Measurement Data Recognition from Seven-Segment Indicator by Mobile Device

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***Abstract*—A task of vital signs tracking is important for people suffering from chronic deceases. One way to keep a measurement diary is to use software installed on a personal mobile device. The application can add records using wireless technologies if both the mobile device and measuring device support this method. But the majority of consumer devices for vital signs measurement provides information only on the built-in seven-segment indicators and do not include wireless modules. In this paper we propose an algorithm to extract data from a picture on a multi-line seven-segment indicator. We designed the recognition algorithm that performs well on pictures taken by the mobile phone's camera without need of special lighting conditions.**

Vital signs measuring devices usually include a seven-segment indicators to display measurement results. A seven-segment indicator is a form of an electronic display for numbers composed of Arabic numerals. An indicator can display several numbers located on a set of lines. For example, a tonometer (a blood pressure measuring device) usually displays three numbers in three rows. The first number is the systolic pressure, the second number is the diastolic pressure, and the third number is the pulse.

We took 374 pictures of 7 different tonometers with the use of 9 mobile devices. We used this sample to test the following open-source image recognition applications:

- Tesseract OCR: https://code.google.com/p/tesseract-ocr/;
- Seven Segment Optical Character Recognition (SSOCR): http://www.unix-ag.uni-kl.de/~auerswal/ssocr/.

Both applications were able to extract information from less than 5 % of the picture sample. This image recognition level is unacceptable for industrial use.

There are a few papers [1], [2] that describe algorithms for a number recognition from an image of a seven-segment indicator. However, these approaches does not work well on real life images retrieved from mobile phone cameras. We created a test sample to determine recognition and preprocessing algorithms that work best on our picture set. The efficiency of existing methods was also not sufficient as in the case with the OCR applications. During the testing of the preprocessing algorithms we determined four classes of defects that can be found in the set:

- shadow on the border of the image;
- gradient illumination of the image;
- patch of light in the random part of the image;
- incline of the seven-segment indicator on the image.

To overcome the issues noted above, we developed a novel recognition algorithm. It includes the following steps:

1) horizontal segmentation to determine indicator row borders;
2) vertical segmentation of each row to determine the digit borders;
3) recognition of each digit.

The algorithm performs vertical and horizontal segmentation using brightness ranges. These ranges are calculated after the brightness normalization of the image. We implemented a special algorithm to convert images to monochrome. It is based on the idea of adaptive local threshold that is calculated using the interpolation over global thresholds of image quadrants. For global thresholding the Otsu method [3] was used. The last step of the algorithm includes the segment restoration technique. This allowed us to fully recognize 90 % of the testing picture sample. The rest of the pictures are barely recognized even by the naked eye.

The resulting algorithm allows to extract information from multi-line seven-segment indicators using only mobile phone's camera. The algorithm was implemented in the Blood Pressure Diary Pro application by EwerestMD LLC (https://play.google.com/store/apps/details?id=org.fruct.yar.bloodpressurediary.pro).

REFERENCES

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