


Weed Detection System

Automated Vegetation Monitoring

Optical system for targeted weed elimination



Unwanted vegetation can be efficiently kept at bay with the help of a system for automated green detection - in the track bed, on roads and other traffic routes or areas.

Living plants can be reliably detected with the help of dedicated cameras. This is made possible by the so-called »green gap« in the electromagnetic spectrum. Fraunhofer IPM's Weed Detection System WDS for automated vegetation detection makes use of this effect to control sensors for the distribution of herbicides in a targeted and economical manner, for example, in railroad beds or on other traffic routes and areas.

Efficient vegetation management

Controlling and maintaining vegetation involves considerable effort for landowners, municipalities or operators of transport infrastructure. This is not just a matter of aesthetics. On traffic routes, unwanted vegetation can pose safety risks. If weed takes root in the cavities of a track system's ballast bed, rainwater cannot drain off quickly enough and the track bed silts up. The gravel loses its buffer function, which may result in changes in the track position.

On roads, sidewalks or bike paths, plants impair pavement or asphalt grip, increasing the risk of slipping. If deep-rooting plants spread into potholes, this can lead to unevenness.

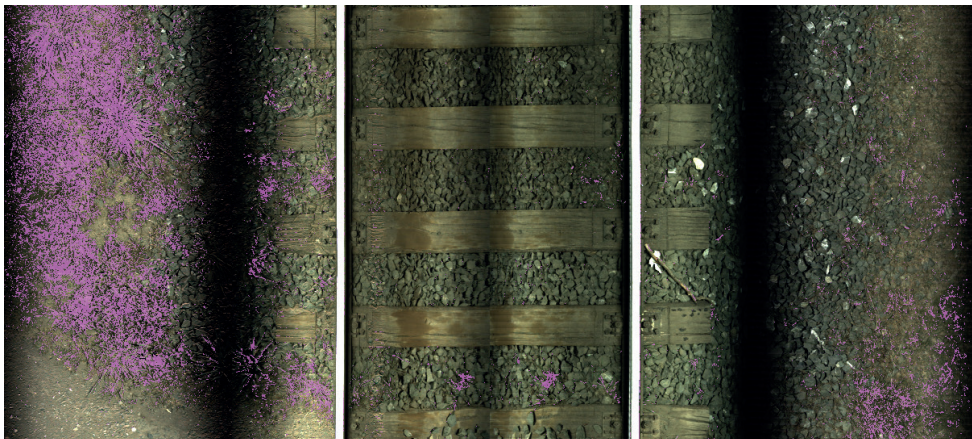
The monitoring and clearance of unwanted plants is a permanent task for rail operators and municipalities, usually involving the use of large quantities of herbicides. Fraunhofer IPM's WDS is an optical system for selective green detection that recognizes living plants by their characteristic spectral fingerprint.

Application of herbicides at 50 km/h

The camera-based system can be mounted on rail vehicles or all-round vehicles for gardening and landscaping. The cameras record the ground surface underneath and in front of the vehicle at a variable detection width. Controlled application of the herbicide is performed at travel speeds of up to 50 km/h.

Advantages at a glance

- **Spraying mechanism:** triggered automatically instead of manually
- **Sustainable:** reducing herbicides
- **Operation:** on mobile platform
- **Measurement speed:** up to 100 km/h
- **Detection range:** variable
- **Documentation:** enables longterm monitoring



Vegetation detection on a track bed: Measurements can be taken at travelling speeds of up to 100 up km/h. The vegetation (depicted in purple) is visible in detail. The command to apply the herbicide is executed specifically on the basis of threshold values.

Evaluation of the measurement data is carried out so quickly that a command for the targeted positioning and activation of the spray nozzles is triggered within approximately one tenth of a second. Thanks to the automated sensor technology, herbicide is only applied to areas with actual plant growth. Compared to visual green detection by humans and manual control of the spraying mechanism, which is common today, the amount of herbicide used can be significantly reduced in this way.

Longterm documentation

Measurement is carried out in combination with the acquisition of GNSS position data for exact localization, enabling the generation of maps with geo-referenced information about the degree of vegetation cover. These maps can then be used to monitor and document the condition over long periods of time, providing a valuable data basis for planning vegetation control.

Multispectral measurement makes use of the »green gap«

Green vegetation exhibits a characteristic spectral fingerprint. Light in the wavelength range between 490 nm and 620 nm, the so-called »green gap«, and from 780 nm in the NIR (near infrared) range is reflected, while the wavelength ranges between 400 nm and 490 nm (blue spectral range) and between 620 nm and 780 nm (red spectral range) are absorbed. The WDS uses this specific behavior of absorption and reflection for the automated detection of living plants.

The measurement system is mounted on the front side of the measurement vehicle and consists of several cameras: One RGB and one NIR camera each form a camera pair aimed to the ground. The cameras are integrated into weatherproof housings.

To ensure reliable, robust operation even under difficult lighting conditions and at night, the ground is illuminated with powerful LED spotlights. These spotlights comprise LEDs emitting white light and infrared light and homogeneously illuminate the target area.

Image processing in a split second

In order to ensure that the spraying mechanism is triggered sufficiently quickly at high travel speeds, image evaluation, signal processing and transmission take place within less than a tenth of a second. The camera images are processed pixel by pixel and analyzed with the help of an FPGA (Field Programmable Gate Array). The recorded areas are subdivided into quadrants of variable size and plant coverage is calculated for each quadrant. As soon as a predefined threshold value is reached, the system generates a trigger signal that activates one or more movable spray nozzles, depending on the identified coverage. The threshold value for the degree of coverage can be set individually.

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