A Child-left-behind Warning System based on Capacitive Sensing Principle

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Abstract—This paper presents a simple and efficient capacitive sensing system suitable for detecting presence of a child in an infant car seat. It also details a warning system that alarms the parents once a child is found to be left alone in a car. Infant seat with child is, usually, kept (safely) in the rear seat. Driver and passengers, in some situations, may leave the car without taking (forgetting) the child. When a car is turned-off (windows closed) temperature inside it will increase rapidly and can be life threatening as the thermoregulatory system of child is weak. Such incidents have been reported worldwide. The proposed capacitive sensor system detects child occupancy. The system also has a warning unit. Once the car is turned-off and a child is found to be left alone in the car (in an infant seat) the unit first generates an audio alarm. After a preset time, if no one takes the child, it will automatically dial (using a GSM module) to parents or driver to help the child. A prototype of the proposed capacitive sensor and warning system have been built and tested. The developed sensor accurately detected presence of a child (in various postures) in an infant seat. It also distinguished a child from other objects such as milk/water bottles, toys, bags, etc. Results showed that the developed system is very efficient and reliable.

I. INTRODUCTION

About 500 children died in USA, between 1998 and 2010, because they were left alone inside parked cars [1], [2]. This has been reported by a non-profit organization called Kids-n-cars. Similar, unfortunate, incidents also happens in various parts of the world. Once a car is turned-off and parked, keeping its window glasses closed, the temperature inside the car increases rapidly even on a day with atmospheric temperature of about 21°C [3]. As the thermoregulatory system of the child is not well developed, this condition may lead to hyperthermia or heatstroke which can be fatal. As we know, the child entirely depends on elders but, unknowingly, in a busy schedule, the driver or passengers may forget to take the child (who may be sleeping) in the infant seat, usually kept in the back seat of the car. Such incidents can be prevented by sensing the presence of a child soon after a car is turned-off and then generating/sending a suitable warning signal to the driver or parents who can take timely action to save the child.

A child presence detection system based on a combination of optical detector, mechanical switch and temperature sensor has been reported in [4]. Optical or thermal sensors are not well suited for this as it may not detect when a child is wrapped in a blanket or clothes. An electric field sensor to detect infants sitting in rearward position in an infant seat in a car has been reported in [5]. A capacitive seat occupancy detection system (for adult passengers) that provides occupancy information to an airbag control unit has been reported in [6]. In these schemes, sensing electrodes are placed in the car seat as it is to detect adult occupancy. Thickness of infant seat available in the market is not fixed. Thus, distance between child and electrodes in car seat can be between 5 to 12 cm (depending on manufacturer). Thus, it is difficult to sense presence of a child using these sensors reliably. Also, such capacitive/electric field systems are not available in all the cars and usually, if available, it is not installed in back seats of cars where probability of forgetting a child is high. A weighing based child detector has been developed by NASA's Langley Research Center [7]. Such weight based sensors may detect water or milk bottles, filled thermo-flask or bag, toy, etc. (or any combination of such items) as a child and may activate an (unwanted) alarm.

In this paper, we propose a simple and compact capacitive sensor that can be placed in an infant seat to detect presence of a child. The proposed system also has a vehicle ignition monitor to confirm presence of driver inside a car. It also has a temperature sensor to keep track on current temperature inside the car. A GSM modem is used to alert driver or parents/guardians as soon as a child left in the car in an infant seat is detected and the car is found to be turned-off. Principle of operation of the capacitive sensor, measurement scheme employed, details of prototype sensor and warning system developed and test results are discussed in the following sections of the paper.

II. CAPACITIVE SENSOR FOR INFANT SEAT

Fig. 1 shows a diagram of the proposed child presence detector and warning system. An infant seat with a child and (placement position of) the proposed capacitive sensor and Measurement and Control Unit (MCU) are shown in

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