ABSTRACT

A Single-Chip Real-Time Range Finder

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Range finding are widely used in various industrial applications, such as machine vision, collision avoidance, and robotics. Presently most range finders either rely on active transmitters or sophisticated mechanical controllers and powerful processors to extract range information, which make the range finders costly, bulky, or slowly, and limit their applications. This dissertation is a detailed description of a real-time vision-based range sensing technique and its single-chip CMOS implementation. To the best of our knowledge, this system is the first single chip vision-based range finder that doesn't need any mechanical position adjustment, memory or digital processor. The entire signal processing on the chip is purely analog and occurs in parallel. The chip captures the image of an object and extracts the depth and range information from just a single picture. The on-chip, continuous-time, logarithmic photorec! eptor circuits are used to couple temporal image signals into the range-extracting processing network. The photoreceptor pixels can adjust their operating regions, simultaneously achieving high sensitivity and wide dynamic range. The image sharpness processor and Winner-Take-All circuits are characterized and analyzed carefully for their temporal bandwidth and detection performance. The mathematical and optical models of the system are built and carefully verified. A prototype based on this technique has been fabricated and tested. The experimental results prove that the range finder can achieve acceptable range sensing with low cost and excellent speed performance in short-to-medium range coverage and is particularly useful for collision avoidance.