

# SEAT HEADREST DEVELOPMENT TO DETECT THE HEAD POSITION OF PASSENGER

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## ABSTRACT

It is the essential technique to percept the position of passenger's head before rear collision to pre-crash headrest for minimizing the one's neck damage. This research introduces the technique of perception of head using the electrostatic capacity sensor in the head rest.

When the distance between the head rest and passenger's head is measured, pre-crash headrest could be adjusted to most proper position for Whiplash protection. It will improve safety technology.

## INTRODUCTION

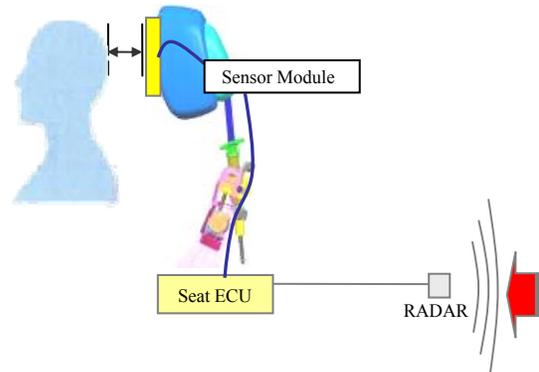
The research of the latest vehicle accidents show that 25% were caused by the rear-end collisions where 80% injuries were to the neck. As a result, the headrest that minimizes passenger's neck injury preceding the rear-end collision is necessary and the number of mechanical/electronic neck injury prevention systems were introduced and being applied.

However, the focus of this study is on developing the system that takes precautions against the possible neck injuries by automatically realizing an optimal safety positioning preceding the rear-end collision. To accomplish this, the passenger head location detection technology is crucial. In this study, the electrostatic capacity styled sensor technology is mounted in the headrest to detect passenger's head location to boost the neck-injury prevention performances by reducing passenger's head and the headrest's Backset in rear-end collision and to address the passenger's comfort by naturally maintaining passenger's head and headrest's distance in daily use. The electrostatic capacity sensor has no directionality in receptive fields and has expansive measurement ranges which makes favorable for the head detection.

## SYSTEM CONFIGURATION

The system is configured for headrest to operate the motor by actually configuring an electrostatic capacity styled sensor to seat's headrest which controls the relative distances between the head and the headrest.

System is configured with the sensor module which processes frequencies detected from electrode areas of electrostatic capacity sensor & head, and the seat ECU which controls headrest's forward and backward operations; the seat ECU is configures with the radar to detect rear approaching vehicles.



**Figure 1. Head Detection Seat Schematic.**

Sensor module & controller converts head's electricity quantum frequency to digital value to extract the distance information then transmits the information to seat ECU for the control of headrest operation commending motor. As the first operation of a sequence, moves the headrest forward/upward by detecting the collision warning signal thru rear radar and stops the motor to maintain 10mm Backset between passenger's head and headrest to minimize the neck injury in rear-ends collision, then moves the headrest to its original position at the end to restore the passenger programmed comfort location.

Fig.2 is the block diagram for sensor module.

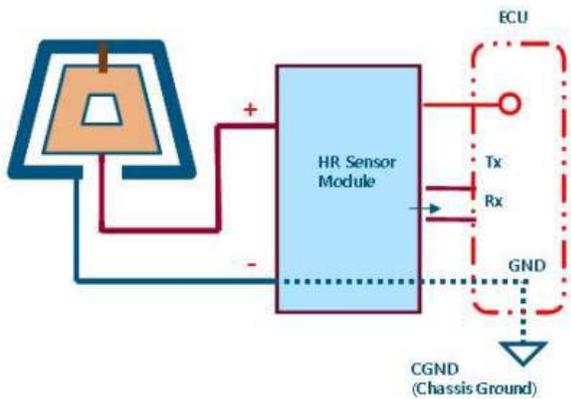


Figure 2. Sensor Module Block Diagram

The system is operated by the logic, Fig.3.

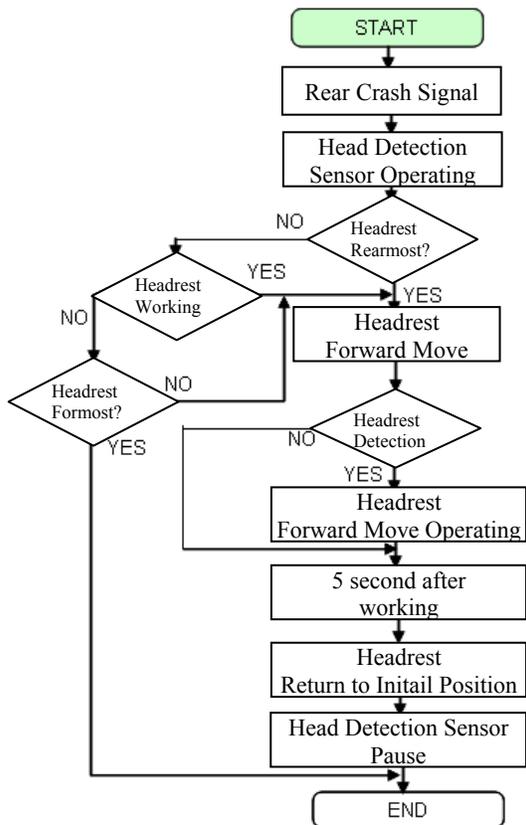


Figure 3. System Control Logic



Figure 4. TEST JIG

### Type Specific Experiments of Electrostatic Capacity Sensors

The experiment is conducted to identify the favorable head sensing materials by measuring 4 forms of electrostatic capacity variations. The silver and copper were chosen for its high conductivity which is favorable for detecting the electrostatic capacity variations. For a detection target, a case containing water that is dielectric constancy favorable with the head were used in an experiment.

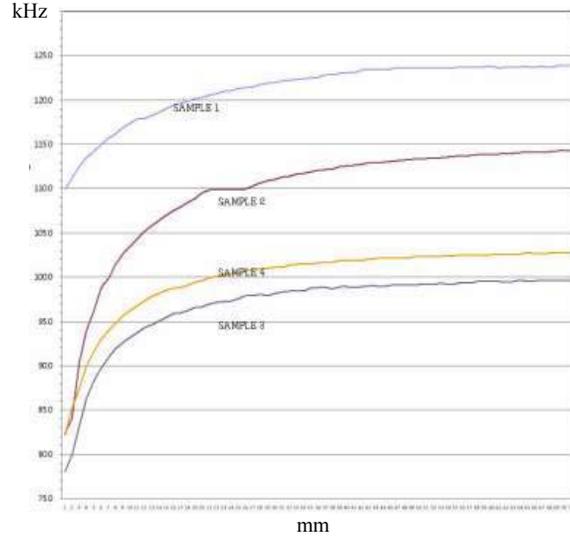
On Fig. 4, the distance corresponding electrostatic capacity variations is detected while moving the water pouch forward and backward directions from the front of seat's headrest. Detected electrostatic capacity is shown as a frequency and distance corresponding frequency variations were measured for the distance measurement.

Table 1. Sample Specific Grouping

Classifications	Shapes	Electrode Quality
SAMPLE 1		Silver
SAMPLE 2		Silver + Copper
SAMPLE 3		Copper (Trapezoid)
SAMPLE 4		Copper (Circular)

### Test Results & Evaluations

Conducted the experiments on 4 samples and obtained the result shown on Fig. 3. Fig. 5 shows the data value of 4 experimental samples. The frequency values from oscillator circuits are measured in accordance to the distances for the experiment value.



**Figure 5. Frequency Value of Sample Specific Distance**

SAMPLES 1, the frequency values per distances are mild.

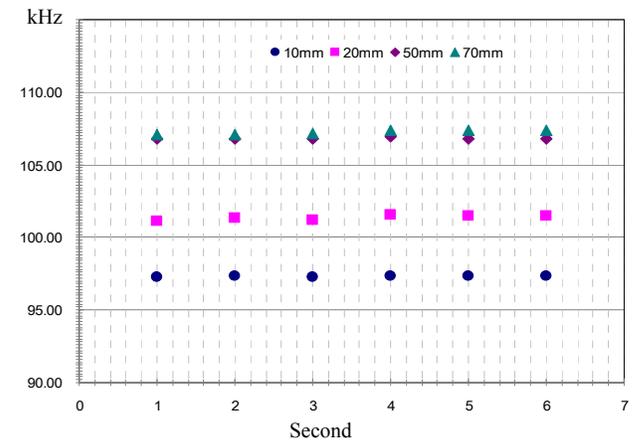
This represents the frequency value for the headrest and the head's distance of 10mm. The case of frequency value's variation error on areas outside the 10mm boundaries, it shows that there can be a greater range of error from the headrest operation halt distance. SAMPLE 2 has about 1 KHz greater frequency displacement volumes for each 1mm at 10mm distance of Fig. 5. Therefore, it can be seen that the halt location establishment is more effective for the existing silver with the copper plate additions compared to other SAMPLES by 0.5 KHz per each 1mm. SAMPLE 3 & SAMPLE 4 show a favorable frequency displacement values which indicates insignificant effect of shape changes. After setting the initial frequency value to where the distance between the head & headrest are 70mm and final frequency value at 0mm, SAMPLE 3 has large variation volumes as shown on Table 2. Also, to effectively detect the electrostatic capacities of human body's dielectric constancy, high electric conductive material should be used. Electrostatic capacity, larger the accumulated electricity quantum is longer the detection distance is. A highly conductive and wider sized material for the pole plate or high dielectric constancy substances increases the electrostatic capacity.

**Table 2. Frequency Variation Value**

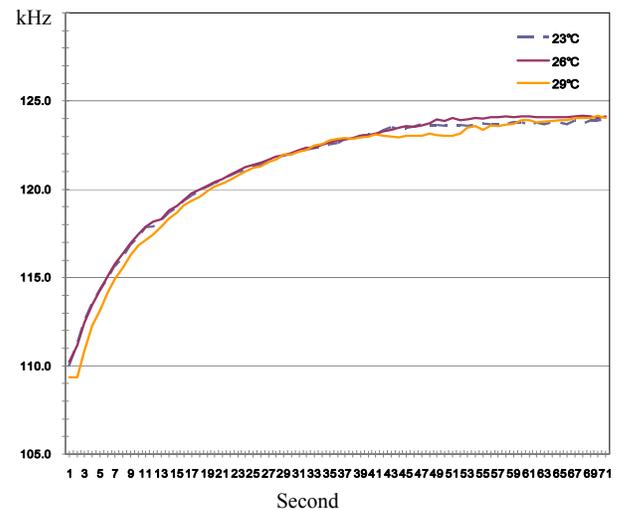
Classifications	70mm~0mm Block			Remarks
	Initial Values	Final Values	Variation Values	
SAMPLE1	123.93	109.97	13.96	Small
SAMPLE2	114.24	82.31	31.93	Large
SAMPLE3	99.60	78.00	21.6	Medium
SAMPLE4	102.74	82.17	20.57	Medium

Over time, there are insignificant fluctuations to frequency values as shown on Fig. 6.

The assurance of stability is indicated since the reliable resulting values were obtained due to minimal volatilities of the initial value.



**Figure 6. Time Specific Displacement Values of the Frequencies**



**Figure 7. Temperature Specific Displacement Values of Frequencies**

Fig. 7 shows the resulting values for the temperature change corresponding frequency values. The same specifications as SAMPLE 1 was repeatedly measured at 23°C, 26°C, 29°C for the temperature displacement measurement and has error range of 1Khz, ±3mm; the effect of temperature displacement is less at upper temperature.

## CONCLUSIONS

In this study, the sensor module is developed to graft the electrostatic capacity sensor technology onto the seat's headrest for the extraction of distance information and TEST JIG was utilized to conduct basic system performance evaluation of the sensor module's pole plate samples which supplies crucial variables. Able to select the useful electrostatic capacity sensor pole plate for the seat's headrest by understanding electrode sample specific characteristics and able to validate the usefulness in acquiring the distance information as the electrostatic capacity fluctuates according to the electricity quantum variations of the distances.

The characteristics of frequency values were verified through the basic performance evaluations, however execution of improvements are crucial from additional environmental tests.

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