GOLDEN-I HAZHAT TRAINING PROJECT

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Abstract

This paper describes the use of a head-mounted computing device (Golden-i) [1] for field-worker training purposes. The purpose of this project was to provide the firefighters at the Texas Engineering Extension (TEEX) firefighting school with a reference tool that can be used in addition to performing critical tasks. Golden-i provides a hands-free device that can be activated and controlled using voice commands. Golden-I aids firefighters by quickly referencing necessary instructional materials, while performing critical tasks such as repairing gas leaks.

Introduction

HAZHAT is a device and application system designed for purposes of training students of the Texas Engineering Extension (TEEX) firefighter and rescue school's Hazardous Materials program. An integral part of the Hazardous Materials (HAZMAT) program at TEEX is that trainees must apply skills learned in the classroom by donning a HAZMAT protection suit and responding to mock hazardous situations. To supplement the HAZMAT trainee's training, HAZHAT can be worn while participating in mock disaster exercises.

HAZHAT is a head-mount display unit designed for use in HAZMAT applications. While wearing/using HAZHAT, trainees have access to numerous documents that contain detailed instructions on how to react in certain situations. This type of reference material is useless for experienced HAZMAT personnel, but has the potential to be very effective for undergraduate trainees of the HAZMAT program. The reference documents that are housed in the HAZHAT devices help remind trainees when they forget what to do in the middle of a mock disaster scenario. This will help the trainee gain a more positive, effective, and efficient learning experience.

Program

Trainees in the field of Hazardous Material (HAZMAT) emergency services are in need of a device and application system that provides information on what to do in disaster scenarios. This device must be small enough to fit on the head of the trainee (the trainee will also be wearing a HAZMAT suit) and the application needs to have hands-free operability. All documents on this device must be easily accessible through voice commands.

Design Implementation

The HAZHAT Training Application is a prototype to show the potential of such an application using the Golden-i hardware. This application delivers a solution that is educationally useful for the client at the TEEX Hazardous Material Training Center. The HAZHAT Training App was built to deliver instructions wirelessly through a simple user interface. The design contains digital renderings of all of the figures in the Chlorine Rail Car Leak manual [2] ,which is currently being used by the school .The figures are centered in the middle of the eye piece for optimal viewing purposes. A black border was added around each figure because it has become known that the human eye cannot see the entire screen on the Golden-i. Each figure is accompanied by descriptive instructions to support a trainee during a training exercise.

Each descriptive instruction is transferred from the manual and is accurate per the customer's request. The HAZHAT Training App was also designed to provide information via voice-activated commands on each page of the manual. The trainee can continue with the exercise while the instructions are read through built-in speakers at the ears. Each instruction screen contains visual buttons that can be selected via voice commands. The voice commands on each screen include 'previous instruction', 'reread instruction', and 'next instruction'. These voice commands allow the trainee to have complete control over the instruction manual. A novice trainee can take as much time as needed with each instruction and is able to replay the instruction as many times as needed. An expert trainee might run through the instructions and be able to complete the exercise via simple diagrams. The HAZHAT Training App opens up a new frontier as old manuals become digital and mobile on hands-free devices such as the Golden-i.

System Requirements

The following section will discuss the items to be delivered. Each item is discussed in terms of meeting specific functional requirements. The descriptions include what features are available or not.

Application on Golden-i

The HAZHAT Training App was developed for Kopin's Golden-i hands-free computer. This hardware is incredibly powerful. Applications developed will pave the road for commercializing the Golden-i. This application was developed [3] specifically for the Golden-i; the HAZHAT Training App will not work on any other platform. Therefore, the demonstration was implemented through the Golden-i.

Automated Manual

The initial purpose of the HAZHAT Training App was to digitize and automate the Chlorine Rail Car Leak manual in order to assist TEEX Training trainees during exercises [4]. This application allows for the training documentation to be mobilized with the trainee and for trainees to acquire more experience and knowledge with training exercises as well as allowing the trainee to not worry about remembering which tactic to use in a certain situation. The automated manual includes diagrams from the original document. However, due to time constraints, no new figures were created. The HAZHAT Training App is as accurately detailed as the original training manual.

Voice Controlled

The HAZHAT Training App is voice controlled with on-screen voice-activated buttons. The buttons can be seen as highlighted text within the figures or commands that allow the user to progress through the instruction set. The Golden-i is a hands-free device. The application will not be motion controlled due to the environment in which it will be used.

Text to Speech

Due to the fact that a real-time operating system (RTOS) [5] was used, polling is not applicable to the implementation of this strategy. Although an RTOS utilizes interruptions, it can be thought of in terms of scheduling events. The Golden-i shell is an RTOS application created for the Windows CE core of the Golden-i headset. The shell has a predefined class hierarchy. When creating an application for the shell, the classes in this hierarchy define all of the tools at the disposal of the user. Keep in mind that the shell was created for demonstration purposes, so the hierarchy is far from completed. Modifying the schedule of different events was not possible, but instead the available classes were applied to produce the desired functionality.

The developed strategy was based on button-pressed events and call-back functions. Although many other features of the shell were used, the transitions using button-pressed events defined the structure of the application. The application for this project was to utilize Golden-i to train field workers in quickly referencing necessary instructional material, while simultaneously performing critical tasks of repairing a critical piece of equipment in a hazardous environment such as a gas leak from the fuel tank of a car. The ability to transition between multiple instructions defined in a chlorine dome tank car repair manual is needed. Chlorine domes are broken into three main sections that can be seen in Figure 1.
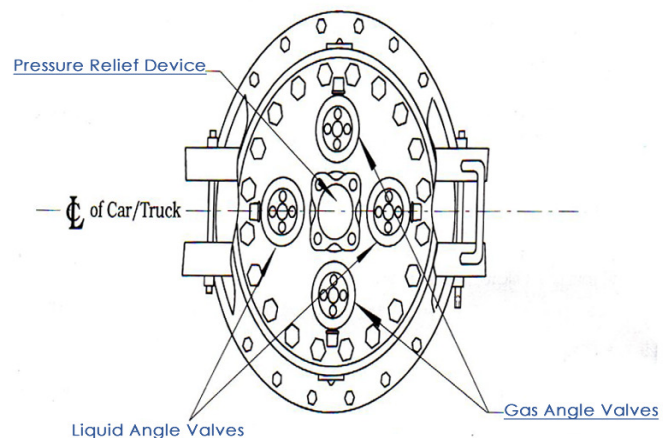

Figure 1. Chlorine Dome

The user can determine which one of the three sections—pressure relief device, liquid angle valves, and gas angle valves—is leaking. The system provides the user with the option to choose the leaking section. The class GISpeechButton is used to define each section as a speech command. Once the sections are defined as speech commands, a call-back function is created to correspond to each speech command. Once a speech command is given, a button-pressed event occurs and the proper call back function for that command is executed.

Figure 2 shows the manway cover gasket and three instruction actions. One is to immediately report a leak to the chlorine supplier. It is not advisable for persons to handle this condition without special training. Second is to tighten the manway cover stud nuts using wrench socket 113, wrench extension, wrench bar adaptor, and wrench bar. The third is to test for leaks.

When the speech command is given for the manway cover gasket, the user must be able to navigate through each instruction set. One thing to note is that only one image is given for all three instructions. A decision was made that

only one instruction should be displayed at a time. So, when the user transitions to this instruction set, he/she will see the image and only the first instruction. This is shown in Figure 2.
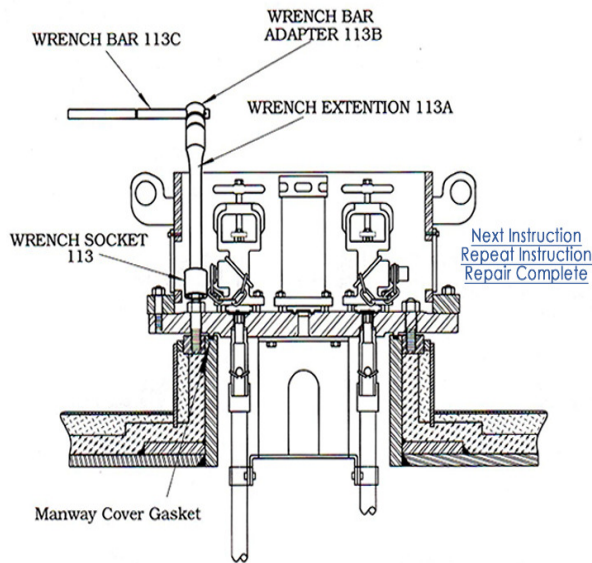

Figure 2. Manway Cover Gasket: Instruction One

For instruction one, the user needs to have three options: the ability to call the next command, repeat the command, and denote that the repair is complete. The options are shown in Figure 3. Up to this point, the significance of the repeat command relates to a feature that has been neglected. Using the speech vocalizer of the shell application, each instruction will not only be shown to the user, but it will also be vocalized to the user. If the user wishes to vocally hear the command again, he can call the speech command (Repeat Instruction). The speech command (Repair Complete) will simple return to the start of the application and allow the user to select a new instruction set.
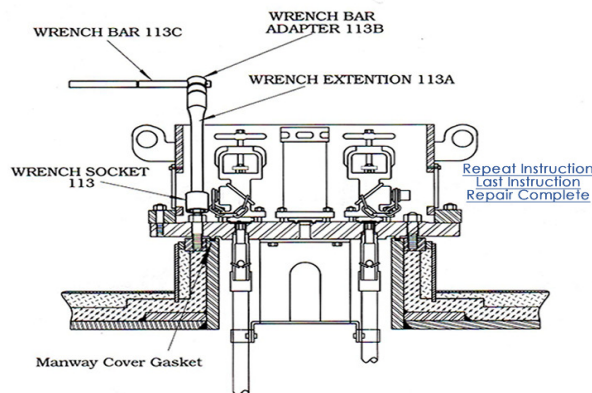

Figure 3. Manway Cover Gasket: Instruction Three

As the user progresses to more instructions, a new speech command (Previous Instruction) is added allowing the user to return to the previous command. This is shown in Figure 3, the third instruction for the manway cover gasket.

Another aspect to note in Figure 5 is that there is no longer a command (Next Instruction) for the manway cover gasket instruction set; instead, only three instructions options are given. The user only has the option to repeat previous commands or finish the repair ;this description excludes the Repeat Instruction. The transition through the example given for the manway cover gasket instruction set defines the standard use for all instruction sets.

Hierarchy Chart

The hierarchy chart shown in Figure 4 details the six instruction sets available and the transition from identifying the source of the leak to choosing the repair instructions. As can be seen, each instruction set has a variable number of instructions that call for either device 6 or device 24 assemblies. In the case of the angle valve packing instruction, it calls for a device 6 assembly .This specific process is detailed in Figures 5 and 6. The process is broken into two figures for easy viewing.
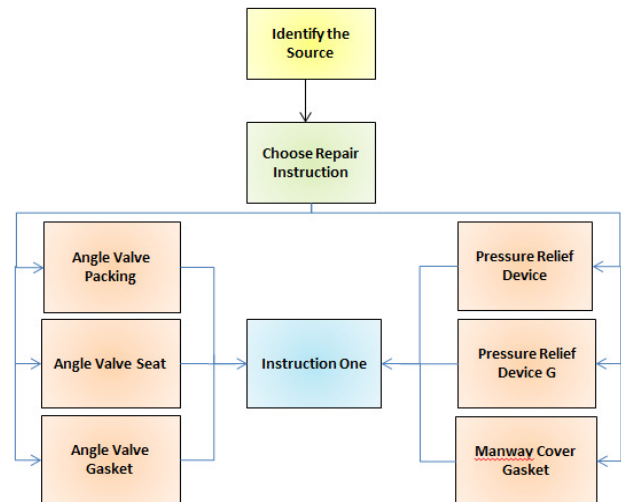

Figure 4. Hierarchy Chart (1 of 3)

For the last hierarchy chart, a discussion on inputs is not applicable. No specific inputs are passed to each function. However, a speech command can be seen as an input to the function, but this is not how they are described.

What is not shown in these charts is the button-pressed function. The button-pressed function has variables passed

through it related to the speech command being called. Every function shown in the hierarchy chart has multiple button-pressed events that can occur. When a button-pressed event occurs, the parameters describing the particular button being pressed are checked through the condition of an "if" statement. The conditions are met for a particular statement if the desired call-back function is executed. For now, the functions shown in the hierarchy chart do not return any specific values. The only outputs that can be identified for each function are speech vocalization and image outputs but, again, no variables are returned as outputs.
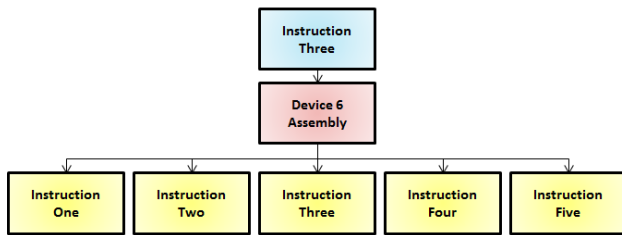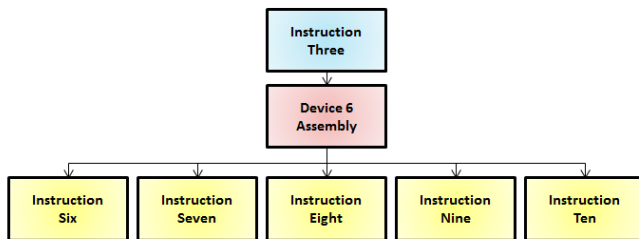

Figure 5. Hierarchy Chart (2 of 3)

Figure 6. Hierarchy Chart (3 of 3)

Testing

Testing of the HAZHAT application has been limited to mostly functional requirements. The unit performed satisfactorily by a novice trainee to conduct a rigorous testing process using the testing documents residing on a static disk memory on the Golden-i system. One of the testing challenges had to do with the impact of wearing the oxygen mask and Golden-i unit under the HAZMAT suit. Due to a lack of physical space inside the helmet/face mask, it takes time for the trainee to get used to the new Golden-I unit. The oxygen mask changes the first-responder's voice; so it will take a few minutes for the voice recognition software to adapt to the new voice pattern. Figure 8 shows one of the students testing the Golden-i unit with the HAZMAT suit.

The team was surprised to see the DSP-based voice-recognition software work so well. The third test conducted

had to determine whether or not the first responder wearing the Golden-i headset could see the miniature display through the HAZMAT face shield—the face shield is connected to the oxygen mask as a single unit. This test was a little difficult since it does require wearing the unit and "test driving" it multiple times. During the first few trials, the responder was not satisfied with the challenge of trying to read the information, which led to graphical changes in the software unit to make it more graphically user based, less text based, simpler and more enjoyable to use. Getting the first responder involved in the process of software redesign truly helped this test to be successful.

Figure 7. HAZHAT Test

The next phase of the project was focused on integration of wireless connectivity between the responder in the field and the master trainer in the main office away from the testing site. In addition to that focus, other features are being reviewed which would allow the master trainer the opportunity to watch what the responder on site is viewing at the same time.

Conclusions

For each image, it was decided that the user should have the ability to call a zoom function. The zoom function would take advantage of the shell's image viewer. When this command is called, the user would be able to use head movement to move through different sections of the image and, once a section of interest is found, the user could zoom in for a closer look. This functionality has already been created; it simply needs to be added to every instruction available. This is a time-consuming task and requires the creation of multiple functions and new speech commands.

Finally, with respect to the overall functionality that a group such as the TEEX HAZMAT group would require, is the integration of voice, video, and file transfer. The idea is that not only can an expert on the ground visually see what the user is doing, he or she would be able to talk to the user. The expert would also have the ability to send an instruction set similar to the one created in this study but for specific models of angle valves and pressure relief devices.

Acknowledgements

References

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[5]   Walls, C. (2009). *Building a Real Time Operating System: RTOS from the Ground Up,* Newnes.

Biographies

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