Wearable Cognitive Assistant for Automatic External Defibrillators (AED)

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Abstract

A cognitive assistant for Automatic External Defibrillators (AED) is built based on Google glass and Cloudlet. The system is aimed to guide novice user go through the AED procedures. Highlights for our system are: 1) The system tries to understand the user's progress with computer vision techniques; 2) The cognitive assistant provides step-by- step guidance to the user; and 3) The system gives user feedback based on progress in real-time.

Project Overview

The system architecture for Wearable Cognitive Assistant system is shown below.

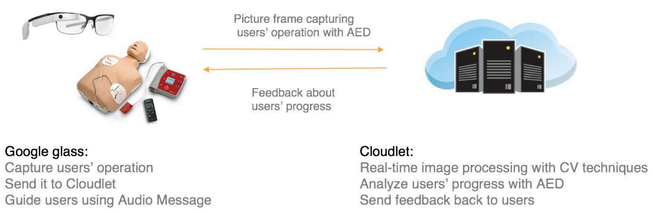

Figure 1. System Architecture

The features used to identify each AED use stage:

Figure 2. AED Use Stages

The process pipeline at our server side is shown below:

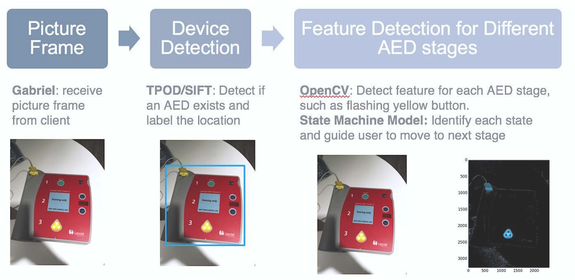

Figure 3. Server Process Pipeline

The entire software workflow acts like a state machine. Each AED use stage is considered to be a state. The system will detect each AED use stage in order. Audio message reminder will be provided to users when they finish each action or get stuck.

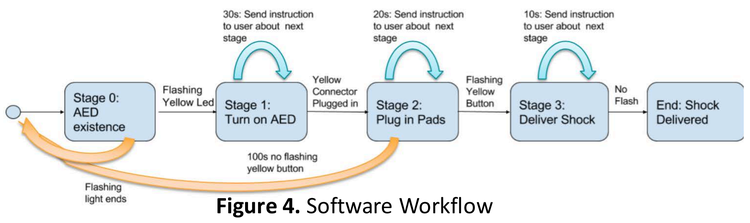

Figure 4. Software Workflow

Computer Vision Components

❖ Object Detection

Object Detection refers to accurately locate an AED in a picture. It serves as the foundation for our computer vision processing pipeline. Scale-invariant feature transform(SIFT) based on OpenCV library and TPOD based on deep neural network object detectors using Faster-RCNN are used for object detection.

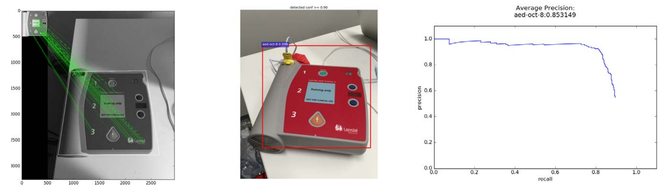

Figure 5. Object Detection Example (left: SIFT, mid: TPOD, right: roc curve for TPOD)

❖ AED Use Stage Detection

-- Flashing Light Detection

To detect flashing light activity, each picture is converted to binary according to color intensity threshold. By comparing continuous sequence of frames, we are able to detect flashing light. Noise is removed by position and size constraints.

Figure 6. Flashing Light Detection

-- Yellow Plug-in Detection

To detect plug-in and button location, we use color filter to filter designated area. The color filter and size constraints are used to identify different feature.

Figure 7. Yellow Plug-in and Button Detection

Server Implementation

We have implemented a multi-process server with the power of real-time image processing. The asynchronous processing architecture enables us to incorporate different components without blocking the system.

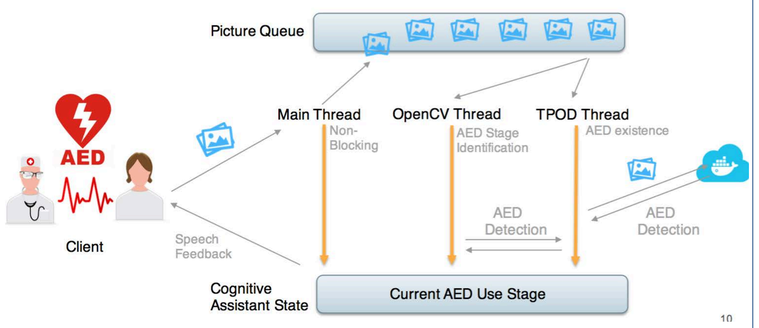

Figure 8. Server Implementation

Evaluation

To fully evaluate the robustness and speed of our computer vision components, we tested our system under different lighting conditions and background conditions. Our experiments show that our system succeeded in detecting user's progress in normal lighting conditions. Dim lighting can lead to failure of our CV algorithm.

Note: Local Testing Environment: CPU:2.5GHz, RAM: 16GB, OS X

	AED detection	Stage 1	Stage2	Stage3	Process Time
Strong Light Reflection 	Y	Y	Y	Y	200ms
No Light Reflection 	Y	Y	Y	Y	85ms
Similar Objects 	Y	Y	Y	Y	350ms
Dim Lighting 	Y	N	N	N	140ms

Table 1. CV Components Evaluation

User Study

We invited 6 students to participate into our user study. By given them an instruction paper, we allow them to explore and interact with the system by themselves. Here is the summary of our findings:

1. Most of users think it is not difficult to use AED without guidance. Average rating score of difficulty is 5 out of 10. Most of students can finish the use of AED by themselves without guidance, though some minor mistakes might occur.
2. Most of users think our system is not very helpful. Most of them gave positive feedback towards our computer vision algorithm. However, they think our audio assistant is not that helpful mainly because AED device has already provides clear audio instruction.
3. Some users reflects that the audio volume is low and the user interface is confused for them to use.

Future Work

1. Most of users think the audio instructions overlap with AED instructions. We need to change the way of assistance. Possibly add more visual assistance.
2. Improve computer vision components to reduce false positive or false negative cases. We will do more testing during later development to add some case-oriented handling features.
3. More user study is needed to test the whole system pipeline in order to improve the system.

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