INTEGRATION OF LOW ALTITUDE DETECTOR AND LOW FUEL INDICATOR IN MILITARY AIRCRAFTS USING PRIORITY BASED AUDIO WARNING SYSTEM

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ABSTRACT

The warning signal is given to the cockpit as soon as the problem occurs in the aircraft. With multiple warnings, the warning system in the cockpit will become over crowded. Cockpit crews spend a lot of time recognizing the warning indicators and identifying the nature of the problem. Speech and auditory displays in general, allow information to be conveyed relatively quick, no matter where the visual attention of the human is focused. Hence this project proposes design of an audio warning system with integration of low altitude warning and low fuel detection. This project also provides priority and acknowledgement based system, so the pilot can easily overcome his workload. Addition to these display systems to make the job of the pilot easier.

Keywords: ATMEGA328P***-PU, aPR33A3, LM358***

I. INTRODUCTION

The goal of this research is to increase safety in aviation. Most of today's avionics Systems are designed and implemented as standalone, hard-wired monolithic applications of software. These stand-alone Systems have proved to increase the safety of the aircraft. However with the late increase of Warning Systems in the cockpit, problem arrived in safety. The need to prioritize warning messages is to avoid the increasing nuisance warnings.

Aircraft warning systems are typically introduced to monitor specific environmental properties that are difficult to observe or not observable at all by the human operators. The system keeps track of a number of parameters and when these parameters exceed a certain threshold a visual and aural warning will be generated to warn the pilots for the threatening situation.

Warning systems generally perform three functions: hazard detection, attention-getting and display of resolution status and commands.

The two warnings are:

- Low altitude warning
- Low fuel indicator

II. LITERATURE SURVEY

Guy Peryeret. al [5] has obtained feedback from 50 commercial pilots on the design characteristics of a set of auditory flight deck alerts during his survey. The first section in the online questionnaire assessed pilot views on current loudness levels and prevalence of cognitive impairment from alert presentation. The second section in the questionnaire required the pilots to rate the effectiveness of 10 auditory alerts currently in operation on a large commercial aircraft. In general, the alerts were rated favorably on informational content variables, but unfavorably on presentation style variables. Loud, continuous alerts can distract pilot attention away from processing task-related information, increasing the potential for error. New methods for alert presentation are suggested, based on real-time analysis of flight deck noise. This is argued to offer a more suitable environment for problem solving, decision making, and communication during alert situations.

Uchtdorf&Heldt [6] of the Boeing 737–300 and the Airbus 310–200 flight deck systems, where 98% of the pilots regarded auditory alerts as extremely important to flight safety in Lufthansa survey. However, almost all participants complained that the alerts were presented at an excessive volume. Manufacturers tend to take the "better safe than sorry" approach when setting the alert intensity level (James, 1996). This approach is understandable, as an alert that is masked by flight deck noise will go undetected and render the auditory warning system useless. However, high-intensity sounds have been reported to have undesirable physiological and psychological effects.

Patterson [7] suggested a model of alert presentation based on the intensity level and spectral content of background noise. Alerts should be presented at least 15dB above the threshold of alert detection and limited to 30dB above threshold to prevent task disruption. The guidelines put forward by Patterson are widely accepted and have been incorporated into the U.K. Ministry of Defense Standard. In addition, similar guidelines can be found for the International Organization of Standardization and the U.S. Human Engineering Standard. Loudness levels of alerts are referred to specifically in this survey as a means of discovering if alert intensity is still a problem 20 years on from Patterson's study.

David J. Sheehan [8], this paper tells that with a head-up display, the pilots' visual attention is directed away from the instrument panel for considerable periods of time. Therefore, for maximum safety and pilot confidence, it may be desirable to display certain instrument panel warning signals on the HUD. This study was performed to determine the warning information to be included in the head-up display and how this information should best be presented.

III. PROBLEM STATEMENT

With the increasing number of warning signals, the attention getting function of the pilot is distracted. This will cause an increase in activity in the cockpit, since all warnings accumulate in the cockpit.

Different warnings occur shortly or simultaneously, that have no direct relation, e.g. below altitude and fuel low. Each warning asks for a different procedure/solution. The pilot must evaluate which problem is most critical, what relation there is between warnings, to decide

- Which problem needs to be solved first. Attention must be economically spread between the warnings. Situations like this put high demands on the pilots.
- The most common complaints from pilots concerning audiolery alerts is excessive volume.

This scenario increases the workload in the cockpit

IV. SCOPE OF THE PROBLEM

Too many warning systems are overcrowding the cockpit in case of abnormal situations. This creates confusing situations for cockpit crews, leaving them with the difficult choice to decide which warning is more threat full warnings. However human operators are poor performers in monitoring low probability events that must be noticed quickly, these warning systems must be available to assist them when necessary. By integrating warning systems as described, warning signals are prioritized and given to the pilots until more important problems have been solved first.

V. METHODOLOGY

The controller that is used is ATMEGA328P-PU, which is more compatible as it combines 32kb flash memory with read-while-write capability, 1024b EE PROM, 2kb SRAM, 23 general purpose IO lines, 32 general purpose working register, 3 flexible timer/counters with compare modes, internal as well as external interrupts, serial programmable USART, 2 wire serial interface which is byte oriented, SPI serial port , 6 channel 10 bit A/D converter, watchdog timer with internal oscillator which is programmable, and 5 power saving modes, which is software selectable. The device operates between 1.8-5.5v.

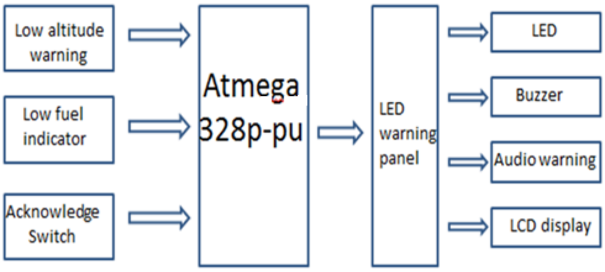

Figure 1: Block diagram of audio warning system

- ➢ Low altitude warning: Here the IR module is used, which detects the altitude of the aircraft. As the aircraft comes below the altitude it sends the warning signal.
- ➢ Low fuel indicator: Aluminium foil is used to sense the capacitance. If the capacitance is below the threshold this module sends the warning signal.

As soon as the problem occurs the warning system is activated by the warning signals. Each warning corresponds to a LED in "LED WARNING PANEL". The controller priorities the warning, and based on priority particular message is heard using Speech synthesizer [aPR33A3] in the headset of the pilot. Simultaneously the LED and the buzzer are drived. The system uses the "ACK" switch through which pilots can acknowledge the warning.

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VI. LOW ALTITUDE DETECTOR

In the IR module circuit diagram, photo diode is connected in reverse bias, non-inverting end (PIN 3) is connected to the junction of photodiode and a resistor and inverting end of LM358 (PIN 2) is connected to the variable resistor, to adjust the sensitivity of the module.

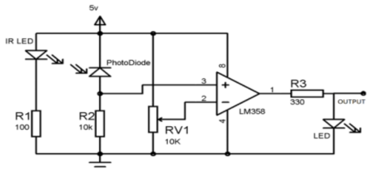

Figure 2: IR module circuit diagram

When the circuit is turned on, there is no IR radiation towards photodiode and the output of the comparator is low. When the object is present in front of the IR pair, then IR emitted by IR LED is reflected by the object and absorbed by the photodiode. When the reflected IR falls on the photodiode, the voltage across photodiode drops, which results for the increase in voltage across series resistors R2. As the voltage at Resistors R2 gets higher than the voltage at inverting end, then the output becomes HIGH and LED turns ON.

Voltage at inverting end [Threshold Voltage], can be set by rotating the variable resistors's knob. Higher the voltage at inverting end (-), less sensitive and Lower the voltage at inverting end (-), more sensitive.

The whole circuit is placed on PCB in order to build a proper IR MODULE.

VII. FUEL INDICATOR

The principle of capacitive level measurement is based on change of capacitance. Two Aluminium sheets acts as the plates of the capacitor. The capacitance depends on the fluid level. An empty tank has a lower capacitance while a filled tank has a higher capacitance

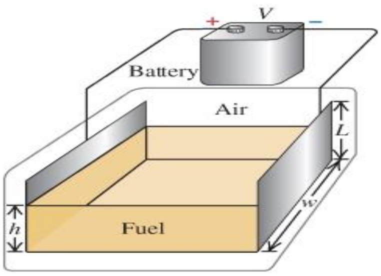

Figure 3: Capacitor based fuel indicator

In this case the capacitance unit or capacitor consists of two Aluminium plates. The dielectrics here used are Fuel and Air. Fuel has roughly twice the capacitance of air. The value of capacitor indicates how much of the container is covered by fuel.

Fuel has different capacitance for different densities. The capacitance increases as density increases and vice versa. Here one plate is connected to ground and other to the input of the controller that we have used. The software tool will be continuously measuring the capacitance and when it reaches the threshold (as we have given), it is considered as a warning.

VIII. FLOWCHART

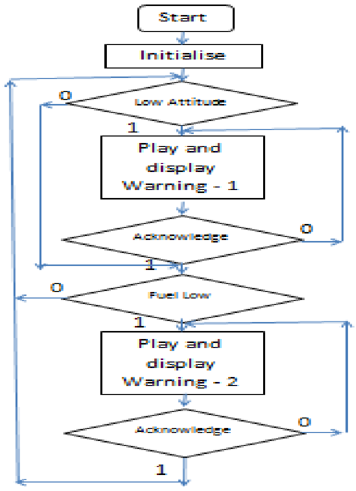

Figure 4: Flowchart

IX. . CONCLUSION

Design of low altitude detector, low fuel indicator and integrating them with priority based audio warning system. Warning systems generate warnings that indicate threat situations. Cockpit crews need to spend more attention to recognize warning indicators and identifying the nature of the problem by choosing the problems to be solved based on the priority. The need for the system is supported by the significant number of near misses reported by the air crew. To overcome excessive volume alert, the audio signal in the limited range of volume is given to the pilots head set.

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