A GUIDANCE ASSISTANCE METHOD FOR PRECISION SUGAR BEET SOWING USING MACHINE VISION.

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INTRODUCTION

The aim of this research was to develop a low cost system to guide a sugar beet sowing machine according to a furrow created during a previous passage. The harvesting machine actually comprises a number of rows being a sub-multiple of the sowing machine's (for example 12 rows for the sowing machine and 6 for the harvesting machine). This restriction could be lifted if the guidance system had a trueness higher than the clearance of the harvest share, which is of about 0.2 m.

MATERIAL AND METHODS

Video sequences of a furrow were acquired during two sowing seasons (2002 and 2003). The pretreatments of the images consisted, as shown in Fig. 1 in extracting the green channel, reducing the size of images, applying a background correction to remove the unevenness (shadows and optical artefacts) and filtering the image with a Gaussian filter. The background was obtained by applying a large median rank filter on the image.

The detection was based on the Hough transform. This method ensured the projection of the image on lines having different orientations, providing an “image” where straight lines appeared as maxima. The absolute maximum was chosen to compute the position of the furrow.

a b c d e

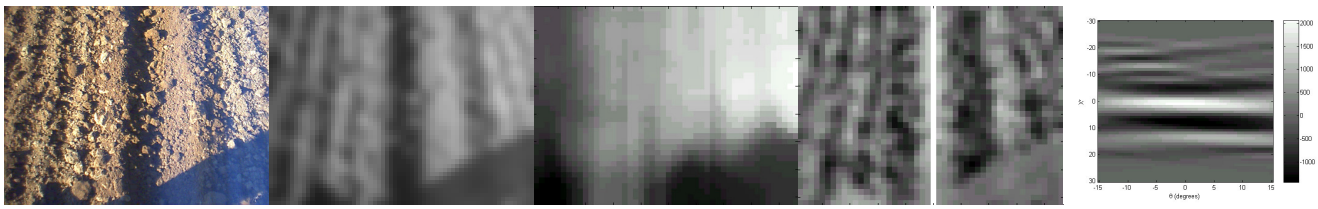

Figure 1 : Pretreatments and detection of a furrow. a, original image ; b, image after extraction of the green channel, size reduction and Gaussian filtering ; c, background; d, image after background subtraction, with the detected line added in white ; e, Hough transform.

The results of the detection were corrupted by noise and the estimation of the position

was evaluated by using a “forgetting factor” filter.

The reference was given by an operator recording the position of the furrow on the video. Five videos were analysed twice to characterise the variability of the operator.

RESULTS

The trace width varied from about 10 mm to around 200 mm. The mean absolute difference between pairs of five videos analysed twice which was of 13 mm.

The results are summarized in Table 1. The distribution were found clearly asymmetric. The mode was not at zero which indicated a slight bias between the reference and the results. This offset depended on the lighting conditions and on the humidity. It appeared that the operator tried to localise the edge of the furrow while the algorithm found the darkest part. The trueness (the means mdx and the medians values) and the precision (the standard deviations msdx) of the absolute difference between the reference and the detected position dx were totally compatible with the application.

The algorithm was considered failing to localise the furrow when dx was above 200 mm, the clearance admitted by the harvesting machine. Nine videos on a total of 326 (i.e. 3%) failed. These data were not observed at random but were grouped into two places and most of these (8) were encountered in one place. A detailed observation of intermediate results showed that the problem was related with the width of the trace which was very thin (10 mm) compared with the others or when the sun was near the vertical plane including the furrow. There was barely no shadow or a too thin one. This was however not systematic, at other places with similar lighting conditions, other factors like the moisture of the soil were able to reveal the trace, while some seedbed preparations produced lures which could be avoided.

More than 7 images could be treated each second, using a Pentium III clocked at 667 MHz.

Table 1 : Results. The first column gives the method. The results are summarised with the mean absolute differences between the reference and detection by the algorithm (mdx), the mean standard deviation of the absolute difference (msdx), the first (Q1), second (median, noted med_{dx}), and third quartille (Q3), the maximum (max_{dx}).

Method	***year***	***mdx***	***msdx***	***Q1***	***med_{dx}***	***Q3***	***max_{dx}***
Hough +	2002	65	44	41	57	76	157
forgetting factor	2003	58	19	21	39	70	284