A Micro-Computer Based Tactical Combat Casualty Care Trainer

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Abstract—Tactical Combat Casualty Care (TCCC) is a mission critical procedure necessary to saving lives on the battlefield. Trainers used in combat simulations need to be realistic. This research designed and integrated a micro-controller based TCCC module to a training mannequin, a module that reliably emulates battlefield conditions. The training mannequin and module mimics the vital signs of the human casualty, including bleeding wounds. This system is designed to allow new simulated symptom designs to be integrated into the platform with minimal hardware and software upgrades.

Index Terms—combat casualty care, micro-controller, tactical trainer, vital signs

I. INTRODUCTION

In a combat situation, and in a mass civilian shooting, it is a scenario that is one full of casualties; a medic has to make time critical choices on who can be saved and who cannot. Thus, the medic must have a level of real life experience to make an instinctual judgement. Having a level of experience is the critical factor in saving a casualty; as ninety percent of combat casualties die before making it to a properly equipped medical facility, see Weiss [4]. Weiss claims that 15 - 20 percent of such deaths are probably preventable, because they come from causes like bleeding extremities, collapsing lungs and airway obstructions [4]. Therefore, better training needs to be implemented. For over a decade trainees have been trained on computers and simulations of casualty situations [2]. These simulators help to identify where the trainee went wrong. For instance, a collapsed airway causes the simulator to "kill" the victim within minutes providing instant feedback to both the evaluator and the trainee [2]. Therefore simulators are useful tools for getting a taste of a real-world situation, but they are still far removed from reality. More recent training programs encompass all of the simulations, using computer aided training and finishing up the course by operating on a live animal [1]. More often than not this is many trainee medics one and only attempt at operating on a living being before deployment [1]. Still, there are effective techniques employed today that save lives. This training is vital to effectively control traumatic hemorrhages due to amputations at the pelvic or pectoral girdle from Improvised Explosive Devices (IEDs) and/or penetrating trauma in these regions [3]. The goal of the research was to develop a realistic training mannequin, along with its associated graphical interactive user interface (GUI) to aid in the training of combat medics.

II. HUMAN ANALOG TRAINERS

Task Trainers designed for Trauma Combat Casualty Care (TCCC) must have the capacity to perform as a tissue analogue of human tissue with appropriate anatomical features required for TCCC medicine. They must accurately mimic the look and feel of live patients and create a learning platform that provides more frequent and greater access for enhanced TCCC training when compared with live tissue models. In addition, the trainer should have a high capacity for versatility by the easy adaptation of the learning platform to meet the needs of various trauma training scenarios. This will be accomplished through very rapid changes of limb or head and neck injury components, including: (1) managing hemorrhage control, (2) wound packing, (3) managing airway and respiration problems and provide fluid resuscitation. For these reasons and more, co-author Dr. Jim Johnson

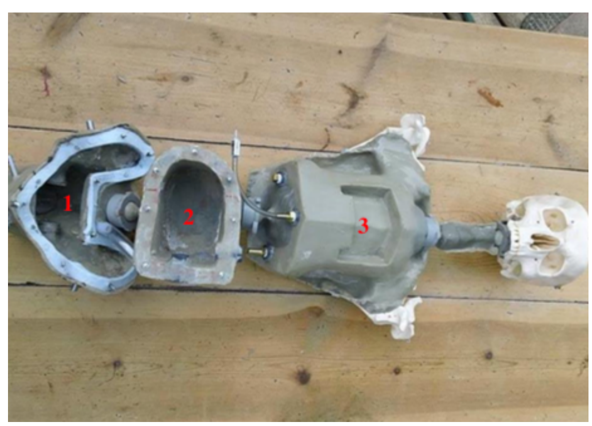

Figure 1 A TCCC mannequin, (1) electronic control compartment, (2) blood pumping housing, (3) blood reservoir

and colleagues, created a mannequin TCCC trainer that provided an optimal model for learning and practicing hemorrhage control procedures, see Figure 1. Bleeding was made variable and remotely radio controlled from selectable sites of hemorrhage. Bleeding from junctional hemorrhages, amputations as well as penetrating trauma at various sites in the upper and lower limbs were capable of being appropriately managed. But the mannequin hardware and software proved unreliable.

III. NEW TRAINER HARDWARE AND SOFTWARE

New hardware and software controllers were developed to overcome the TCCC mannequin 's reliability issues without affecting the mannequin's realistic features in any way. Therefore the mannequin must, (1) operate continuously without fault, (2) fit into the original electronic control compartment (Figure 1), (3) operate all the mannequin actuators (Figure 2), (4) have a friendly interactive user interface (Figure 3). A Raspberry Pi handled the communication between the user and the mannequin and saved all current state information. The Raspberry Pi was effective for prototyping and problem solving. Using this configuration in Figure 2, the user could open any WiFi enabled device and a browser webpage and control the mannequin. Furthermore, a database holding all current states of the vital signs on the mannequin would be stored on the Raspberry Pi. This setup reduced the communication between the user and the mannequin to only updating the mannequin's vital signs. The only time the user sends a signal to the Raspberry Pi is when the user requests a change in the mannequin's state, e.g., the heart rate. An Arduino Mega fitted this project because it had sufficient I/O pins, pulse width modulation (PWM) controlled outputs; to control the two linear actuators of the lungs, dc motors for the wound(s), and four servos for the pulse points. Furthermore, programming the Arduino uses the common C language and has many available predefined libraries and functions that simplified the process of controlling the vital signs. The user interface was designed to be user friendly. It is designed as a webpage with a simplistic outline of a body, Figure 3. The user clicks locations on the body to update the vital signs associated with that region on the mannequin. Text boxes and radio buttons are used to accept user input and to change the vital signs on the mannequin [5].

IV. CONCLUSIONS

After feedback and tests it was determined that the realistic nature of a TCCC mannequin comes from the controls of breathing, pulse, and bleeding as well as the look and feel of its skin. The additional measures to accurately shape the internal bone structure through casts and molds would increases complexity and does not add to the realistic nature of the scenario as performed on TCCC mannequins.

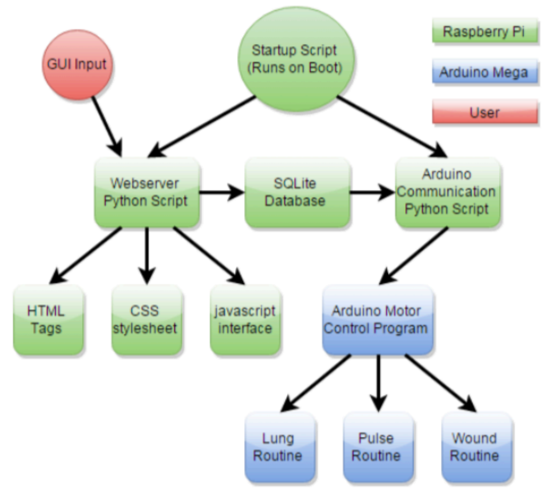

Figure 2 The hardware and software control architecture

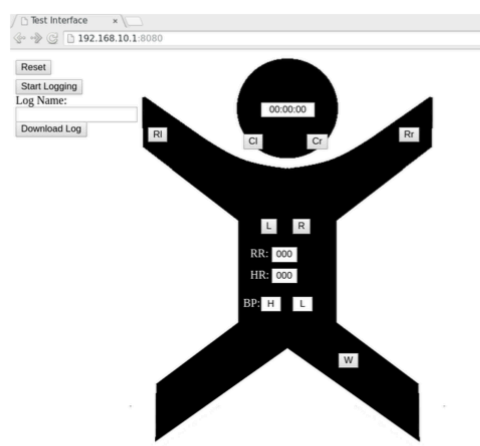

Figure 3 The interactive user interface showing vital signs

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