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Enhancement of a Radiation Safety System
Through the Use of a Microprocessor Controlled Speech
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A speech synthesizer is being used to differentiate eight separate safety alarms on a high energy accelerator at Argonne National Laboratory. A single board microcomputer monitors eight signals from an existing radiation safety logic circuit. The microcomputer is programmed to output the proper code at the proper time and sequence to a speech synthesizer which supplies the audio input to a local public address system. This eliminates the requirement for eight different alarm tones and the personnel training required to differentiate among them. A twenty-word vocabulary was found adequate to supply the necessary safety announcements. The article describes the techniques used to interface the speech synthesizer into the existing safety logic circuit.

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ENHANCEMENT OF A RADIATION SAFETY SYSTEM THROUGH THE USE OF A MICROPROCESSOR CONTROLLED SPEECH SYNTHESIZER

D.J. Keefe and W.P. McDowell

Safety systems are often needed to monitor areas for radiation hazards and other critical parameters. When certain monitored parameters exceed predetermined limits, alarms are initiated. The problem in some of these systems is how to differentiate one alarm out of many. Common schemes as simple as alarm lights, horns, bells and the like are used with the shortcoming that training in differentiating the many different types of sounds is required for all personnel with access to these monitored areas. A means of providing a voice message, after a common alert horn, on a localized public address system has been implemented at a reasonable cost on a high energy accelerator at Argonne National Laboratory.

Voice messages have been used in safety applications using electronically controlled continuous tape recorders, but the recent development of speech synthesizers for the commercial market make this all electronic approach particularly appealing from a reliability standpoint.

This system monitors both gamma and neutron radiation in five separately controlled areas for two independent accelerators. The design specifications require warnings prior to the start-up of either of these machines, a warning prior to the opening of a shutter which allows the beam into the target area and the high radiation warnings for the five

controlled areas. Either gamma or neutron radiation in any controlled area constitutes an unsafe condition, thus requiring only one high radiation message per controlled area. Eight separate messages are given on command by the microprocessor to the monitored area. These eight messages use a vocabulary of 20 words.

The microcomputer¹ consists of a single board containing an 8085 CPU with 256 bytes of RAM, 2k of EPROM and 22 programmable I/O lines. One eight bit parallel I/O port was used to input the eight alarm conditions. The other two ports were used to communicate with the speech synthesizer.² This includes the addressing of the single words of the desired message and the handshaking between the synthesizer and microcomputer. The use of single word addressing provides the designer with the flexibility of generating pauses between words for greater clarity and emphasis in the delivered message. If desired, the synthesizer can be programmed to deliver complete messages with a single address, but this restricts the use of addressing individual words to create additional messages with the existing vocabulary at some later date.

The cost of the speech synthesizer interface is slightly less than that required to design and build circuits to modulate eight separate alarms. The advantage is the savings realized in not having to train personnel to interpret the different sounds.

In this system the logic circuitry, which has been in use for over seven years, required only minor hardware modification to provide the required signals to the microcomputer. A small interface circuit was

¹ Pragmatic designs CPU 1

² Telesensory Systems, Inc.

required to mate the synthesizer to the microcomputer I/O ports, and provide a band-pass preamplifier to output the audio to the public address amplifier. A 500-word assembly program burned into PROM provides the operating program which continuously scans the input I/O for a coded message or messages. Provisions are made in the program to read out more than one message in priority format. The repetitions of the alarm messages are set at 3 but can be easily altered by a single line change in the program. Delays were written in subroutine form to facilitate pauses between words as desired for emphasis or clarity. Additional messages could be added if desired by implementing additional inputs with only minor software changes. The twenty-word vocabulary can be increased by the manufacturer, if desired, as only 3k of the 4k memory was used in the synthesizer memory.

Messages such as "High Radiation Alarm, Area 4" and "Dynamitron On In 30 Seconds" certainly result in less confusion than the commonly used methods. This enhancement in safety was obtained at a cost under that required for eight different conventional alarm signals for the eight separate conditions. In this application English words are used, however, speech synthesizer vocabularies in other languages are available.

The paper will provide the details of the software and hardware interface required to provide voice announcements for the radiation safety system.