THE SPEECH SYNTHESIS APPLICATION IN THE ENGINE ROOM SIMULATOR TRAINING

Stefan Kluj
Gdynia Maritime University
ul. Morska 83, 81-225 Gdynia, Poland
kluj@am.gdynia.pl

ABSTRACT

The paper discusses the formal issues of the speech communication in the engine room simulator training. Both STCW requirements for the simulator training and IMO Resolution A.918(22) have been taken into consideration. The paper describes the possibilities of the speech synthesis application in the activities typical for an engine room simulator training. The examples of the fault scenarios, checklists and assessment with an embedded artificial voice are given. The paper discusses also problems related to the speech synthesis application in both directions: the understanding of the artificial comments on one hand and the voice recognition issues on the other hand.

1 FORMAL ISSUES

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers revised in 1995 (STCW 95) includes several references to the problems of the internal communication and language skills. The table A-III/1 in [1] specifies a minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room. One of the requirements included in this table states that the engineering officer of a watch should posses an adequate knowledge of the English language to enable the officer to use engineering publications and to perform engineering duties in other words: his communications should be clear and understood. The table A-II/2 on the other hand includes the minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more. In this case the ability to use an internal communication system should be proven also in "approved simulator training, where appropriate" [1]. Also a table A-III/4 which shows the minimum requirements for ratings forming a part of an engineering watch and requires the ability to use an appropriate internal communication system. The section B-I/12 of [1] includes the guidance regarding the use of simulators in the marine engineering training and assessment. According this document, an engine room simulator should incorporate the facilities to create a real-time environment for seagoing and harbour operations with communication devices and simulation of appropriate main and auxiliary propulsion machinery equipment and control panels.

The International Maritime Organization (IMO) Resolution A.918(22) adopted on November 29th, 2001 (RESOLUTION) includes IMO Standard Marine Communication Phrases in order to support compliance with the standards of competence as required by table A-II/1 of the STCW Code [2]. The part A of the RESOLUTION specifies the external communication phrases and includes only Standard Engine Orders as a reference

to the engineering crew training. On the other hand the part B which lists mainly on-board communication phrases includes also:

- fire protection and fire fighting,
- damage control and reporting
- cargo handling,
- ballast handling,
- checking the seaworthiness.

All above items are closely related to the engine room operation but the strict engine room terminology and the communication phrases are missing in the RESOLUTION. This is a very important weakness of the RESOLUTION in the author's opinion.

The Engine Room Simulator Model Course 2.07 [3] specifies that the relevant communication passed and received from the bridge or other stations: e.g. bunkering, emergency stations including equipment status should be included in the simulator training program and an evaluation form.

The engine room communication issues were also on ICERS agenda from very beginning. The paper [4] describes a Speech Recognizer as a part of a Virtual Man-Machine Interface. The requirement for the proper representation of the communication systems appropriately augmented with training enhancements as a part of the engine room training facility can be also found in the paper [5].

The above presented formal issues can be summarized as follows:

- There is a need for the integration of the internal and external communication problems in the engine room simulator training.
- There are no clearly described, standard communication phrases and training methods to be applied in the engine room simulator.

Especially, the second issue should be taken into consideration by the international maritime institutions like IMO or IMarEST.

2 PRACTICAL ISSUES

Speech synthesis is the artificial production of human speech. A computer system used for this purpose is called a speech synthesizer, and can be implemented in a software or hardware. A text-to-speech (TTS) system converts normal language text into speech; other systems render symbolic linguistic representations like phonetic transcriptions into speech [6]. Synthesized speech can be created by concatenating pieces of recorded speech that are stored in a database [6]. It means that speech synthesis is not a reproduction of the recorded words, phrases or sentences but that speech sound is created 'on-line' from the ASCII code stored in a file or created 'live' by the software.

There are several software and hardware challenges connected with a speech synthesis. Texts are full of heteronyms, numbers, and abbreviations that all require expansion into a phonetic representation. There are many spellings in English which are pronounced differently based on context [6]. The maritime English is full of abbreviations which are very popular in a written form but should be avoided when preparing the texts for a synthesized speech. Generally, it is recommended to try and listen each sentence prepared for a synthesis because 'what looks good as a text, does not have to sound good when artificially spoken'! From the technical point of view the speech synthesis is not a big problem because all modern operating systems are prepared for this task. For example

Microsoft Windows XP and Vista operating systems do not require to install any special software package and usually the user can even select one of several available (male and female) voices.

It should be said that a speech synthesis and speech recognition are two different (even if connected) tasks. The computerized voice recognition is a more complicated problem, mainly because typically it requires a certain learning process when a user 'teaches' the computer how he pronounces certain phrases. Because in the normal maritime training, for many trainees English is not a first language and the training time is very limited; it is hard to expect that the requested level of the speech recognition can be easily reached. Because of its complicated nature, the speech recognition requires also a special software packages or libraries, what can have the influence on a simulator price.

Generally, the following areas of the simulator functionality should be considered as a place where a synthesized speech could be implemented:

- imitation of an expert person (typically a chief engineer) being present in the engine room and offering an instruction what should be done now, what is the current problem or a warning if necessary.
- imitation of the voice communication with a bridge, in parallel to the telegraph commands of course. This can be done better if the speech recognition is implemented as well, so the bi-directional communication is possible.
- imitation of the communication with other members of the engine room crew (passing orders, collecting reports etc.).

The following chapter presents an example of the synthesized speech implementation.

3 IMPLEMENTATION

The speech synthesis has been widely implemented in the latest version (4.5) of the Virtual Engine Room (VER) simulator. The implementation includes the following tasks:

- On-line advice called 'Ask Chief' offers a verbal information about the most important problems in the present engine room configuration and is based on the integrated expert system analysis. The target point for this analysis is the engine room ready for the main engine start. Because it is possible that many problems can be on the list, only the most important one will be reported. For example if there is no steam and no voltage on the bus bars, only the missing voltage will be reported. This is so called 'top of the heap' strategy. It is also possible to see the same advice as a text if the trainee has the problems with the understanding the voice advice.
- Spoken checklists include the same information as the normal checklists but it should be taken into consideration that it takes more time to listen the spoken text than to read it! This may be a reason why some users may prefer rather the classic checklists instead the spoken version.
- Spoken text embedded in the scenarios. This seems to be the very important advantage of the synthesized speech, because the voice comments can be mixed with the introduction of the different faults. At the early stage of the education this feature can be used for turning the attention of the trainee at the symptoms which may be not visible at the first glance. The scenario editor includes an additional field where the text comments can be written and introduced with or without the faults.
- Verbal warning and advice in the critical situations. For example when the critical speed of the main engine is reached the spoken warning can be listen together with

the visual information about the engine heavy vibrations. This is an advantage over the traditional approach because the eyesight of the trainee can be focused on the gauges or mnemonic diagrams causing an omission of the written warning.

The experience of the trainees with the above features shows, that the synthesized speech creates a new value in the simulator training. The most important advantage is that the trainee starts to listen not only to the engine room mechanical sound but also to the spoken information which may be audible in the real engine room environment. The second advantage, especially for the foreign students is the intuitive learning of the spoken English, a very important feature even if taking into consideration that the synthesized speech is far from to be perfect spoken language. The students report, that in many cases the new the English names of the equipment but they did not know how to pronounce them. In other words: the trainees learn the English language just by the way.

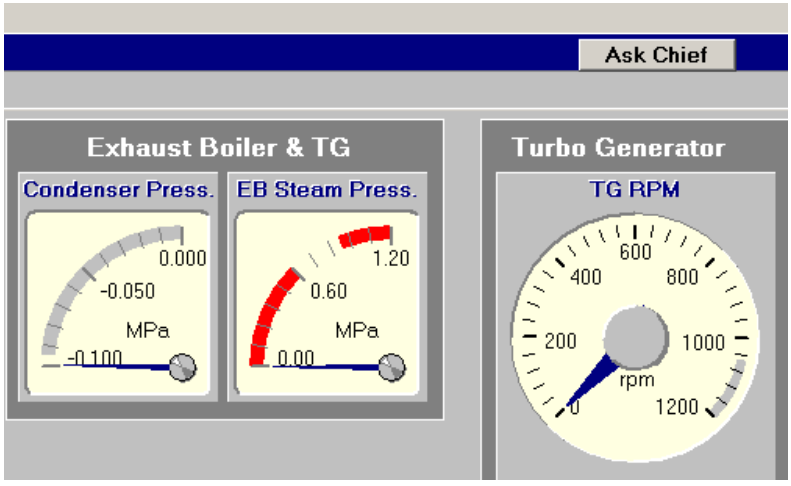

Figure 1: Ask Chief button.

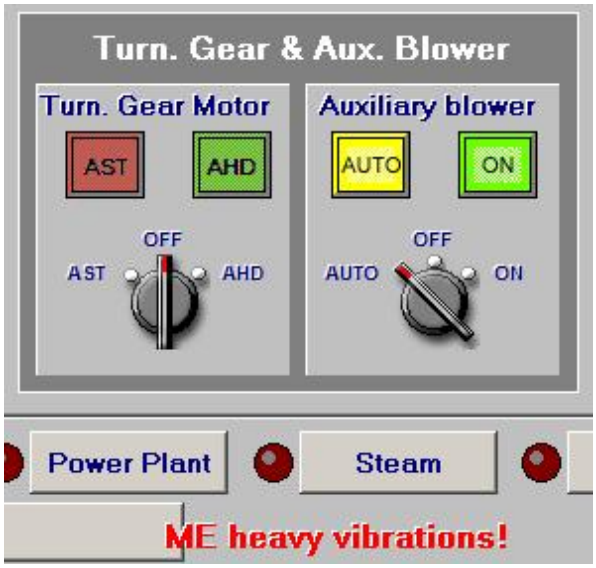

Figure 2: Critical speed warning

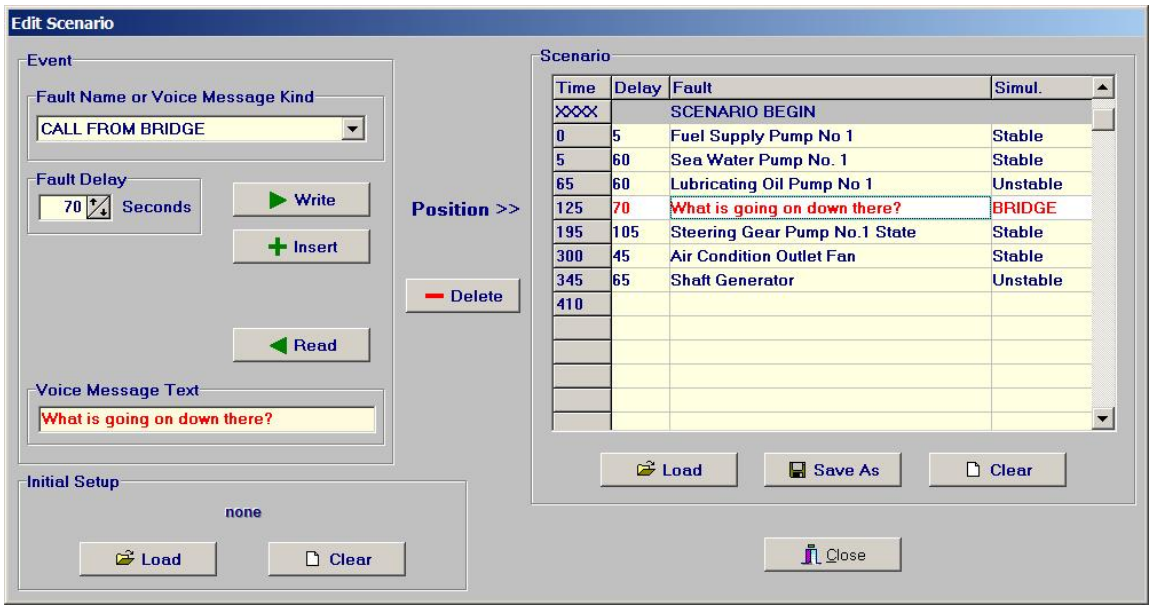

Figure 3: Scenario editor window includes the voice messages and their source.

Unfortunately, the sound features discussed above can not be fully shown in the written paper, so they will be demonstrated during the paper presentation.

5 CONCLUSION

There is a need for the better and deeper integration of the internal and external communication within the engine room simulator training. The synthesized speech can be an interesting solution, but future belongs to the solution where the speech recognition will be used as well. It is worth to remember that the synthesized speech requires a texts which slightly different that the written text, means they will optimized for the computer reproduction.

REFERENCES

[1] International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, IMO Publications, London, 1995.
[2] IMO Standard Marine Communication Phrases, IMO Publications, London, 2002.
[3] Model Course 2.07, IMO Publications, London, 2001
[4] A. Al-Ali, E.R. Odoom, "Specification of COTSIM – the Machinery Space Simulator in Kuwait", The Proceedings of ICERS 2, Rimouski, 1995.
[5] R.D. Hayhoe, J.F.W. Morley, "The Procurement of a New Machinery Controls and Surveillance Procedural Training Facility for the Royal Navy Type 22 Frigates", The Proceedings of ICERS 3, Svendborg, 1997.
[6] http://en.wikipedia.org/wiki/Speech_synthesis

BIOGRAPHY

Dr. Stefan Kluj has obtained his PHD in Engineering Science form Gdansk Technical University (Poland) and currently is employed as an Associate Professor in Gdynia Maritime University. He is an author of two academic books and ca. 30 internationally published papers. Among others Stefan Kluj has developed two engine room simulators: Turbo Diesel or Virtual Engine Room which are used in 50 countries all over the world..