

Test of the TOMI device – 04.11.2007

Technology: WebCAM at 30 fps / VGA resolution. Sensor with 4 LED emitter sensors. Software with picture analysis.

Functionality: The 4 LED signals are received by a Web Cam standing at a distance of about 1 meter. The result is a simple VGA picture containing only the 4 LEDs as dots. It is quite clear that already the pixel resolution of the webcam at a distance of about 1 meter is critical. The sampling frequency of 30 Hz means a data point each 30 milliseconds. At a speed of 1.6 m/s around impact the distance between the measured data points is about 58 mm! With a data signal which is not precise as a video signal no reasonable interpolation is possible.

The next problem is the two dimensional picture. This is only providing information on two translational axis (up/down and left/right) and one rotational axis (in the side axis). All the information on other translations and rotations is only calculated from the geometrical form identified on the screen.

Analysis:

The calibration is complicated and it is unclear what exactly is calibrated. It seems that the path direction is calibrated by the direction of the receiver unit. As this unit is placed "parallel" to the target line all errors in placing the receiver unit are affecting path direction. Additionally the mounting of the sensor clip seem to affect the data.

The data of the TOMI is generally affected by significant errors. However the data for face at impact, path direction, impact spot, shaft angle and timings is generally extremely faulty and often displays even completely wrong data values. Especially path and spot are extremely affected by face rotation. Both face rotation and lateral distance to the receiver unit must be identified by change of the distance of the two side sensors. Often face angle and path angle seem to be interchanged. Aim and rotation seem to be somehow more accurate.

This can only be explained by mis-interpretations of the stroke. As the two dimensional picture does not contain enough information to really measure a putting stroke, the software needs to simulate the stroke and then to decide which conclusion is more likely. I.e. if aiming offcenter the data seems dramatically wrong. Also if delofting the face the path is showing extremely wrong data.

Conclusions:

- There is a general problem with the technology, not precise, frequency too low, only a two dimensional picture available.
- TOMI data is generally affected with significant noise and unpredictable errors.
- Especially path, shaft, spot, speed and timing are often not related to true data.
- For 5 consistent putting strokes the results seem better, but always with random noise
- Assumption - Tomi might take the first putt as a reference to show some reasonable data. The other putts are then tuned / faked in comparison to the first one.
- For inconsistent putting the data falls apart. Especially for a home model this is critical. Sometimes it is hard to believe that you look at the same data sample. Data seems random.
- Putting with delofting or with offcenter aiming results in random results.
- Aiming is in most cases accurate in a range of about ± 1 degree, but sometimes also off.
- Rotation is in most cases accurate in a range of ± 2 degrees, but sometimes also off.
- For amateurs TOMI might show some rough average tendencies.
- However it is not distinguishable what is data and what is error.
- The unpredictable extreme errors are completely confusing if repeating measurements.
- There is no reliable information on consistency (the most important aspect for good players).
- For better players TOMI might be even dangerous in showing wrong data, especially in face, path and spot.
- For skilled players the resolution of TOMI is also too low to show any relevant data.

Statistical comparison of a data sets

	Mean error	Abs error	Biggest error	% Error	% biggest error
Face address	1,36 °	1,48 °	5,5 °		
Face impact	0,24 °	4,24 °	5,9 °		
Path impact	1,0 °	1,56 °	4,2 °		
Rot backswing	1,06 °	3,2 °	5,67 °		
Rot forward	1,39 °	4,46 °	8,7 °		
Rot total	1,85	4,92	9,6 °		
Shaft angle	-0,4 °	2,98 °	4,71 °		
Impact spot	-19,2 mm	24,4 mm	38 mm		
Backswing time	-62,4 ms	62,4 ms	-128 ms	8,8 %	19%
Forward time	24,8 ms	38,8 ms	47 ms	10,4 %	11 %
Stroke rhythm	-0,34	0,35	0,58	18,2 %	31,8 %
Speed	6,8 mm/s	77,2 mm/s	-176 mm/s	7,90 %	17,3%