

J. Biomechanics, Vol. 30, No. 8, pp. 857-858, 1997 r 1997 Published by Elsevier Science Ltd. All rights reserved Printed in Great Britain 0021-9290377 \$17.00 +.00

LETTER TO THE EDITOR

PII: S0021-9290(97)00020-1

ACCURACY OF AN ELECTROMAGNETIC TRACKING DEVICE

A. M. J. Bull* and A. A. Amis

Biomechanics Section, Mechanical Engineering Department, Imperial College, London SW7 2BX, U.K.

In a recent technical note Milne *et al.* (Journal of Biomechanics **29**, 791-793, 1996) presented positional and rotational accuracy for a direct-current (DC) electromagnetic tracking device — Ascension Technology's 'Flock of Birds' (Burlington, VT, U.S.A.). The authors defined positional accuracy as the difference between measured displacements and the markings on a calibration grid. They determined positional accuracy in measuring 25 mm displacements ('steps') over a receiver to transmitter separation of 150-850 mm. From this they defined an 'optimal operational zone,' for which there was a mean error of less than ± 0.5 mm and, within this zone, measured the accuracy of the device for step sizes of 25-152 mm. Similarly, they measured rotational accuracy and the effect of different metals on the results. Because of the increasing use of this device in biomechanics research, we would like to address some questions which come out of their work.

We were surprised at the errors of 1.8% of step size found in measuring position and chose to repeat — as closely as possible from the description — the positional accuracy tests. Our results are presented in Figs 2 and 4 — next to the data of Milne *et al.* in Figs 1 and 3. Two significant points can be made from the comparison: (1) the optimal operational range for measuring 25 mm steps found by Milne *et al.* (225-640 mm) was confirmed by this work (217–723 mm), (2) the accuracy which we obtained when increasing the step size up to 152 mm was an order of magnitude better than in the work of Milne *et al.* (0.23% compared to 1.8% of the step size).

We hypothesise that a relevant factor in this comparison is the effect of transmitter power output. The 'Flock of Birds' system maintains the strength of the magnetic field at the receiver by stepping up the transmitter power as the receiver becomes more remote, and we discovered that transients during this process affected the system adversely. This was overcome by using a power supply with a higher rating than that supplied by the vendors. This may explain why our data does not display such high errors at the extreme of the transmitter to receiver separation (Figs 1 and 2) and why the position errors for higher step sizes are significantly less in the work presented here. A further point is that the data of Milne *et al.* shows a negative offset across the optimal operational range. This can be corrected by modifying the scaling factors employed in the vendor supplied software. Other factors may also be involved, such as electromagnetic environmental effects in the laboratory.

Because the use of multiple receivers is desirable in biomechanics research, the effect of using two and three receivers on the accuracy must also be assessed. The main point of this letter, however, is to show that the electromagnetic tracking device can be set-up to be an order of magnitude more accurate than has been suggested previously.



Address correspondence to: A. M. J. Bull, Biomechanics Section, Mechanical Engineering Department, Imperial College of Science, Technology and Medicine, Exhibition Road, London SW7 2BX, U.K.

0 ÷ a 🖷 Π **Optimal Operational Range** 0 Δ Ċ σ 2 υ J Mean Error (mm) 0 -2 ۵ -4 0 + X. + Y. - Z Ω - X. -Y. + Z . 2 . 7 + X, - Y, - Z -6 20 60 40 80 Separation (cm)

Fig. 1. The mean position error for 25 mm steps, over the working range of the device (n = 10). The six symbols represent the six directions of travel. An optimum operational range was defined as the tranmitter-receiver separation over which each of six axes exhibited a mean error of less than ± 0.5 mm. This was found to be 225-640 mm (from Milne *et al.*, 1996).



Fig. 2. The mean position error for 25 mm steps over the full range of the device (n = 10). The six symbols represent the six directions of travel. Using the same criterion as Milne *et al.* the optimal operational range was within a transmitter to receiver separation range of 217-723 mm.





Fig. 3. The mean and standard deviation of positional error for steps of 25-152 mm along all six axes (n = 10). The mean error was found to be 1.8% of the step size. Measurements were taken near the centre of the previously defined optimal operational range (from Milne *et al.*, 1996).

Fig. 4. The mean and standard deviation of positional error for steps of 25-200 mm along all six axes (n = 10). The mean error was found to be 0.23% of the step size. Measurements were taken within the optimal operating range as defined previously.