edus^2 TM

Emergency Department Ultrasound Simulator

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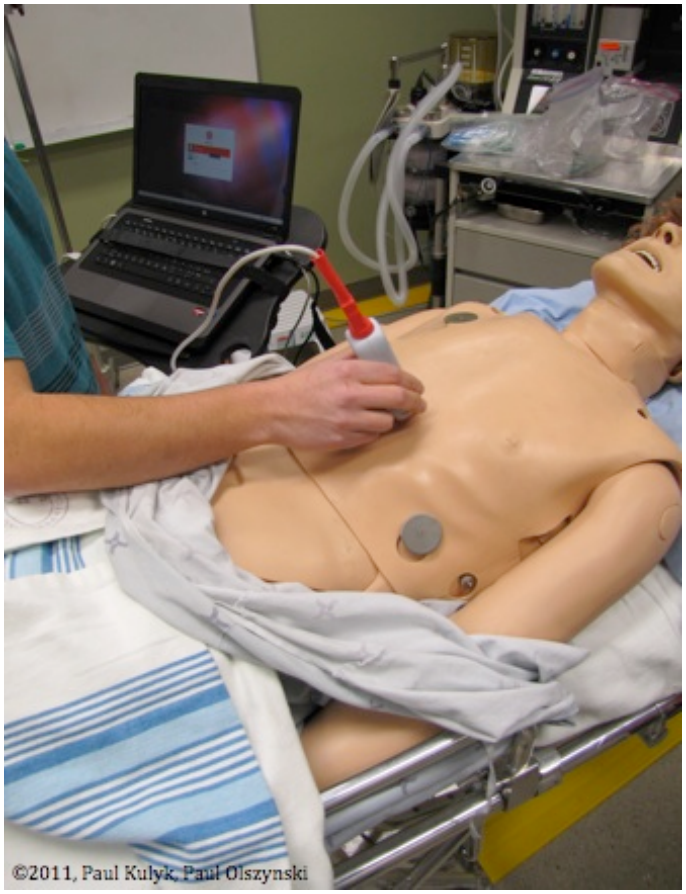
Project Summary

The **e**mergency **d**epartment **u**ltra**s**ound **s**imulator (**edus^2**) is a portable bedside ultrasound device that allows for the seamless integration of Emergency Department Ultrasound (EDUS) into high fidelity simulation scenarios (HFS). Competence in bedside ultrasound requires 3 components: awareness of indications, mastery of image generation and sound image interpretation. These components are commonly gained through course attendance & reading, scanning of largely healthy volunteers, and video review respectively. However, the application of indications and interpretation of positive and negative findings in the setting of a critically ill patient is much less common. Trainees using the **edus^2** have the opportunity to learn the indications of bedside ultrasound while learning proper image generation technique and image interpretation all within the context of an HFS scenario.

The **edus^2** plays predetermined video clips of areas of interest through the coupling of those videos to specific Radio Frequency Identification Device (RFID) cards placed under the skin of an existing HFS mannequin. A USB based RFID scanner is hidden inside a hollowed low frequency US probe. Passing the US probe over a RFID card in the mannequin initiates video clips on **edus^2** specific to the anatomic area on the HFS mannequin. Multiple scans are possible during any given scenario including thoracic, cardiac, abdominal and pelvic. To our knowledge, this is the first such EDUS simulator that allows for actual use of a probe on any available manufactured HFS mannequin resulting in seamless incorporation of EDUS into all HFS scenarios.

Background

Many of the critical illness scenarios addressed in the emergency department merit assessment with Emergency Department Ultrasound (EDUS). The utility of EDUS is well illustrated by the following examples of patients presenting with unexplained hypotension: a pregnant woman, an older patient with back pain or a patient with severe shortness of breath and pleurisy. In the above, assessments for ectopic pregnancy, ruptured abdominal aortic aneurysm, and massive pulmonary embolism respectively are enhanced by the use of EDUS and represent official indications for its use. The incorporation of **edus**^{2} in High Fidelity Simulation (HFS) provides trainees an opportunity to use EDUS in real time during various scenarios and thus increases the fidelity of the simulated scenario. By giving the trainee realistic access to an important and established diagnostic aid in modern emergency care, EDUS in HFS also highlights indications for use of EDUS in emergency care.



The role and benefits of simulation in healthcare professional training is well established. A review of the current literature shows promise for this new educational tool. We identified already existing integration of EDUS into HFS through the use of a simple laptop and pre-recorded de-indentified videos by Kobayashi and colleagues[i]. Furthermore, Girzadas and colleagues recently investigated the benefits of a pelvic ultrasound task trainer/HFS scenario hybrid on trainee skill and knowledge assessment.[ii] Commercial products that include dedicated non-HFS mannequins and ultrasound trainers are available but given their limited applicability in high fidelity simulation and significant cost we elected to develop a novel EDUS simulator (**edus^2**) for use in practically all types of HFS suites.

Methods

We have designed an EDUS simulator that plays predetermined video clips of areas of interest through the coupling of those videos to specific RFID cards placed under the skin of an existing HFS mannequin. We use a USB based RFID scanner hidden inside a gutted low frequency probe as a simulated probe to offer learners a realistic integration of the **edus^2** into the HFS suite. To our knowledge, this is the first such EDUS simulator that allows for actual use of a probe on any available manufactured HFS mannequin resulting in seamless incorporation of EDUS into all HFS scenarios.

Video Library

All videos for this project were generated with consent from real patients or student volunteers. Videos we generated and saved using a Sonosite M-Turbo with the following probes: low frequency curvilinear, mid frequency phased array, high frequency linear, and endo-cavitary high frequency probe. Video length was determined depending on the type of scan and range from 15 to 60 seconds.

Hardware

The hardware for this system was kept at a minimum and consists of a single USB-based RFID scanner with associated cable, a laptop, and one RFID card for every scan video added to the system. No custom parts were necessary (though encasing the RFID scanner in an actual ultrasound probe shell adds realism). The design uses one RFID card per specific scan video thus allowing preceptors to easily swap cards as desired for a given scenario. Once a given scan has been added to the system one must simply open the program and scan the tag to see the desired video.

The RFID scanner is an Olimex MOD-RFID125 that has been configured as a keyboard human interface device. As such, scanning the tag is equivalent to typing in the tag ID at the keyboard and pressing enter. This simplified the project further and allowed easy cross platform development by removing the need for operating system-specific serial drivers.

Software Design

This project utilizes several open source tools with simple application programming interfaces (APIs) enabling interconnection. The project is written in Python. GTK and glade provide the graphical user interface. MPlayer is used to play the video via the X11 interface. Additionally, the PyMPlayer module is used to call MPlayer from within a python script. Any operating system could be used provided it can run X11 and has MPlayer built specifically with support for this. It was originally developed using Mac OS X 10.6-7 and the fully working prototype was implemented using Ubuntu Linux 11.04.

Simulated Probe

The probe was designed with realism in mind. Given the lengths we have gone to in hopes of offering increased fidelity in simulation as well as addressing some aspects of image generation it was felt that the probe should look and feel real to the trainee. We therefore acquired a broken probe from Sonosite and removed its contents leaving only the outer shell. We then modified our RFID scanner to fit into the probe housing. The USB connector was de-soldered from the scanner and the USB cable was cut and soldered directly to the board. The probe fit nicely into the housing, hot glue was all that was necessary to stop it from sliding side to side. Heat shrink was then added to fix the cable in place.

Integration into Simulation

The Department of emergency medicine at the University of Saskatchewan regularly employs high fidelity simulation (HFS) to enhance training in both undergraduate and postgraduate education in critical care medicine. Our HFS suite is located within the Clinical Learning Resource Centre of the Health Sciences Building at the U of S. Our suite uses Laerdal's Sim Man, Sim Man 3G, and Sim Baby.

Simulation sessions are scheduled biweekly for all clerkship trainees during which time attendance from all off service residents as well as EM residents on service is also mandatory. We also run EM Mega Sims for our EM residents quarterly. Simulation scenarios are essentially divided by primary problem type (airway, breathing, circulation and disability) with advanced scenarios showing increased complexity with several concurrent management challenges. Until the development of the EDUS2, any bedside ultrasound information would be either shown via printed image or laptop or through overhead announcement when asked for by he trainee.

With the development of the **edus^2**, all scenarios are now enhanced by the placement of appropriate Radio Frequency Identification Devices (RFIDs) prior to commencement of the simulated case. As such, trainees need not be cued to use bedside ultrasound during their case and instead are simply aware that the option to use it is always available to them.

Placement of RFIDs

Both of our adult mannequins have removable skin sections. As such, we have found it very easy to slide the desired RFIDs under their plastic skin and into the proper anatomical locations.* This approach allows for an assessment (albeit limited) of trainee skills given that image generation starts with proper probe handling and knowledge of the anatomical landmarks for a specific scan.

These include:

- Cardiac: sub-xyphoid, apical 4 chamber
- Thoracic: hemothorax and pleural effusion
- Abdominal: abdominal aorta, hepato-renal and spleno-renal interfaces, kidneys

(hydronephrosis), bladder, & uterine scans.

*For all other scans we have used coin-sized RFIDs and taped them onto the surface of the mannequin using skin colored tape. These include scans for pneumothorax, sternal fractures, cardiac parasternal long view and IVC assessments.

Feedback from Trainees

We trialed the **edus^2** during high fidelity simulation sessions attended by residents of our CCFP and FRCP EM programs. The various scenarios included both pertinent positive and negative scans. Feedback from the trainees included the following themes:

Theme 1. Opportunity to integrate EDUS scans into the assessment of patients

> "…you have to make the decision: Do you need it? Is it important to use it now? When do you use it?"
>
> "I feel this re-enforces it (use of ultrasound) for me."
>
> "I think the greatest value will be as we start incorporating scans into everyday scenarios… I do have that (EDUS) as a tool that I can use… Sometimes positive, sometimes not, but its going to get incorporated into what we do and how we approach things…that's how I think (it) will affect clinical practice. "

Theme 2. Valuable image interpretation

> "… before we would ask for ultrasound and the voice of (sim) god came over and announced "the abdominal aorta is 8 cm". Whereas now I had to look… and look at hash marks and landmarks and make sure of what I was seeing…"
>
> "In my case, I liked that you gave me all these normals… because I'm expecting to find an abnormal… and (instead) I was finding that this was normal, that was normal, so having to declare it normal… it forces me to be sure (about my image interpretation)."
>
> "It's also nice for when we're on non-ED rotations… we see x-rays but we don't see bedside ultrasound so it's a good refresher."

Theme 3. Offers some basic image generation practice

> "The land-marking thing was huge for me. I haven't touched a probe since doing the (EDE) course… here I was stabbing with the probe to get the RFID to read because I just simply hadn't landmarked."

Other comments

> "It was fantastic!"
> "Looks real, feels real, its slick."

Dissemination

It is our belief that the **edus^2** will prove helpful in critical care medical education. As such, we have decided to make this educational innovation available to other training institutions on a not-for-profit basis. In hopes of achieving greater collaboration we have designed a website (www.edus2.com) at which other departments and programs can access all software and instructions required to run an EDUS^2 at their own site while also being able to offer feedback and add to the video library. New users will simply need to download the software code and accompanying videos for use in their own institution. Additionally, each site is responsible for supplying its own laptop, USB based RFID scanner, RFIDs and machine stand (estimated cost of $600). We encourage other institutions to fashion probes similar to our own to ensure the highest possible degree of fidelity.

Instructions for assembly are outlined within this document (see Methods and Integration into Simulation) as well on the website. We have also included a short video detailing use within a high fidelity simulation suite.

About the Designers

Paul Kulyk, B.Eng., B.Sc. (3-year) is a third-year medical student at the University of Saskatchewan. He has several years of research and development experience in the telecommunications industry. His interests include emergency medicine and technology integration in medical education.

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Citations

[i] Kobayashi L , Shapiro M, Nagdev A, Gibbs F, Emergency Medicine Ultrasound Simulation (U/SS) Case Scenario Package. MedEdPORTAL; Available from: www.mededportal.org ID 531

[ii] Girzadas Jr. D. V.et al. *Hybrid Simulation Combining a High Fidelity Scenario with a Pelvic Ultrasound Task Trainer Enhances the Training and Evaluation of Endovaginal Ultrasound Skills*. Academic Emergency Medciine (2009). doi : 10. 1111/ j . 1553- 2712. 2009. 00399. X