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# Mobile, Wireless, Multi-Camera Audiovisual Solution For Simulation: A Novel Application Of Existing Technology

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**Abstract**

Introduction

Video capture is used in simulation for the purpose of video-assisted debriefing, assessment or multiple research applications. Each application has its own requirements and selection of an audiovisual (AV) solution must be based on consideration of the location of the proposed system, personnel available, purpose(s) of the system and available budget.

Methods

We reviewed several commercially available AV systems for our mobile in-situ simulation program. We then found an alternative whereby we used existing technology from the field of extreme sports video to create a novel ultraportable set-up for healthcare simulation video capture.

Results

Wireless, high-definition video cameras are positioned around our in-situ simulation environments. They are controlled remotely via Wi-Fi to capture several points of view simultaneously. They are then integrated into a single media file where the four feeds may be viewed contemporaneously using any media viewing software.

Conclusion

We have created an AV solution that emulates the principal features of a commercially available system at a fraction of the cost.

## INTRODUCTION

When designing a simulation program, consideration must be given to the audiovisual (AV) solutions. Video capture is widely used during high-fidelity patient simulation but can also be applied to low-fidelity simulation or part-task training1. We know that reviewing video of high-stakes situations is associated with improved clinical performance2 although this has not consistently been shown to be superior to oral debriefing without video playback3. Detailed video may be captured for the purposes of assessment, where an expert rater can score performance after the event4-6. Education research methodology often involves video-recording simulated events that may then be analyzed in line with the objective of the study.

There are many factors which dictate the suitability of an AV solution for medical simulation activities. Firstly, the location: whether the system will be a static, hard-wired solution integrated into the infrastructure at a given location (e.g. simulation centre) or a portable set-up for mobile in-situ simulation. For the location-anchored solution, wall or ceiling-mounted camera angles and zoom may be controlled and mobile trolley or boom cameras positioned but the set-up cannot be used beyond the confines of the premises at which it is installed. For a mobile solution, portability is paramount whilst complex functionality might be sacrificed. Placement and angle of cameras must be versatile, adjustable and ideally wireless to reduce clutter.

The second factor regards personnel – the number of educators, their ability to manage technical issues and the availability of technical support staff. In the context of a simulation center, there are often full time technicians who are responsible for operating and troubleshooting audiovisual systems. The task can be more complex and can take advantage of the multiple features of a sophisticated, commercially available AV system because this member of the team can focus their attention on it. If a simulation center does not have full time technical support or cannot provide an outreach technician for in-situ simulation sessions then occasionally a sole clinician-educator will be responsible for facilitating the session, operating the mannequin, noting points for debriefing, conducting the debrief and operating the audiovisual system. Not only is this a cognitive load that strains their ability to excel at any one of these tasks, but it virtually eliminates the chance to take full advantage of the functionality of an advanced system. Furthermore, advanced AV technical ability is not a universal characteristic of simulation educators such that some excellent facilitators are not in a position to operate a sophisticated AV system. Thirdly, we must consider the intended purpose of the AV system. The video playback requirement may be considered in two categories: immediate real-time playback for observing/debriefing and detailed retrospective review at a later date. For purposes of debriefing, periods of playback should be brief to illustrate a specific point or stimulate reflection and discussion. It must be used judiciously lest it distract from the process of reflection, analysis and discussion.7 It is not imperative that the same AV system fulfil both needs. Immediate real-time playback can be a simple system without enormous data burden. The detailed capture can be done with an equally simple but high-definition system that generates large files (in the order of gigabytes) that although cumbersome for immediate playback are ideal for manipulation and review later.

For research, detailed retrospective analysis is required. The goal is usually to produce a single file composite video that can be viewed in a regular media-playing program (e.g. Windows Media Player® or Apple Quicktime®). Otherwise video raters, who may be at a different institution, are obliged to install specialist software to view simultaneously the several videos of each scenario. Creating a single media file requires time-matched integration of multiple video files into a single file which shows (for example) a two-by-two grid with four contemporaneous feeds (e.g. the patient monitor and three camera angles of the scenario playing out). This can be achieved with a commercially available hardware/software combination (see below) or the employment of a professional audiovisual technician to design and construct a custom solution.1,8 Alternatively, it can be accomplished with the solution described here.

Finally the cost of the system is a major consideration. Tighter budgets may preclude investment in a commercial AV system that costs tens of thousands of dollars. Similar results may be produced at a fraction of the cost. If the extended functionality of a more costly system is never going to be exploited then the cheaper option should be considered.

## METHODS

Our institution has a well-established simulation program that comprises an on-site simulation center, three satellite simulation suites around the hospital and an outreach/in-situ simulation program. The central simulation center has recently upgraded to a commercially available AV solution but we were investigating solutions that would fulfil the needs of our satellite areas and in-situ program. We use video-debriefing and collect video data for research. Our previous solution was custom designed and built by our audio-visual technicians similar to systems described in the literature.8

We reviewed several commercial systems for suitability (SimView (Laerdal Medical, Stavanger, Norway), Studiocode (Studiocode Business Group, Sydney, Australia), LearningSpace (CAE Healthcare, Montreal, QC, Canada), SMOTS (Scotia UK plc, Edinburgh, UK) and SimCapture (B-line Medical, LCC, Washington, DC, USA)). The investigation involved online review, live demonstrations (e.g. at conferences and other simulation centres) and liaison with sales representatives. Each system has merit albeit that the degree of portability varies.

We looked further afield to discover our final solution. GoPro® (Woodman Labs Inc, Half Moon Bay, CA, USA) produces compact, high-definition, wireless digital cameras for use in extreme sports. They are Wi-Fi enabled, such that they are discoverable on a specified network. They may be controlled by a Wi-Fi remote (the size of a key fob) or their images viewed and functions controlled via an app for a tablet or smartphone. They run on a rechargeable battery that will last for approximately three hours of continuous use and may be changed for a fresh battery if exhausted.

## RESULTS

The GoPro mounting accessories allow versatile placement of cameras around the in-situ simulation environment (figure 1). We adapted an operating room light handle and a surgeon's head light to affix our cameras (figure 1B and 1D). The mounting accessory designed for use on bicycle handlebars or seat post works well on an intravenous (IV) pole (figure 1C). A variation on the IV pole solution has been previously described.9

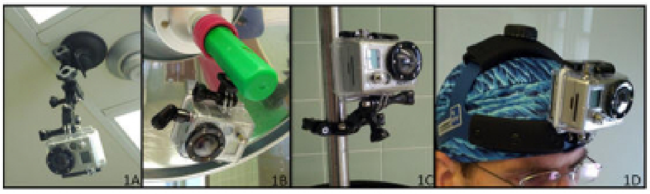
We adjust the camera angles for optimum field of view by wirelessly viewing what they are capturing (in real-time) via the Wi-Fi link to our tablet or smartphone. We found configuring the Wi-Fi link between the cameras and the remote control or the smartphone App to be intuitive and straightforward. We position cameras such that one is focused on the patient monitor, one takes a wide-angle bird's eye view (e.g. attached to the ceiling) and one is at head level near the end of the patient bed. A facilitator may operate a fourth hand-held or head-mounted camera if they choose. For optimum audio capture, we modified the camera casing to accommodate a miniature external microphone (visible in figure 1B). Although the internal microphones of the cameras are adequate, we found this alternative gave crisper audio. Once the cameras are correctly positioned, we activate recording with the Wi-Fi remote. The same remote stops recording of all cameras simultaneously. The advantage of this is that recording is started and stopped in all the cameras at exactly the same point in time. This is important later when integrating the videos into a single file. For the purposes of video debrief, a useful feature of the GoPro app will be the playback of stored footage function allowing us to view the scenario on a tablet or smartphone. We acknowledge this will lack the advanced review features of the commercial systems (e.g. tagging, coding, 'skip-to' etc). As an alternative, we use Laerdal Debrief Viewer® (Laerdal Medical, Stavanger, Norway) when using the Laerdal products. The only requirement for this is a webcam attached to the laptop controlling the mannequin. We then view the recorded scenario by projecting from that laptop (whilst still in the simulation environment) or we transfer the debrief file (on a USB drive) to be viewed onto a separate laptop (± projector) in a dedicated debrief area. Debrief Viewer uses compressed video and small file sizes such that rapid replay and review is reliable.

Following the simulation session the four video files need time-matched integration into one movie file. Most entry-level movie editing software allows picture-in-picture. We use Sony Movie Studio Platinum version 12 (Sony Creative Software Inc, Middleton, WI, USA). This was installed on an existing personal computer (i.e. did not require the purchase of a separate desktop/laptop). We create a two-by-two picture-in-picture grid and simply import the four videos into the respective windows. Time-matching is automatic as all the files start at the same point in time and are of the same duration. The high-definition capture means that the patient's vital signs are visible on the monitor at all times. The finished movie is then rendered into a single (.mp4) movie file. The size of that file can be manipulated by specifying the compression rate prior to rendering. These finished movie files are more than adequate for our research purposes.

The total cost for cameras, mounting accessories plus the movie editing software was CAD 1567.84.

**Figure 1**

Camera locations during our in-situ simulation sessions. 1A ceiling mounted. 1B operating light handle mounted (with aftermarket external microphone adaptation). 1C intravenous pole mounted. 1D head mounted (adaptation of surgeon's headlight).




## CONCLUSIONS

We have constructed a cost-effective AV solution capable of emulating the essential features of a commercially available system at a fraction of the cost. Our solution has the added advantage of being significantly more portable. We recognize that the features necessary for immediate playback and debrief are not the same as for detailed retrospective review. Deriving the finished movie file as described is no more labour intensive than exporting similar files from the commercial solutions.

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## FINANCIAL DISCLOSURE SUMMARY

Neither of the authors have any conflict of interest, commercial sponsorship or financial disclosures to declare.

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