Fraunhofer IPM

Weed Detection System

Automated vegetation monitoring

Unwanted vegetation can efficiently be kept at bay with a system that automatically detects greenery in track beds, on roads, and on other traffic routes or areas.

Special cameras can reliably detect living plants. This is made possible by the "green gap" in the electromagnetic spectrum. The Weed Detection System (WDS) uses this effect to precisely control sensors for herbicide application in track beds, on traffic routes, and in other areas.

Efficient vegetation management

Controlling and maintaining vegetation requires considerable effort from landowners, municipalities, and transportation infrastructure operators. It is not just a matter of aesthetics. On transportation routes, unwanted vegetation can become a safety hazard. For example, if weeds grow in the gaps of the ballast bed of railroad tracks, rainwater will not drain quickly enough, causing the track to silt up. Consequently, the gravel loses its buffer function, which can cause changes in track alignment. On roads, sidewalks, and bike paths, plants can reduce pavement or asphalt grip, increasing the risk of slipping and falling. When deeply rooting plants spread into potholes, the ground becomes uneven.

Monitoring and clearing unwanted plants are ongoing tasks 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.

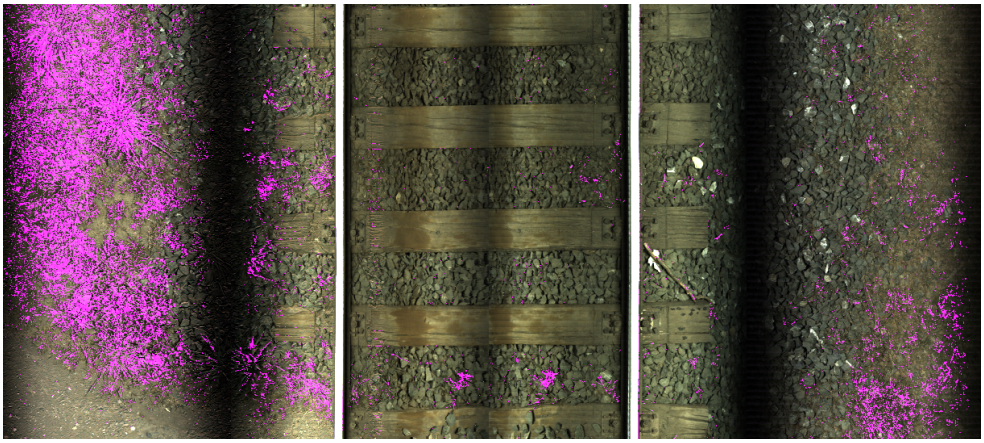
Targeted application of herbicides at 50 km/h

The camera-based system can be mounted on rail, dual-mode, and all-purpose vehicles, including those used for gardening and landscaping. The cameras record the ground surface in front of and underneath the vehicle at variable detection widths. Herbicides are applied at controlled rates and travel speeds of up to 50 km/h.

The measurement data is evaluated so quickly that the command to set the target position and activate the spray nozzles is triggered in about one-tenth of a second. Thanks to automated sensor technology, herbicides are

Advantages at a glance

- **Spraying mechanism:** automatic trigger instead of manual
- **Sustainability:** reducing herbicide use
- **Operation:** on mobile platforms
- **Measurement speed:** up to 100 km/h
- **Detection range:** variable
- **Documentation:** enables long-term 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.

only applied to areas with actual plant growth. Compared to the current method of visual green detection by personnel and manual control of the spraying mechanism, the amount of herbicide used can be significantly reduced.

Long-term documentation

Measurements are carried out in conjunction with the acquisition of GNSS position data for precise localization, which enables the generation of geo-referenced maps detailing the degree of vegetation cover. These maps can then be used to monitor and document conditions over long periods of time, providing valuable data 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 in the near infrared range (NIR) above 780 nm is reflected. In contrast, wavelengths between 400 and 490 nm (the blue spectral range) and between 620 and 780 nm (the red spectral range) are absorbed. The WDS uses this specific absorption and reflection behavior for the automated detection of living plants.

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

Powerful LED spotlights illuminate the ground for reliable, robust operation even under difficult lighting conditions and at night. The spotlights contain LEDs that emit white and infrared light, which homogeneously illuminates the target areas.

Image processing in a split second

To ensure the spraying mechanism is triggered quickly enough at high travel speeds, image evaluation, signal processing, and transmission must all occur in 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 divided into quadrants of variable sizes, and plant coverage is calculated for each quadrant. Once 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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