Experiments to Verify the rate-of-going of IOTA-VTI

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In late 2010 the Tony Barry contacted me and requested if he could test a new Video Time Inserter (VTI) that he was developing, by videoing the display of the new device and the display of KIWI-OSD at the same time. This was accomplished by Tony visiting my observatory a number of times, which is located in The Blue Mountains, west of Sydney, Australia. Over the next few weeks Tony made great progress and by early January 2011, he was able to leave prototype #1 with me for testing while he assembled prototype #2.

I was able to install onto my computer, the programming software for the microcontroller board, so I was able to update the on-board software quickly and easily, soon after it was written, thereby saving the ~ 70km round trip that Tony undertook to visit my observatory.

Note: some of the images refer to GPS-VTI, which was the original name of IOTA-VTI.

The Goal

The following tests are designed to compare the time stamps applied to the video fields by IOTA-VTI with that of two other GPS based sources and so, we can deduce that the time-stamp applied to the video field by three independent devices are accurate to within at least 0.001 seconds of UT.

Reference devices

KIWI-PC is a Time Stamp utility developed by Geoff Hitchcox of New Zealand around the turn of the century. It's details are fully described online[1] and photos of the device I built in 2002 are also online[2]. Basically is has a Trimble GPS that supplies TAIP serial data and the 1 pulse per second (1pps) signal to a PC, in this case a Toshiba laptop running DOS 3.2. Tests and reviews on the accuracy of KIWI-PC are available online[3&4] as well as videos of the some of the menu options are available on YouTube[5&6].

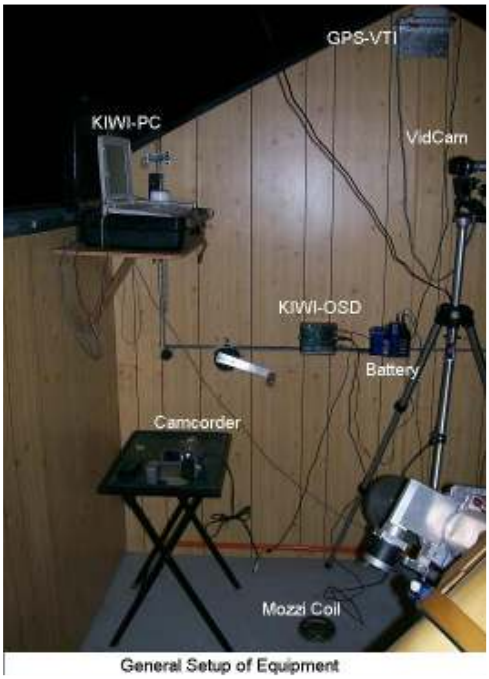
KIWI-OSD is a device also developed by Geoff Hitchcox, it's début was towards the end of 2004. Production units were manufactured[7] in U.S.A. between about 2005 and 2009 and over 1000 were made. It is one of these production units that was used for the tests. It has a Garmin 18x LVC GPS.

Tests to rate KIWI-PC and KIWI-OSD

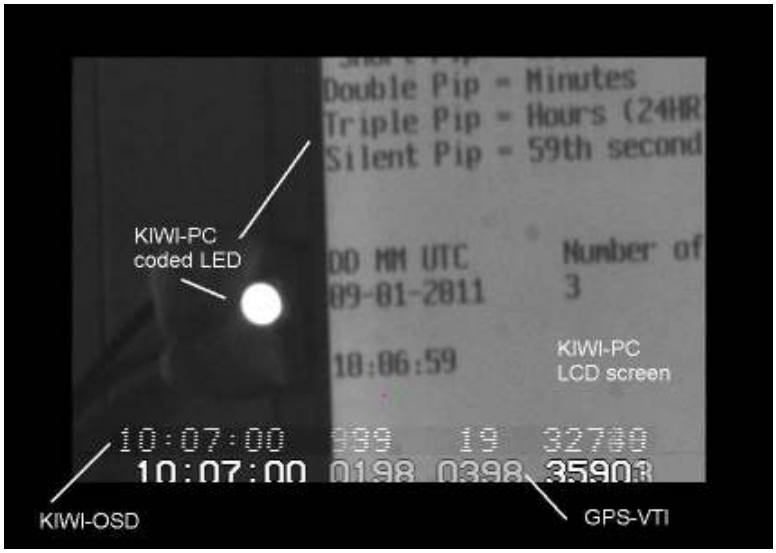
In 2004 I made a video that compared the coded LED flash produced by KIWI-PC and the time stamp of KIWI-OSD to that of a pure1PPS produced by the Trimble GPS. This video is available on YouTube[8] and shows that the time of the coded LED flash and the timestamp applied to the video field by KIWI-OSD are consistent to the flash of the LED produced by the pure 1PPS.

Test 1 – Compare IOTA-VTI to two KIWIs (PAL/CCIR)

Broadly speaking there are two problems to be investigated. Problem 1) is to show that the correct integer seconds are displayed (the so called "which second") and problem 2) is to show that the time applied to a particular video field is accurate to 1 millisecond of UT. I arranged to video the screen of the Toshiba laptop and the coded LED flash simultaneously to investigate problems 1 and 2 respectively, and then to pass the video stream through IOTA-VTI and KIWI-OSD, finally to be recorded on a camcorder. The photos (below) show the general arrangement of equipment and also shows the various displays of time. KIWI-PC made audible beeps during the test but this was not recorded.



General Setup of Equipment



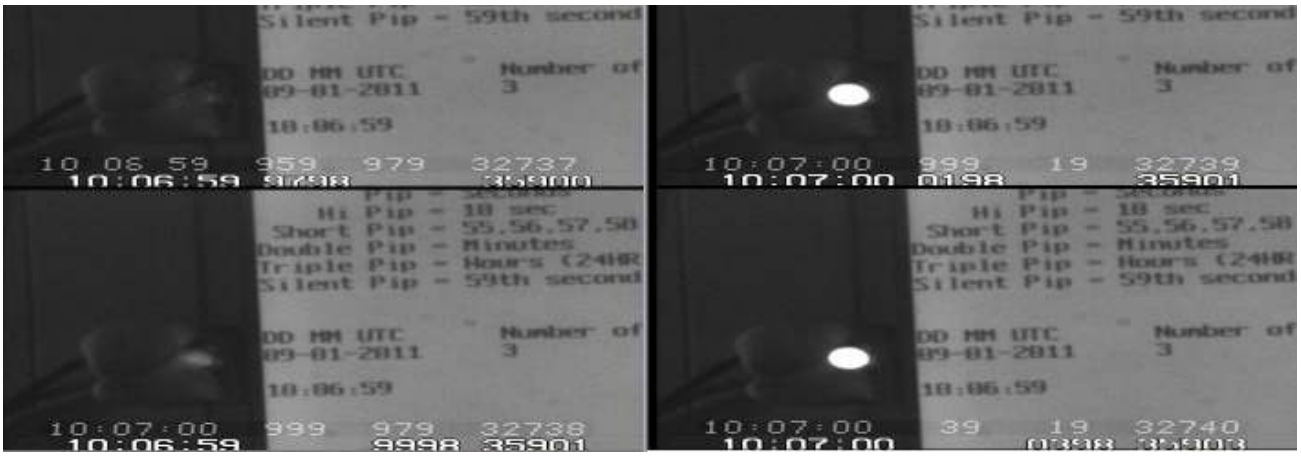
The camera used to record the screen and coded LED of the KIWI-PC is KT&C 350BH. The video made of this test is available on YouTube[9]. Viewers will note that GPS-VTI displays time to 100µseconds. It is interesting to watch the coded LED flashes and the so-called locked millisecond display that seems to be counting backwards. Not that IOTA-VTI can divide the locked milliseconds. This is a symptom of the PAL/CCIR camera with slow frame rate, not quite matching 25.00 frames per second.

The following LiMovie screen shots with the "View Fields" option were made of selected frames to investigate the time stamps in detail.

- The top left pane shows that both VTIs agree on the end time of the video field of 10:05:59.9810 UT and the coded LED is not lit.
- The bottom left pane shows that both VTIs agree that the end time of the field as 15:06:00.0010 UT and shows a dim coded LED flash, indicating a lit exposure duration of about 0.001 seconds.
- The two right fields show the coded LED fully lit and that the LCD screen of the laptop has a delay in excess of 41msec.

This combination of fields indicate that IOTA-VTI can timestamp the end of a video field consistent to the times derived by two other separate GPS systems.

Here is another set of fields for the end of the next minute …

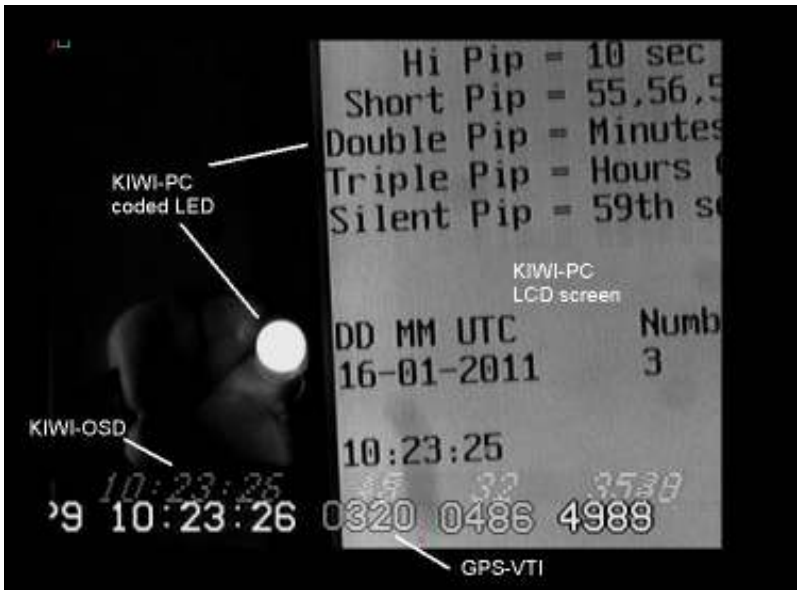


- The top left pane shows a sub-millisecond miss-match in the end time of this field as generated by both VTIs.
- In the bottom left pane, and as far as the 1msec/100µsec displays are concerned, both VTIs agree that the Vsync end time of this field was before the end of the 6th second, however the full seconds display of KIWI-OSD has already ticked over to the 7th second and is inconsistent with the millisecond display. Also the coded LED of KIWI-PC is very dim (but definitely lit) indicating the beginning of the 7th second and judging by the previous image, probably indicates and exposure duration somewhat less than 1msec.

This combination of fields indicates sub-millisecond timing issues that might prompt further investigation, possibly to include a miss-match in the Vsync and the end of the optical exposure timings of the camera.

Test 2 – Compare GPS-VTI to two KIWIs (NTSC/EIA)

Test two is the identical to test one, except the camera used to record the LCD screen and coded LED pulse of KIWI-PC is a NTSC (EIA) type and therefore IOTA-VTI and KIWI-OSD are time stamping video fields at the rate of 59.94 fields per second. The camera is the PC164C.



The arrangement of time displays is similar, except the KIWI-OSD has sloping digits, indicating a NTSC (EIA) frame rate.

Also IOTA-VTI now reports the code P9, meaning; P = 3D fix and 9 = number of satellites in the fix.

This LiMovie view-fields screen shot that shows;

- KIWI-OSD time as 10:23:11.000
- IOTA-VTI time as 10:23:11.0003
- KIWI-PC coded LED is not fully lit, indicating an exposure of about 0.0003 seconds duration.

Here is another set of video fields

- The left panes are before the end of the 29th second and the coded LED is not lit.
- In top right pane both VTIs agree that the time of the Vsync pulse from the camera ended before the end of the 26th second, however the KIWI-PC coded LED is definitely on but is shown very dim and indicates the beginning of the 27th second.

This combination of fields is very similar to the last image shown in Test 1 and it too indicates sub-millisecond timing issues that might prompt further investigation, possibly to include a miss-match in the Vsync and the end of the optical exposure timings of the camera.

Test 3 – rate-of-going after loss of Satellite Fix

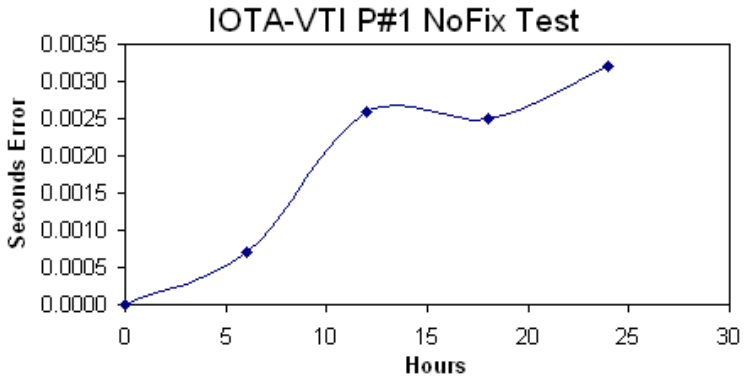
This a 24 hour 'N0' fix test on the accuracy of the EM406A's crystal and hence IOTA-VTI, to gauge how accurate the timestamps might be in the case of loss of fix due to bad satellite geometry, poor site choice, or if all the GPS satellites fall out of the sky at once.

Method;

- to run the video stream from a PAL (CCIR) camera, through KIWI-OSD and then through IOTA-VTI and then to the frame grabber of my observatory PC.
- KIWI-OSD's Garmin GPS had an unobstructed view of the sky at all times through out the test.
- establish a solid P fix with IOTA-VTI for an hour and take the first (0h) sample video grab
- wrap P#1 in aluminium foil and then confirmed that the timer screen showed that "N0" fix was reported. The temperature at local time of 11:45am was 27degreeC
- take video grab samples at 6hr, 12hr, 18hr and 24hours, after confirming that the fix status was still "N0" and I also recorded the temperature
- after the final video grab, I opened the observatory roof and removed the aluminium foil and allowed the GPS to get a fix, which took 6m35s.
- summarise the timestamps and temperature readings in the image shown below

Conclusions;

- IOTA-VTI's total error was 0.0032 seconds fast over the 24 hour period
- The incremental error is described in the accompanying image file
- the ideal temperature to run IOTA-VTI seems to be about 20degreesC
- IOTA-VTI will provide accurate timestamps in the case of the loss of Pfix for periods of at least 2 hours, provided a Pfix is established for at least 15 minutes or after an almanac update message has been reported prior to the loss of the Pfix.



References

1) KIWI-PC http://www.oocities.com/kiwi_36_nz/kiwi/kiwi.htm
2) Dave's timer http://users.tpg.com.au/users/daveg/Sv6.html
3) Gerhard Dangl's Tests http://www.dangl.at/menu_gge.htm
4) Art Lucas' Review http://www.oocities.com/kiwi_36_nz/kiwi/review.htm
5) Menu Options of KIWI-PC http://www.youtube.com/watch?v=9k8FIgTmOfE
6) KIWI-PC in action http://www.youtube.com/watch?v=LTppV1JfXAE
7) PFDsystems http://www.pfdsystems.com/kiwiosd.html
8) KIWIs and 1PPS tests http://www.youtube.com/watch?v=Q0PVNZalu8U
9) Test 1 video http://www.youtube.com/watch?v=J-oXN0MnuoI
10) Test 2 video http://www.youtube.com/watch?v=crgtO-_ypBo

End