Combat Casualty Identification and Assessment System (CCIA System)

DII Internally Funded Project, January, 2017

Introduction

Application of unmanned/robotic technologies has the potential to perform timely extraction of casualties in man-denied environments and reduce the risk of injury to medics and other personnel during casualty extraction attempts in high threat areas. Current robotic systems are prohibitively slow and rely heavily on tele-operation. For autonomous robotic systems to be utilized effectively for casualty extraction missions, the perception system must locate a casualty and then assess care requirements. Such a sensor system would also be valuable in civilian applications including casualty rescue in fire-fighting, terrorist incidents or in hospital patient care.

In the initial phase of this project, DII is:

- Evaluating Candidate Components for a Prototype CCIA System
- Demonstrating Pose Sensor and Pose Analysis Using Existing Hardware
- Developing an Integrated Prototype Design

CCIA Mission Requirements

Design of the CCIA System must rest on a firm definition of the casualty identification and care requirements. And the requirements are best understood in the context of the specific tasks that must be performed in the mission. Figure 1 below shows the relationship of these tasks.

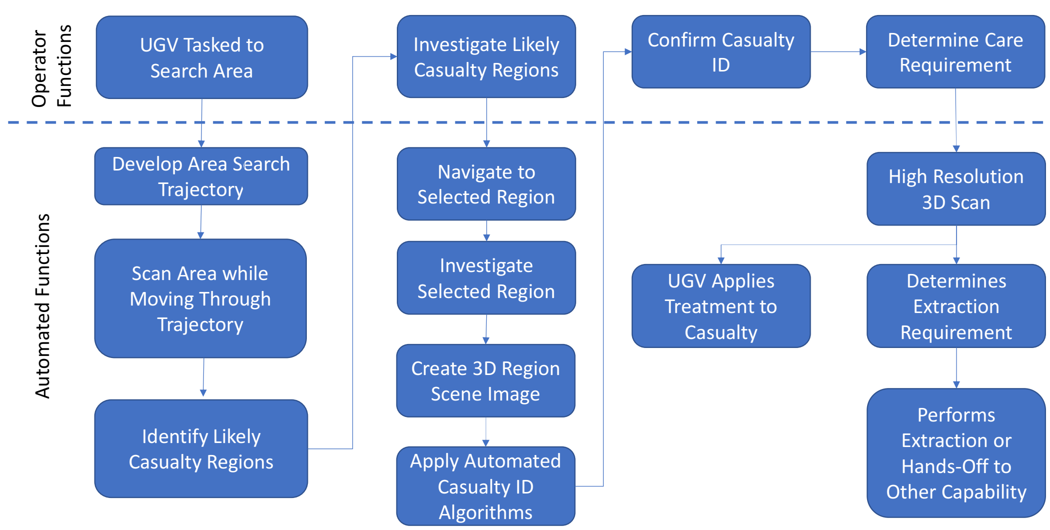


Figure 1. Tasks Requirements for Casualty Identification and Care

As illustrated, the Mission can be divided into three sets of tasks:

- Search area to localize any regions with likely casualties
- Intensively investigate those regions and identify specific casualties present

- Care requirements assessment and apply care (treatment or extraction) of identified casualties

While each of these mission task sets impose specific requirements on the CCIA System, DII's project's focus is on the last set, Casualty Care including assessment, treatment and extraction of the casualty.

Casualty Assessment and Care

In the Care Mode, the UGV will approach within a few feet of the casualty. This will allow communication with the casualty by the operator, if the casualty is conscious. It will also allow the UGV to perform a high-resolution scan of the casualty. The scan will use the 3D and 2D cameras of the CCIA System to obtain a 3D image of the casualty. This 3D image will have two functions, it can be relayed to the teleoperator for diagnosis and it will be automatically analyzed by the UGV.

The primary goal of the automated analysis will be to determine the "pose" of the casualty's body. Here pose is defined as the determination of the position of all the casualty's body components and any attached equipment (e.g. backpack, helmet, etc.). The pose will be analyzed using a parametric model of the human body and attached equipment to the 3D measured image to the casualty. The fitting will include both the 3D data and the 2D textures included in the measurement to provide the best fit.

Once the model pose has been matched to the casualty, it can be analyzed for structure. For example: does the pose indicate that the casualty has displaced or broken bones? Are limbs missing? Is there equipment on the body that would make extraction difficult? What is the weight and center of gravity of the casualty? Are there obstructions on or near the body that would need to be moved to extract the casualty?

Once this detailed imaging and pose analysis has been performed, the UGV would report the results to the teleoperator. Depending on the situation, the operator could decide to provide care of the casualty in place or initiate an extraction operation.

To provide care-in-place, the UGV might have on-board basic supplies, such as water, bandages, antiseptics, pain killers, etc., that could be applied by the UGV or given the casualty, if conscious, for his use. Or given the situation, a medic might be directed to the casualty for immediate triage care.

If the chosen course is casualty extraction, the UGV present at the scene or another UGV might be directed to perform the extraction operation. In either case, the 3D imagery and the matched pose model would provide the information to plan and execute the extraction operation. The estimated weight, size and weight distribution of the casualty would determine if a specific UGV could safely extract the casualty. This information would be useful whether the extraction is totally automated or is controlled by the teleoperator.

CCIA System Component Selection

The imaging-related task requirements can be related to performance specifications of the components that must be included in the CCIA System. We are exploring a multi-mode sensor system design for the Care task, consisting of a short-range 3D laser scanner, and co-bore sighted thermal infrared and visible cameras. Figure 2 shows pictures of some candidate sensors.

Figure 2. 3D Scanner, Visible Camera, Thermal Camera and LIDAR Candidate Sensors for CCIA System

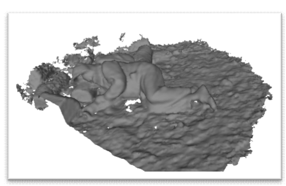
(Shown approximately at approximately two-thirds of real size)

Care Task Sensing Demonstration

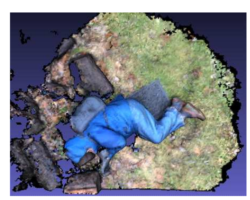
As discussed above in the Care Task, the CCIA System will first perform a high-resolution scan of the casualty. The scan will use the 3D and 2D cameras of the CCIA System to obtain a fused 3D-2D image of the casualty. The goals of the Care Task would be analysis of that information.

Figure 3 below, shows examples of 3D image obtained by DII with one candidate 3D sensor. This data was obtained in approximately 30 seconds, while hand-holding the sensor approximately 6-feet from the casualty, and moving around one side of the casualty. This has created a true 3D model of the casualty, including textures obtained from the bore-sighted visible camera. The model is stored in a standard format ".obj" file and the textures are stored in a ".jpg" file. The first two images show the visible image and a shaded mesh image created from the 3D points measured with the 3D sensor. The other four images are created by virtual movement of the view point of the scene using the 3D viewer application.

Visible Photo

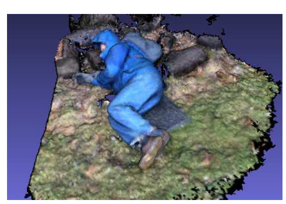


3D Mesh

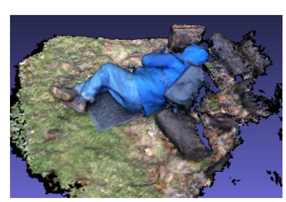


3D Top View

3D Left Side View



3D End View



3D Right Side View

Figure 3. Scanned 3D Image of Casualty on the Ground

In the Care task, first, the imagery would be made available for inspection by the teleoperator and/or a medic. The display algorithms would be imbedded in a 3D display window on his computer. (Note that

DII has developed the FlyCast software in previous projects that includes these data fusion and display capabilities.)

- Care Task Operator Display
  - Display of fused 3D with 2D image of casualty, allowing operator to view casualty from a variety of angles, to magnify the image from any view angle
  - Ability to control the 2D cameras to scan image in high resolution any region of the 3D image
  - Capability to send the complete data or individual frames of data to others for review.

Then secondly, algorithms are applied for automated analysis of the data to determine the possibility and method of extraction of the casualty. That analysis will include:

- Determining the pose of the casualty from the 3D and 2D imagery
- Determination of physical injuries to the casualty, including broken limbs, missing limbs and large wounds
- Using the pose determination to estimate the weight and weight distribution of the casualty
- Determination of best methods to lift and move the casualty

Schedule

- Complete feasibility demonstration and CCIA Sensor prototype design -- December 2017
- Complete prototype CCIA Sensor System -- December 2018