

Robotic System for Integration of Electronics into Textiles

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A system for automated assembly of electronic devices into fabrics has been developed. Conductive yarn for the power supply of LEDs is woven in the backside of the fabrics. Advanced vision algorithms have been used to identify the position of bonding spots on the yarn.

Direct integration of electronics in textiles is a topic which attracted major interest in recent time. Nevertheless, automated reliable low-cost assembly is technically challenging. We present a vision based approach for one sub-task: identification of bonding positions for LEDs.

Due to the flexibility of a textile the position of yarn and the bonding spots are not known a priori. Even if the textile pattern seems to be regular, each bonding area looks different (see Figure 1). To identify the correct bonding spots, an adaptive position recognition algorithm based on artificial neural networks was used.

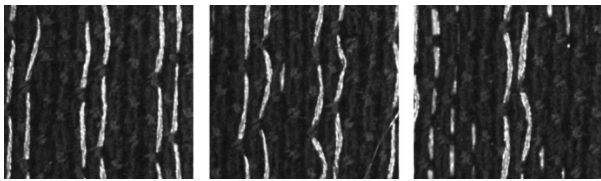


Figure 1: Images showing the different shapes of the conductive, bright wires. The LED's should be placed between two of them.

For image analysis we applied an algorithm based on a deep-belief network analysis. The goal is to find and track corresponding pairs of conductive yarn. The first step is a local image decomposition: At several points of interest a local log-polar-transformation is applied, and local (sharp, high resolution) and peripheral information (unsharp but still visible, similar to the perception of a human eye) is stored in a 16 x 16 pixel image (see Figure 2).

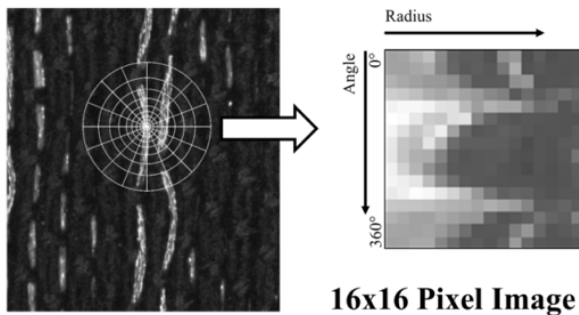


Figure 2: Symbolic representation of the log polar transformation.

Such transformed images serve as input for an initial training step. During this user-assisted process the systems learns the relevant features that are characteristic for a certain situation (Figure 3). The information is abstracted and the complexity is reduced. Only the significant information—appearance of a conductive wire—is considered.

In the next step of the training, the images are encoded with the previously learned procedure. The abstracted result is directly used to train the classifier ('what') and the localizer ('where') network (Figure 4).

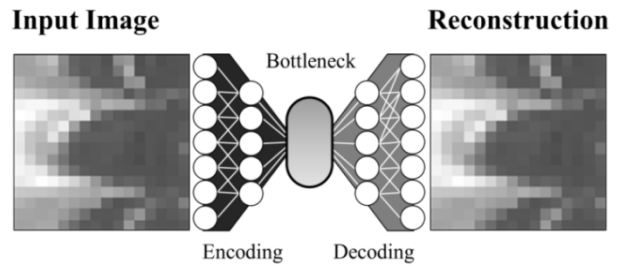


Figure 3: Illustration of the training where the image is encoded and decoded to reconstruct an image which is similar to the input image.

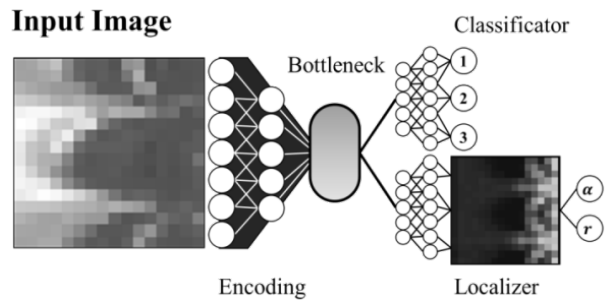


Figure 4: The two trained networks for classification and localization.

The localizer provides a jump map with the angle and the distance of interesting locations. Each map pixel stores the probability to be a point of interest. In Figure 5 the crosshair marks the current spot being analyzed. The circles are indicating where the next spots could be. Even when the starting spot is in a completely uninteresting place the jump map indicates peripheral POIs. With this efficient strategy an analysis of the entire image can be achieved within a few iterations in real time. The analysis of an image (Size 760x840) takes 182 ms.

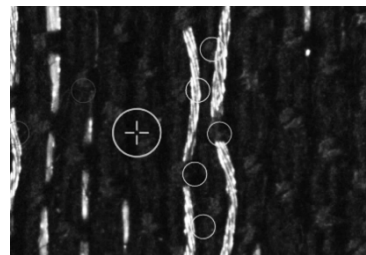


Figure 5: The cross-hair marks the spot which is analyzed, circles the interesting points.

This analysis yields precisely the position of bonding spots for the LEDs and the following automated assembly. The assembly process is described in "Process development for integrating electronics in textiles" in this volume.

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