# “Unstable Bluff” Detection System

Unstable bluffs in the Del Mar, California area present hazards to train tracks at the top of the bluffs as well as potential harm/loss of life to people sitting on the beach near the bluffs. The goal of this detection system is to monitor the bluffs in the Del Mar area and alert authorities when unstable bluff areas are detected.

The initial version of this system will be a prototype developed to monitor a 300-foot stretch of bluffs in Del Mar to evaluate the feasibility of this system for further use on other bluffs of concern on the California coastline. The system will use 6 fixed cameras to monitor the 300-foot stretch of bluffs. Each camera will be a 10-megapixel wifi-enabled camera with an interval timer and night vision capability that can transmit images periodically to a central site for processing as well as receive control commands from the central site. Control commands can specify the intervals between images as well as modify image specifications. Each camera will be mounted on a pole with access to power. Each camera will be mounted so that it can capture a 50-foot by 50-foot image of the top of the bluff, including the bluff edge, resulting in 4,000 pixels per square foot. Each camera will have the ability to take color or grayscale pictures employing 8 bits per pixel. You can assume that the camera poles are in a relatively straight line.

Each image will include a 32-bit time stamp and a 32-bit geo location. For simplicity, assume that the timestamp and geo location information are included in the 10-megapixels for each image.

For the initial version, images will be transmitted hourly to a local test facility (acting as the central site) within 100 meters (~300 feet) of each camera. Images will be transmitted via some combination of IP networks and network components such as wireless access points, routers, and repeaters. Wireless outdoor routers, including those on the cameras, can transmit camera images up to 300 feet. Amtrak railway also has agreements with cellular providers to cards that can provide direct access from cellular-enabled cameras to cellular service and is willing to provide this capability in the future if it is of interest for the railway companies.

The central site processing system has image comparison algorithms and supporting database(s) to maintain one month’s worth of hourly data plus one image per day for images older than one month for up to one year. If bluff changes are noticed, each change shall be rated from zero to five (amount of change for each level is user-defined):

- A rating of zero indicates no identifiable change.
- Ratings between one and three are considered predictive of a significant slide.
- A rating of four indicates some significant change and further evaluation is required immediately to determine if rail traffic should be stopped and people evacuated from the area.
- A rating of five indicates that a major change occurred, rail traffic should be stopped immediately, and people evacuated from the area to avoid injury or death. In addition, the image indicating a major change should be compared to the last image at that location to determine if trains or people were in the area right before the bluff change and rescue operations initiated.

Ratings at levels 4 and 5 will cause alarms to go off and messages sent to rail operators and lifeguards.