

Roboweeder: A Robotic Weeds Killer Using Electromagnetic Waves

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Abstract : Weeds reduce farm and forest productivity, invade crops, smother pastures and some can harm livestock. Farmers need to spend a significant amount of money to control weeds by means of biological, chemical, cultural, and physical methods. To solve the global agricultural labor shortage and remove poisonous chemicals, a fully autonomous, eco-friendly, and sustainable weeding technology is developed. This takes the form of a weeding robot, 'Roboweeder'. Roboweeder includes a four-wheel-drive self-driving vehicle, a 4-DOF robotic arm which is mounted on top of the vehicle, an electromagnetic wave generator (magnetron) which is mounted on the "wrist" of the robotic arm, 48V battery packs, and a control/communication system. Cameras are mounted on the front and two sides of the vehicle. Using image processing and recognition, distinguish types of weeds are detected before being eliminated. The electromagnetic wave technology is applied to heat the individual weeds and clusters dielectrically causing them to wilt and die. The 4-DOF robotic arm was modeled mathematically based on its structure/mechanics, each joint's load, brushless DC motor and worm gear' characteristics, forward kinematics, and inverse kinematics. The Proportional-Integral-Differential control algorithm is used to control the robotic arm's motion to ensure the waveguide aperture pointing to the detected weeds. GPS and machine vision are used to traverse the farm and avoid obstacles without the need of supervision. A Roboweeder prototype has been built. Multiple test trials show that Roboweeder is able to detect, point, and kill the pre-defined weeds successfully although further improvements are needed, such as reducing the "weeds killing" time and developing a new waveguide with a smaller waveguide aperture to avoid killing crops surrounded. This technology changes the tedious, time consuming and expensive weeding processes, and allows farmers to grow more, go organic, and eliminate operational headaches. A patent of this technology is pending.

Keywords : autonomous navigation, machine vision, precision heating, sustainable and eco-friendly

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