

# Automatic reading of domestic electric meter: an intelligent device based on image processing and ZigBee/Ethernet communication

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**Abstract** In undeveloped areas around the world, many traditional meters need to be upgraded. Compared with replacing the mounted meters with high-cost modern ones, it is a better choice to upgrade them with new technologies. In this paper, an automatic reading system of the traditional household meter is designed on the basis of image processing and advanced DSP system. To identify the meter reading accurately, a regional average method is proposed to implement the image-scaling in order to avoid the distortion. In the image-filtering process, we raise an average-product method which is verified to attain good effects. For image segmentation, a new union thresholding method, based on the grayscale transformation, is proposed to enhance the adaptability of uneven luminance. Iterative rejection is applied to decrease the errors during character localization. Then, a training sample library with 1,400 characters is designed and collected for the training of the BP neural network. For data transmission, NAT technology is introduced to build data connection between the remote server and the data collectors working in the local area network. According to the field test, the proposed system can obtain a recognition rate of 99.7 % under normal environment, with the identification period below 2 s, while the resulting data can be transferred reliably through 1–3 walls in ordinary buildings.

**Keywords** Automatic meter reading · Image processing · BP neural network · DSP · ZigBee

## 1 Introduction

In undeveloped areas around the world, there are many traditional household meters which need to be upgraded. As compared with replacing the mounted meters with high-cost modern ones, it is a better choice to upgrade them with new technologies. Utility companies (electricity, gas, and water suppliers), governments and researchers are urging to deploy communication-based meter reading systems, known as automatic meter reading (AMR) [1]. AMR system is envisaged to bring benefits to customers, utilities and governments. With AMR system, we can effectively attain those goals such as reducing peak demand for energy, supporting the time-of-use concept for billing, and avoiding unnecessary visits from meter readers. The AMR system consists of two important elements such as accurate identification of reading numbers and reliable communications between meters and utility servers.

With the rapid development of technology and living standards, AMR has been pushed forward by varieties of advanced network technologies [2]. In Europe, USA, and other developed areas, AMRs with RF (Radio Frequency) or PLC (Power Line Carrier Communication) have been widely used. However, similar technologies are rarely used in undeveloped areas nowadays owing to different resident building styles and network infrastructures. The emergence and development of NGN (Next Generation Network), Wi-Fi (Wireless Fidelity), WIMAX (Worldwide Interoperability for Microwave Access) and other advanced technologies provide solid support for AMR deployment and application [3]. Traditional cable transmission is a stable method for data transmission and has been widely used in newly built houses and industrial buildings. But for those old and existent buildings, it is not suitable. In recent years, wireless data transmission technology, such as GPRS,

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