Chapter 2
The Storage and Retrieval Technologies of Quantum Images

ABSTRACT

Quantum image processing represents an emerging image processing technology by taking advantage of quantum computation. Quantum image processing faces the first question: How is an image stored in and retrieved from a quantum system? To solve the issue, the authors provide six quantum image representations, which can be divided into three categories. The first, second, and third categories store color information using amplitudes, phases, and basis states, respectively. Next, they design their circuits to implement the storage of quantum image. Then, retrieval methods are introduced. The storage and retrieval technologies of quantum image are the basis and premise condition to process quantum images.

INTRODUCTION

Quantum image representation (QIR) is a stored pattern by which images are stored in a quantum system. Compared with classical image representations (Cohen & Weiss, 2012), quantum image representation has displayed the enormous storage capacity (Le, Dong, & Hirota, 2011; Li, Zhu, Zhou, Li, Song, & Ian, 2014).

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The amplitudes or phases of a quantum state were used to store information (Long, & Sun, 2001). For the convenience to retrieve accurately images, basis states were used to store information (Zhang, Lu, Gao, & Wang, 2013). Therefore, quantum image representations are classified into three categories. The first, second, and third categories store color information using amplitudes, phases, and basis states, respectively (Li, Song, Fan, Peng, Xia, & Liang, 2019).

The first category of QIRs includes: Qubit Lattice (Venegas-Andraca & Bose, 2003, 2010), flexible representation of quantum images (Le, Dong, & Hirota, 2011), quantum states for *M* colors and quantum states for *N* coordinates (Li, Zhu, Song, Shen, Zhou & Mo, 2013), multi-channel representation for quantum images (Sun, Iliyasu, Yan, Dong, & Hirota, 2013), the model of a normal arbitrary superposition state (Li, Zhu, Zhou, Li, Song, & Ian, 2014), a simple quantum representation of infrared images (Yuan, Mao, Xue, Chen, Xiong, & Compare, 2014), the model of a normal arbitrary quantum superposition state (Li, Zhu, Zhou, Song, & Yang, 2014), the model of a normal arbitrary superposition state with three components (Li, Zhu, Zhou, Li, Song, & Ian, 2014).

The second category of QIRs has a flexible quantum representation for gray-level images (Yang, Xia, Jia, & Zhang, 2013), and a normal arbitrary superposition state with relative phases (Li, Zhu, Zhou, Li, Song, & Ian, 2014).

The third category of QIRs includes: a novel enhanced quantum representation (NEQR) (Zhang, Lu, Gao, & Wang, 2013), quantum image representation for log-polar images (Zhang, Lu, Gao, & Xu, 2013), Improved NEQR (Sang, Wang, & Niu, 2016), a flexible representation of quantum audio (Yan, Iliyasu, & Guo, 2018), quantum image representation based on bitplanes (Li, Chen, Xia, Liang, & Zhou, 2018), generalized NEQR (GNEQR) (Li, Fan, Xia, Peng, & Song, 2019), quantum representation of real-valued digital signals and quantum representation of complex-valued digital signals (Li, Fan, Xia, Peng, & Song, 2019).

This chapter discusses the storage and retrieval technologies of quantum images by using some typical examples of QIRs of three categories.

QUBIT LATTICE

As the first of quantum image representation, Qubit Lattice stores a

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