

# TESTING OF AN OPTO-ELECTRONIC SENSOR FOR THE HIGH-THROUGHPUT MEASUREMENT OF SEED SPATIAL DISTRIBUTIONS

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**Abstract**— We present testing results of an intelligent opto-electronic seed sensor system allowing the high throughput measurement of seed spatial distributions. With this aim, we evaluate the correlation between actual and sensor estimated distances between seeds. The tests take into account two important features in farming performance: the planter speed and the sensor-soil distance. While the former one determines the man-hours required, the later one determines the feasibility of sensor mounting and its useful life. Results show that precise measurements can be obtained with the proposed sensor at typical planter speeds, even with the sensor on top of the drop tube.

**Keywords** — Precision Agriculture, Opto-Electronic, Seed Sensor, Embedded Microcontroller, Corn Crop.

## I. INTRODUCTION

Precision Agriculture involves a broad spectrum of technologies (Scarlett, 2001). The aim of these technologies is the optimization of agriculture resources. In this paper, we focus on the optimization of sowing performance through the study of the Seed Spatial Distribution (SSD). It has been noted by many authors (Bragachini *et al.*, 2002; Nielsen, 2006), that plant spacing variability, which can be estimated from SSDs, strongly affects yield crop.

A closely related quantity to the SSD, actually its inverse, is the Seed Rate (SR). Raw SR estimations are obtained using Opto-Electronic Seed Sensors (OESS) designed for counting the number of seeds within a pre-defined time window. Usually, rather large time windows are used, in the order of 9 [sec]. As a result, the precision of SR measurements depends on the variability on the planter speed: the larger the planter speed, the smaller the precision of SR measurements. Hence, the indirect estimation of SSDs from SRs is particularly limited. Aiming to overcome this problem, a OESS system for the precise measurement of SSDs was devised. Our approach is based on the distributed SSD measurement across a number of OESS units, in multiple seed lines, and a central unit to which all OESS units report (Fig. 1).

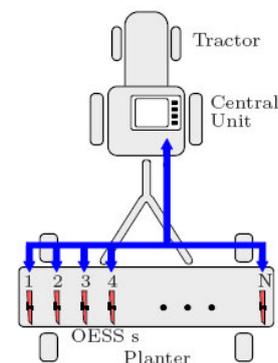


Figure 1: OESS System.

We build upon previous work of Steffen (1985) and Dragne *et al.* (1999). In particular, similarly to Steffen (1985) our system can deal with high SRs. In addition, similarly to Dragne *et al.* (1999), our system employs OESS units with embedded microprocessors. However, in our proposal, just standard hardware components are used. This is a key requirement for the design of low cost and highly scalable electronic devices.

In this paper, the testing results of core OESS units used in the proposed system are presented. OESS units were specifically designed for allowing the real tracking of a fixed number of seed events, i.e., we focus on the time between seed events instead of the number of seeds within a fixed time window. This feature allows, the system operation within a broad spectrum of SRs, and the real time measurement of SSDs.

The following functional constraints were considered in the design of core OESS units: (a) they must be able to accurately estimate local SSDs, and (b) they must be quite independent of their position and the planter speed. Point (a) is associated with the feasibility of overall OESS system. Point (b) is related to the installation of individual OESS units on the seed drop tube and the operation in real sowing environments (seed rate and planter speed).

Based on the above requirements, we present a correlation study between real and estimated SSDs at individual OESS units taking into account: i) OESS unit correlation vs. planter speed and ii) OESS unit correlation vs. OESS unit mounting position on seed drop tube.