

## Data acquisition from S/5 GE Datex anesthesia monitor using VSCapture: An open source.NET/Mono tool

Sir,

Modern anesthesia monitors that are commonly used in operating rooms such as GE Datex S/5 (System 5) series monitor (GE Datex Ohmeda, Helsinki, Finland) allows external data logging through its RS 232 (Recommended standard 232) serial communications port on the monitor. A large set of physiological data can be captured in real time such as invasive or non-invasive arterial blood pressure, ECG, ST segment data, oxygen saturation, end-tidal carbon dioxide, anesthetic agent identification and concentration, temperature, entropy, BIS, EEG. Logging of this data is important for documentation and research purposes.<sup>[1]</sup> Capturing these vital signs can allow for statistical analysis, development of models of anesthetic maintenance and recovery, hemodynamic-respiratory interactions.<sup>[2]</sup> Automated data capture and record-keeping accurately stores events that maybe otherwise omitted in manual data logging.<sup>[3]</sup> These data capture components maybe used to develop anaesthesia information management systems that help in quality assurance.<sup>[4]</sup>

The RS 232 communication port maybe identified through its standard male 9 pin D-shaped connector on the backend of the GE Datex S/5 monitor. The user may refer to the user manual for confirmation. Physiological data is sent from the monitor on request through this port, at a time interval of 5 seconds or greater, by a valid binary data-frame request constructed by client software with checksum verification of both sent and received bytes. These frames are transmitted in 8-bit binary format using hardware handshaking.

We describe an open source tool *VSCapture* developed in C# programming language on the .NET/Mono platform that allows the tool to run on Windows, Macintosh OS X, Linux Ubuntu operating systems. Unlike commercial

solutions that cost several thousands of dollars and maybe available only for limited operating systems, this tool can be freely downloaded and installed from its project page <https://sourceforge.net/projects/vscapture/>. The program requires the *.NET 4 runtime* that maybe downloaded and installed on Windows operating system from the Microsoft download page <http://www.microsoft.com/en-us/download/details.aspx?id=17718>. Running the program on Linux or Macintosh OS X requires a Mono version of *VSCapture* that can be installed from the project website, also required is a Mono runtime from <http://www.go-mono.com/mono-downloads/download.html> (Xamarin Inc, USA). The capture of data is based on an event-triggering programming paradigm at the serial port.

Hardware requirements for interfacing a PC with the anaesthesia monitor, includes a serial port and a standard null modem serial cable. Most modern laptop computers do not have this RS 232 serial port. However, inexpensive converter cables that plug into the Universal Serial Bus (USB) port of the laptop and provide a serial port conversion are commercially available, such as Future Technology Devices International (FTDI limited, UK) or PL2303 (Prolific Technology Inc., Taiwan) chip-based USB-serial cables. In addition, an inexpensive standard *null modem* serial 9 pin D-shaped female-female cable is required to connect the serial port of the PC to the serial port of the monitor. After the software is opened, the cables can be connected, the user is then prompted to select the port to which the cable has been assigned. In Windows operating system, looking up the hardware *Device Manager* can reveal the COM port number. In Linux and Macintosh OS X operating systems, the name can be obtained from the list of available ports shown by the software such as `/dev/ttyUSB0` or driver specific names. The next step involves entering a 5 second or greater data transmission interval in the software. Subsequently, data is captured to the console screen in real-time and in a larger subset to a CSV (comma separated value) file called

```
VitalSignsCapture (C)2012 John George K.
Select the Port to which Datex AS3 Monitor is to be connected, Available Ports:
COM3
COM4
COM1
COM2
COM port(COM1):
You may now connect the serial cable to the Datex AS3 Monitor
Press Enter to continue

Enter Transmission interval (seconds):
Requesting 5 second Transmission from monitor

Data will be written to CSV file AS3ExportData.csv in same folder
Press Escape button to Stop

Time:16-05-2012 17:03:27
ECG HR 99/min NIBP 147/69(99)mmHg SpO2 96% ETCO2 0mmHg
IBP1 -/-( )mmHg IBP2 -/-( )mmHg MAC 0 T1 -°C T2 -°C
ST I1 1.74mm ST U5 0.42mm ST aUL -0.28mm

Time:16-05-2012 17:03:32
ECG HR 101/min NIBP 147/69(99)mmHg SpO2 96% ETCO2 0mmHg
IBP1 -/-( )mmHg IBP2 -/-( )mmHg MAC 0 T1 -°C T2 -°C
ST I1 1.13mm ST U5 0.72mm ST aUL -0.2mm

Time:16-05-2012 17:03:37
ECG HR 102/min NIBP 147/69(99)mmHg SpO2 96% ETCO2 0mmHg
IBP1 -/-( )mmHg IBP2 -/-( )mmHg MAC 0 T1 -°C T2 -°C
```

Figure 1: *VSCapture* software capturing physiological data in real time on the Windows operating system

"AS3ExportData.csv". This is captured to the same folder as the program [Figure 1]. This file may be directly opened in spreadsheet software such as *Microsoft Excel* for statistical analysis or archiving, after the program has terminated (using the *Escape* key on the keyboard).

The software presented above may be used by anesthesiologists involved in research, to capture anaesthetic data from the GE Datex S/5 series monitor with minimal initial expense and hardware requirements. Future efforts from open source developers could involve the development of a graphical user interface, adding graphical data analysis tools in the software.

### John George Karippacheril, Tam Yuk Ho<sup>1</sup>

Department of Anaesthesiology, Kasturba Medical College Manipal, Manipal University, Manipal, Karnataka, India, <sup>1</sup>Department of Anaesthesia and Intensive Care, Chinese University of Hong Kong, Hong Kong

**Address for correspondence:** Dr. John George Karippacheril, Department of Anaesthesiology, Kasturba Medical College Manipal, Manipal University, Manipal, Karnataka, India.  
E-mail: johngeorgedon@gmail.com

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