# IMAGE TECHNIQUES FOR THE IDENTIFICATION OF DEPRESSIONS AND OTHER OBSTACLES IN AUTOMATED GUIDANCE OF ROVING ROBOTS

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## ABSTRACT

In this study, we analyze the problem of detection of depressions or drop-offs in the automated guidance of roving robots. The proposed approach is based on the principle that if one is too near a depression, one is bound to see new information which initially was occluded. To exploit this principle, two steps are undertaken. The first step involves the derivation of the correspondence process to allow the vision system to relate a location of interest in a sequence of frames. The second step involves the development of methods to detect and identify, in this location of interest, the occluded information.

## RÉSUMÉ

Nous presentons dans cette étude une méthode visuelle pour la détection de dépression de terrain (creux, pente, bordure de pavé, etc) dans le but d'assurer sauf-conduit pour un robot autonome. Cette méthode est basée sur le principe que si on s'approche d'une dépression de terrain, on est apt d'apercevoir certains elements d'information qui auparavant n'etaient pas apparents. Pour exploiter ce principe, deux etapes d'action sont prises. Dans la première étape, nous etablissont le rapport qui existe entre une serie de photographes pour permettre au robot de reconnaitre une même location d'intérêt dans deux ou plusieurs de ces photographes. Ces photographes sont prises en succession et en s'approchant de cette location d'interêt. Dans la deuxième étape, nous décrivont les techniques necessaires pour identifier et extraire les éléments d'information qui caracterisent la presence d'une depression de terrain.

## INTRODUCTION

Depressions or drop-offs constitute a serious problem in the automated guidance of roving robots. Unfortunately, the detection of depressions is also a complex image analysis problem. In the human vision system, many visual cues such as stereopsis, occlusion cues, context in the viewed scene, change in textural properties, etc., are all interpreted and integrated with relative ease to yield an almost effortless perception of what, in fact, is a complex perceptual task. In image processing, however, a computer implementation exploiting any one of the aforementioned cues becomes a complex information processing problem.

Clearly, there is no simple way to solve this problem. In the approach proposed here, the aim is to extract the occluded information given a sequence of frames based on methods which allow for a relaxed image correspondence process between these frames. The two methods devised here make use of intensity profiles or pixel intensity distributions. The first method identifies primary cues which suggest the presence of a depression. The second method extracts the occluded information to confirm the presence of a depression.

Before we describe the approach for the detection of depressions, we first take a broad view of the automated guidance of roving robots. In this view, with the aim to extend beyond the ideal settings generally considered, we make an assessment of real-world scenes identifying pertinent problems towards enhanced guidance of roving robots.

## SCENE INTERPRETATION PROCESS

Figure 1 illustrates a process of analysis and interpretation of real-world scenes. In this process, the first function of the vision system is to provide the robot with a safety path. To carry out this function, the vision system uses the first-pass evaluation process[1] which exploits the surface consistency constraint[2] by comparing the environment ahead of the robot with an initial environment which is already determined to be obstacle-free. Computer results of an implementation of this first-pass evaluation on outdoor scenes are shown in Figure 2. The second function of the vision system is to provide the robot with the needed additional information in the event where an object blocking the path of travel is detected, or if some landmark need to be identified. To carry out this second function, the objects the robot is likely to encounter are categorized, and their essential visual characteristics are identified. In the process of Figure 1, these categories are: (1) shadows (false alarm), (2) depressions, (3) upright objects, and (4) flat objects. The essential features characterizing the above categories are:

1. Shadow. A surface upon which a shadow is cast will preserve its intrinsic physical characteristics. This is due to the relatively uniform effect of shadow on the image gray level intensities.[3,4]