# Chapter 4
# Reducing the Optical Noise of Machine Vision Optical Scanners for Landslide Monitoring


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## ABSTRACT

*An application of landslide monitoring using optical scanner as vision system is presented. The method involves finding the position of non-coherent light sources located at strategic points susceptible to landslides. The position of the light source is monitored by measuring its coordinates using a scanner based on a 45° sloping surface cylindrical mirror. This chapter shows experiments of position light source monitoring in laboratory environment. This work also provides improvements for the optical scanner by using digital filter to smooth the opto-electronic signal captured from a real environment. The results of these experiments were satisfactory by implementing the moving average filter and median filter.*


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## INTRODUCTION

Landslide is a term associated to downslope movements of rock, debris or earth under the influence of gravity, which may cover a wide range of spatial and temporal scales. Physical factors, human activities and natural environmental changes like earthquakes, volcanic activity, heavy rainfalls and changes in ground water are typical natural triggering mechanisms for landslides, which amplifies the inherent weakness in rock or soil (Savvaidis, 2003).

Landslides are a major hazard worldwide causing fatal disasters, property losses and degradation of the environment, so it is necessary to understand the mechanisms that trigger them. To understand the dynamics of the landslides it is necessary to monitor de surface displacements including accurate inventories of past slides, their location, extent, type and triggering mechanism (Kerle, Stump, & Malet, 2010). The magnitude, velocity and acceleration of displacements can provide an indication of the stability of the slope. These movements, if detected early enough, can indicate impending catastrophic failure of a sloping mass. (Savvaidis, 2003).

The long term monitoring of instability phenomena has become relatively inexpensive and affordable due to the recent technological growth in the field of data storage and transmitting. Measurements of landslide movements that integrate hydrological and geological data have greatly improved the knowledge of landslide mechanics and the integration of different techniques allows for a better understanding of this kind of phenomenon and thus better protecting human settlements and infrastructures. (Anderson & Tallapally, 1996), (Rentschler & Moser, 1996).

There are many landslide types depending on the slope movement and the type of terrain. Slope movement may be fall, topple, lateral spreading, slide and flow and the earth material could be rock or soil. In past decades, photograph sensors, including extensometers, in-place inclinometers, tiltmeters, pressure transducers and rain gauges, were used to landslides monitoring. However, researchers had several difficulties for accurate assessments and evaluations, monitoring times were long and the measurement process very expensive.

In this chapter, a machine vision application to landslide monitoring tasks is presented. Machine vision is a new alternative that uses different optoelectronics devices as vision systems, nowadays the most used devices include photographs and video cameras. However, camera images are detailed and therefore contain a large amount of information.

Our application uses an optical scanner with incoherent light emitter as a vision system.

The scanner used in this application was also proposed for structural health monitoring tasks (Rentschler & Moser, 1996), (Rivas López, Flores Fuentes, Rivera Castillo, Sergiyenko, & Hernández Balbuena, 2013), but in this chapter, we will show the advantages in landslide monitoring using incoherent light. Several position measurements were carried out with a laser emitter and incoherence light emitter. Position measurements were carried out during the scanning process moving the position of light emitter source from the nearest distance to the optical aperture sensor to the farthest position from the optical aperture sensor along the same angle line. Experiments show that with laser emitter, alignment difficulties were presented in all positions. When the laser emitter was moved to 10mm up, down, right or left, the light beam was not detected in the scanner aperture.

On the other hand, an incoherence light emitter was positioned to distances of 2m, 4m, 6m, and 8m. In each position, the emitter was moved 10cm, 20cm, 50cm, to up, down, right and left. The light was detected in the scanner aperture without problem in all positions. In this way, we opted to use optical scanning with incoherent light for measurements of coordinates and calculate displacements.

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