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Context Awareness in Biometric Systems and Methods: State of the Art and Future Scenarios

Michele Nappi, Stefano Ricciardi, Massimo Tistarelli

Abstract - In the last decade, research in biometrics has been focused on augmenting the algorithmic performance to address a growing range of applications, not limited to person authentication/recognition. The concept of context awareness emerged as a possible key-factor for both performance optimization and operational adaptation of the capture, extraction, matching and decision stages. This may be particularly effective for multi-biometrics systems. The knowledge of the context in which a task is being performed, may provide useful information to the system in several manners. For example, it may allow to adapt to a specific environmental condition, such as shadow or light exposure. On the other hand, it may be possible to select the best available algorithm, among a given set, to address the task at hand, which best performs within the given context. This paper aims to provide an overall vision of the main contributions available so far in the field of context-aware biometric systems and methods. The survey is not confined to a particular biometric modality or processing stage, but rather spans the state of the art of several biometric modalities and approaches. A taxonomy of context-aware biometric systems and methods is also proposed, along with a comparison of their features, aims and performances. The analysis will be complemented with a critical discussion about the state of the art also suggesting some future application scenarios.

Keywords: Biometric systems, context-awareness, context-adaptive biometrics, state of the art survey

1 INTRODUCTION

In the last two decades, biometric systems and methods have been applied to a wide range of application domains. This resulted in a vast corpus of research topics, ranging from the study of new modalities (physical, behavioral or a combination of both) to performance improvements. This trend affected each of the main computational stages of a biometric system, including uncontrolled capture conditions or the presence of malicious attacks. Regardless of the topic considered, it is worth noting that even the most effective method or the best performing modality, may not be the most suited for a particular context. Therefore, the high variability of the real world requires a corresponding versatility of an automatic biometric recognition system. This can be achieved by purposively choosing the best performing algorithmic solution for a given context. Throughout the paper, the term "context" is to be considered in the widest sense, encompassing all kind of variables (environmental and oper-

ational conditions, type of usage, sensor efficiency, motion, etc.) which may have an impact on the application at hand. For example, context awareness may allow a biometric system to trust more the response of those modules which have been tested as best performing under the same context.

Context-awareness and context-aware systems have been extensively described in literature. However, the application to biometrics have been explored only in recent years. According to [1] "a system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task". This concept of context-awareness is often closely related to other issues like *responsiveness* [2], *adaptivity* [3], *reactivity* [4] and *context-sensitiveness* [5]. All these issues imply the capability of detecting the context and of modifying the operation based on that context to achieve the best performance. Considering the current biometric technologies, this may be implemented in several ways. For example, designing a biometric recognition system capable of dynamically selecting the optimal feature extraction method for a given data capturing condition. Another potential implementation of context awareness is to select the best suited feature matching method, balancing speed versus accuracy, according to the operational requirements (high security versus low false rejections). These

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