors for applications of monitoring the elderly's activities of daily living (ADLs) at home. RFID tags are attached to medicine bottles and first detected by RFID readers from the antenna. However, the RFID detection can only detect RFID tags within a certain range of the antenna. Once a medicine bottle is moved out of the range of the RFID antenna, a camera will be activated to continue detecting and tracking the medicine bottle for further action analysis based on moving object detection and color model of the medicine bottle. The experimental results demonstrate 100% detection accuracy for identifying medicine bottles.

1. Introduction

The number of elderly people in the world who are 60 years or older will increase from 10 percent currently to around 20 percent in 2050 [1]. The proportion requiring personal assistance with everyday activities increases with age**,** ranging from 9 percent for those who are 65 to 69 years old to 50 percent for those who are 85 or older. These data indicate that the demand for caregivers will reach far beyond the number of individuals able to provide care. One solution to this growing problem is to find ways to enable elders to live independently and safely in their own homes for as long as possible [2].

Remote monitoring of the elderly allows them to stay at home longer and offers them flexible and efficient medicine monitoring. Here, we aim to design a new framework for monitoring the actions of taking medications by combining a video camera and RFID sensors. The RFID sensors can effectively identify medicine bottles in a small range of their antennas. Once a medicine bottle with a RFID tag is removed from the RFID antenna's range, a video-based vision system is activated to continue to track the movement of the RFID tagged medicine bottle for further action analysis. As shown in Fig. 1, our proposed system contains two main parts, RFID-based medicine bottle detection and video-based tracking. The RFID first detects the medicine bottles that have tags attached to them in the antenna's range. When a tagged medicine bottle is out of the RFID antenna range and the reader cannot detect it, the video-based component will be activated to continue to track it in a larger range for further human action analysis.

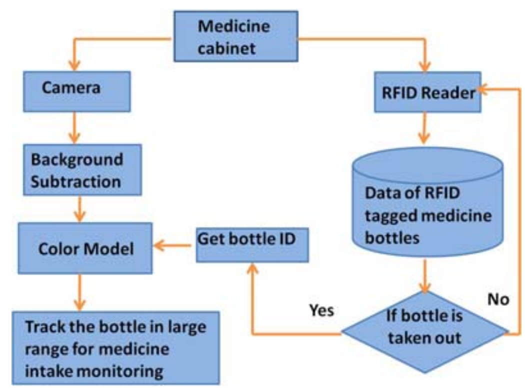

Fig. 1: System diagram of the proposed medicine bottle identification by combining video camera and RFID sensors.

2. RFID-based Medicine Bottle Identification

As shown in Fig. 2(a), we use one SkyeTek's M2 RFID reader [3] which can read a radio frequency of 13.56 MHz in our experiments. Remote identify tags IS015693 [4] are used to provide faster readability in detecting RFID tags. As the tags are retrieved, object information is conveyed to the user. Fig. 2(b) demonstrates the setup of identifying medicine bottles with RFID tags (in blue color). All the RFID tag medicine bottles must be in the range of the antenna.

Our RFID-based method achieves an accuracy rate of 100% for identifying two medicine bottles.

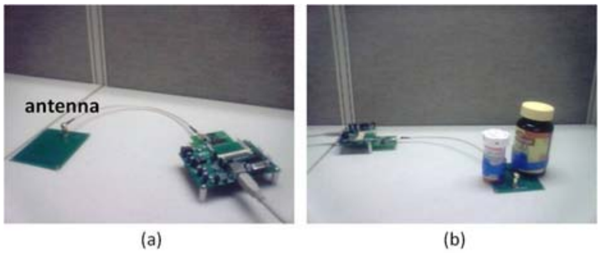

Fig. 2: SkyTek M2 RFID system [3] includes USB connection, antenna, reader and a host interface board for identifying medicine bottles.

3. Vision-based Method of Tracking Medicine Bottles

Although RFID can get 100 % accuracy in object identification, but the objects must be in range of the RFID antenna. To continue to identify the object when it is out of range, we propose using a video camera to monitor the medicine cabinet and continue to identify medicine bottles sensed through RFID. The vision system consists of 4 main components: (a) modeling the background, (b) identifying moving objects or blobs using background subtraction, (c) segmenting the objects using color model; and (d) tracking moving objects.

In our work, the background model is adaptively updated. Once an RFID tagged medicine bottle is moved, the system stops updating the background image until all of them are put back in place. In order to segment the medicine bottle from other moving objects, we use the tag's color information to determine which foreground region is the medicine bottle.

4. Experiments

To evaluate the performance of the proposed system algorithm, we conducted the test with ten users trying to acquire RFID two tagged medicine bottles placed in the RFID reading range. The resolution of images is 320x240 pixels. The average speed of the RFID-based and vision-based algorithms for detecting two medicine bottles is 0.8058 seconds and 0.02400 seconds respectively. The accuracy rate of identifying and tracking two medicine bottles is 100% in testing with the ten users. Fig. 3 demonstrates the example results of identification and tracking of two medicine bottles. The identified medicine bottles are displayed in red boxes which are detected based on the color model of the blue tags.

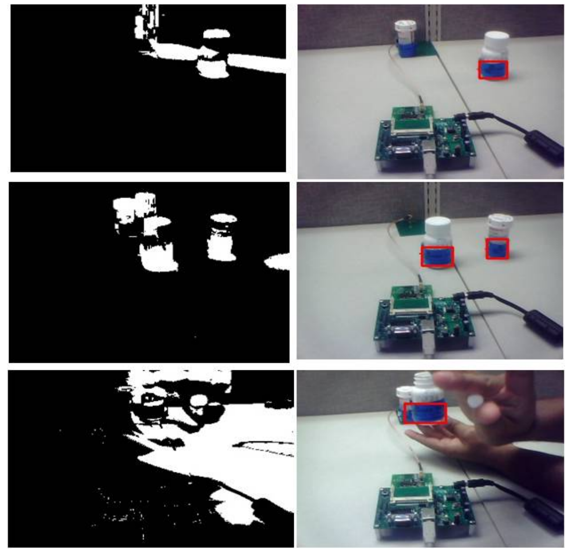

Fig. 3: Experiment results of medicine bottle identification by combining RFID and vision method. Left column: Foreground Images of moving objects; right column: Identifying medicine bottles by color detection. First row: Tracking of one medicine bottle. Second row: Tracking of two medicine bottles. Third row: Human action of taking out the medicine from the bottle.

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References

[1] U. N. Population Division, DESA, Executive summary," January 2010. "World population ageing 1950-2050: http://www.un.org/esa/population/publications/.

[2] C. Johnston, UCSF Division of Geriatrics Primary Care Lecture Series May 2001

[3] Readers and technology that optimize inventory asset usage and enhance customer service, "Products & Services Overview" 2004 – 2006. Available: http://www.skyetek.com/.

[4] Remote Identity, "Welcome to Remote Identity" 2010. Available: http://www.remoteidentity.com/