Recognizing Ancient Coins Based on Local Features*

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Abstract. Numismatics deals with various historical aspects of the phenomenon money. Fundamental part of a numismatists work is the identification and classification of coins according to standard reference books. The recognition of ancient coins is a highly complex task that requires years of experience in the entire field of numismatics. To date, no optical recognition system for ancient coins has been investigated successfully. In this paper, we present an extension and combination of local image descriptors relevant for ancient coin recognition. Interest points are detected and their appearance is described by local descriptors. Coin recognition is based on the selection of similar images based on feature matching. Experiments are presented for a database containing ancient coin images demonstrating the feasibility of our approach.

1 Introduction

Numismatics is at a point where it can benefit greatly from the application of computer vision methods, and in turn provides a large number of new, challenging and interesting conceptual problems and data for computer vision. For coin recognition we distinguish between two approaches: coin identification and coin classification. A coin classification process assigns a coin to a predefined category or type, whereas a coin identification process assigns a unique identifier to a specific coin. What makes this application special and challenging for object recognition, is that all the coins are very similar.

The first coins were struck in Asia Minor in the late 7th century BC. Since then coins are a mass product [1]. In the Antiquity coins were hammer-struck from manually engraved coin dies. Coins from the same production batch will have very much the same picture and also the same quality of its relief. Depending on the series of coins in question, the only varying details can be either part of the picture or legend or there can be a difference in a prominent detail such as the face of a figure. The scientific requirement is to assign a coin its correct number according to a reference book.

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Fig. 1. Different coins of the same coin type

Fig. 2. Different image representations of the same coin

Ancient and modern coins bear fundamental differences that restrict the applicability of existing algorithms [14]. Due to their nature ancient coins provide a set of identifying features. The unique shape of each coin originates in the manufacturing process (hammering procedure, specific mint marks, coin breakages, die deterioration, etc.). Furthermore, the time leaves its individual mark on each coin (fractures, excessive abrasion, damage, corrosion, etc.). Eventually, identification of ancient coins turns out to be "easier" compared to classification. For example, Figure 1 shows ten different coins of the same coin type. A classification algorithm should ideally classify them all of the same class. However, they all provide complete different characteristics (see shape, die position, mint marks or level of details). At the same time, exactly those features enable the identification process.

In contrast, Figure 2 presents five pictures of one and the same coin. The pictures were taken using different acquisition setups, i.e. scan as well as fixed and free hand cameras with varying lighting conditions. The figure points out the challenges for an automated identification process as well as the importance of quality images for the process itself. Different lighting conditions can hide or show details on the coin that are significant for a successful identification process (e.g. compare the first and the third image in Figure 2).

The remainder of this paper is organised as follows: In Section 2 related work on recognizing coins is presented. Section 3 gives an overview of local features with respect to our needs. The coin recognition workflow is described in Section 4. The experiments performed and their results are presented in Section 5. We conclude the paper in Section 6 with discussion on the results achieved and an outlook for further research.