

fall of the electric field much like a person standing in the water of an ocean. The presence of a dielectric body between the plates causes the waves to get bigger as more electrons flow to and from the plates of the capacitor. Thus, an occupant affects the magnitude of these waves which is sensed by the capacitor circuit. Thus, the electromagnetic field is a material agent that carries information about a passenger's position in both Kithil's and a beam-type electromagnetic wave sensor.

[0045] The following definitions are applicable and are from the Encyclopedia Britannica:

[0046] "Electromagnetic Field"

[0047] "A property of space caused by the motion of an electric charge. A stationary charge will produce only an electric field in the surrounding space. If the charge is moving, a magnetic field is also produced. An electric field can be produced also by a changing magnetic field. The mutual interaction of electric and magnetic fields produces an electromagnetic field, which is considered as having its own existence in space apart from the charges or currents (a stream of moving charges) with which it may be related . . ." (Copyright 1994-1998 Encyclopedia Britannica)

[0048] "Displacement Current"

[0049] ". . . in electromagnetism, a phenomenon analogous to an ordinary electric current, posited to explain magnetic fields that are produced by changing electric fields. Ordinary electric currents, called conduction currents, whether steady or varying, produce an accompanying magnetic field in the vicinity of the current. [. . .]

[0050] "As electric charges do not flow through the insulation from one plate of a capacitor to the other, there is no conduction current; instead, a displacement current is said to be present to account for the continuity of the magnetic effects. In fact, the calculated size of the displacement current between the plates of a capacitor being charged and discharged in an alternating-current circuit is equal to the size of the conduction current in the wires leading to and from the capacitor. Displacement currents play a central role in the propagation of electromagnetic radiation, such as light and radio waves, through empty space. A traveling, varying magnetic field is everywhere associated with a periodically changing electric field that may be conceived in terms of a displacement current. Maxwell's insight on displacement current, therefore, made it possible to understand electromagnetic waves as being propagated through space completely detached from electric currents in conductors." Copyright 1994-1998 Encyclopedia Britannica

[0051] "Electromagnetic Radiation"

[0052] ". . . energy that is propagated through free space or through a material medium in the form of electromagnetic waves, such as radio waves, visible light, and gamma rays. The term also refers to the emission and transmission of such radiant energy. [. . .]

[0053] "It has been established that time-varying electric fields can induce magnetic fields and that time-varying magnetic fields can in like manner induce electric fields. Because such electric and magnetic fields generate each other, they occur jointly, and together they propagate as electromagnetic waves. An electromagnetic wave is a transverse wave in that the electric field and the magnetic field at

any point and time in the wave are perpendicular to each other as well as to the direction of propagation. [. . .]

[0054] "Electromagnetic radiation has properties in common with other forms of waves such as reflection, refraction, diffraction, and interference. [. . .]" Copyright 1994-1998 Encyclopedia Britannica

[0055] The main part of the Kithil "circuit means" is an oscillator, which is as necessary in the system as the capacitor itself to make the capacitive coupling effect be detectable. An oscillator by nature creates a time varying electric field in a capacitor or waves. The system can operate as a sensor only if an alternating current flows through the sensor capacitor, which, in fact, is a detector from which an informative signal is acquired. Then this current (or, more exactly, integral of the current over time—charge) is measured and the result is a measure of the sensor capacitance value. The latter in turn depends on the passenger presence that affects the magnitude of the waves that travel between the plates of the capacitor making the Kithil sensor a wave sensor by the definition herein.

[0056] An additional relevant definition is:

[0057] "Capacitive Coupling"

[0058] The transfer of energy from one circuit to another by means of the mutual capacitance between the circuits. (188) The coupling may be deliberate or inadvertent. Capacitive coupling favors transfer of the higher frequency components of a signal, whereas inductive coupling favors lower frequency components, and conductive coupling favors neither higher nor lower frequency components." <http://www.its.bldrdoc.gov/fs-1037/dir-006 / 0842.htm>

[0059] Another similarity between one embodiment of the sensor of this invention and the Kithil sensor is the use of a voltage-controlled oscillator (VCO).

[0060] 7. Ultrasonic Occupant Sensors

[0061] The ultrasonic system is the least expensive and potentially provides less information than the optical or some radar systems due to the delays resulting from the speed of sound and due to the wave length which is considerably longer than the optical (including infrared) systems. The longer wavelength limits the detail, which can be seen by the system. In spite of these limitations, as shown below, ultrasonics can provide sufficient timely information to permit the position and velocity of an occupant to be accurately known and, when used with an appropriate pattern recognition system, it is capable of positively determining the presence of a rear facing child seat. One pattern recognition system that has been used to identify a rear facing child seat is a neural networks and is similar to that described in the above-referenced papers by Gorman et al.

[0062] 8. Occupant Location Based on Focusing

[0063] A focusing system, such as used on some camera systems, can be used to determine the initial position of an occupant but, in most cases, it is too slow to monitor his position during a crash. This is a result of the mechanical motions required to operate the lens focusing system, however, methods do exist that do not require mechanical motions. By itself it cannot determine the presence of a rear facing child seat or of an occupant but when used with a charge-coupled or CMSO device plus some infrared illumi-