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Child perception-based plant species identification

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Abstract

Automation of mechanically pulling the weeds out of the crop row not only copes well with the new European high environmental standards but also removes the high cost of mere conventional alternative as high hand-weeding. The objective of this research work is to propose a similar distinguishing methodology of a weeding labour when discriminating the weeds species to choose and remove the undesired ones. The method is governed by a systematic analysis carried out on recognition method of an immaturely trained human brain. In other words, a number of children, who have never seen a maize agricultural field, were examined while recognizing a maize pattern using at most five sample images. The proposed method works mainly based on morphological operators for extraction of fundamental plant features in the image. The advantage of the proposed method is producing similar results to human labour which is approximate identification. This final decision was made by a fuzzy classifier which generate the degree of membership to either of weed or crop plant groups. Unlike the very popular research trend for object classification in the literature, our proposed methodology neither requires huge sample of images nor a high capacity processor. The accuracy of maize plant discrimination from typical Mediterranean weeds under extreme July sun illumination was observed as 95% for a scene of a single plant and 85% for a scene containing multiple objects.

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Keywords: Weed/crop plant classification; fuzzy decision maker; machine vision; in-row weeding; approximate plant identification (API).

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1. Introduction

Demand for environmental saving and organic agriculture is significantly growing globally. European countries, in particular, have raised the toughness of environmental protection regulations against air polluting materials such as herbicides. Traditional farming results in the hazard of chemicals spread (herbicides, fertilizers), resulting in high cost of production and soil depletion (Kataoka, Kaneko, Okamoto, & Hata, 2003; Astrand & Baerveldt, 2005). On the other hand, the most efficient alternative for killing weeds by mass herbicide distribution is hand-pulling the weeds out of each crop row (in-row weeding) that is an expensive and labor-intensive task.

On one hand, Automation of in-row weeding is one the few remaining drudging challenges for agricultural scholars (Sospedra & Nebot, 2014; Mitiby et al. 2016). On the other hand, machine vision has shown a great potential to replace the human plant recognition (Brosnan and Sun, 2002; Davies 2009; Ruiz et al., 2014; Zhang et al., 2014; Sujaritha, et al., 2017). There have been numerous efforts to develop techniques and machines for robotic in-row weeding since 1983 (Slaughter, Giles, & Downey, 2008; Midtiby, et al., 2016). Various shape descriptors were used and derived to distinguish between two groups of plants (Weis and Gerhards, 2008; Giselsson, Midtiby, and Jørgensen, 2013). Europe has been pioneering in robotic in-row weeding by manufacturing robots such as Garfords Robocrop (Garford, 2011) and Robovator by F. Poulsen Engineering (Frank Poulsen Engineering, 2014).

Studying the papers in the literature, we have observed that the recent trend of object detection and in particular "crop plant classification" diverges from a practical method, however provides high accuracy. Although, employing various versions of neural network might solve ta specific problem such as the system proposed by Dyrmann, Karstoft, & Midtiby, (2016), it adds another problem of a need to high capacity PC for model training procedure which takes a week. Model trainings presented in the literature have required numerous samples (Arribas, et al., 2011). Moreover, deployment of a such methodology is practically impossible low-cost and newly developed single-board computers such as Raspberry Pi. This recent trend contradicts even a child object identification manner at least how to distinguish among two very different patterns. This childish object classification can simplify typical plant classification task and thus in the present study, a novel recognition methodology is proposed and verified for a significant demand in agriculture.

2. Emulation of Human Brain for Pattern Identification

Human brain at early ages is not trained much and thus systematically and psychologically examining the recognition behavior of a child of younger than six years old guides the study to the correct path. A number of four to six years old children were examined while recognizing the maize plants on a set of images of plant species. Their manner of pattern recognition the was systematically studied and the minimum requirements were recorded which forms the basis of this paper. Simply speaking, unlike the computerized systems and perhaps mature humans, a child makes a "guess". Child recognition implies that he records very basic shape features even in a quick blink. He, first segments the large colorful parts as well as a few bright lines out of the whole image and then continues over a low resolution image. As a matter of fact, child approximately fits a pattern. Figure 1 describes the child perception-based object identification.