part 21, and a process is carried out in which a unit fee is taken from this prepayment amount.

Fig. 4(C) depicts operation of the prepayment amount update mode.

In n30, a determination is made as to the locked state of the interlock A. If the interlock A is in a locked state, then the prepayment amount update mode is established. At this time, data are read from the pulse sensor 16 that also serves as the optical communications link. At this time, a fake finger is provided on the pulse sensor 16, and data corresponding to the paid prepayment amount is input to the diving watch main body 10 (n32). In addition, although not shown in the drawing, confirmation thereof is carried out in n33 in order to check the pass code when the prepayment amount is input. The process advances to n34 and subsequent steps only if the pass code corresponds. In n34, the update mode is set to "1," and the prepayment update process is carried out in n35. Next, the update mode is set to "0" (n36), and a condition is produced in which the pulse sensor 16 can detect pulse data (n37).

In n7, if the risk evaluation value of the data that has been read from the ROM 19 is extremely high, the antenna 18 is driven, and an emergency signal is sent to the receiver of an aid boat or a buoy.

As a result of the above operations, the insurance premium is determined in accordance with risk evaluation values that change over time and are evaluated with a diving watch. Settlement of the change in insurance premium can be carried out using a prepaid amount.

Credit settlement may also be performed using a credit card, rather than settlement of the payment using a prepaid amount. Moreover, an electronic currency transfer request may be produced and transmitted. Moreover, in this example of embodiment, an external sensor and internal sensor were used together, but either one of these may be used alone. Detection of states contributing to risk and calculation of risk evaluation values by fuzzy logic were carried out in real time using an external sensor and internal sensor, but the risk evaluation values also may be determined subsequently, or the change in insurance premium may be calculated subsequently from the determined risk evaluation values. In addition, fuzzy logic was used as the means for determining risk evaluation values in this example of embodiment, but determination may be carried out without using fuzzy logic. Calculation may also be carried out using a common insurance table.

Another example of embodiment of the invention is described below.

Fig. 5 is a configuration diagram of a device that employs an insurance premium determination system in a risk evaluation device installed in a vehicle (automobile).

In the figure, 30 denotes a doppler radar main body, which detects speed relative to an object using ultra-short-wave radio waves or 10 kHz-band FO waves. When ultrasound is used, it is possible to use waterways as propagation paths.

This doppler main body 30 has a transmission part 31, a radiation and coupling part 32, and a receiver 33. The transmission part 31 includes an oscillator with stabilized output. When the ultra-short-wave is to be used, the radiation and coupling part 32, for example, is constituted by a directional antenna for transmission and reception and a waveguide tube-type coupler. When air ultrasound is to be used, it is constituted by a ring-shaped piezoelectric ceramic element equipped with a reflector, and when water ultrasound is to be used, it is equipped with a Langevin-type piezoelectric ceramic element having a matcher. A three-coil transformer is used in combination with each. Moreover, the receiving part 33 carries out homodyne wave detection using the ultra-weak transmission wave component 34 that leaks from the radiation and coupling part 32 as a local oscillation frequency, and also separates the doppler component. This transmission wave component 34 is the signal f_{00} that is reflected towards the subjected to be monitored via the transmission medium. In addition, the received waves 35 are reflected by the subjected to be monitored, thus producing a signal that has a doppler frequency shift, specifically $f_{00} + f_a$ and $f_{00} + f_x$. Fig. 6 shows the spectrum of the transmitted and received waves.

The doppler component 36 obtained as the wave detection, specifically, f_0 and f_x are output from the aforementioned doppler main body 30. f_0 corresponds to the ground speed of the automobile (boat) reflected from a non-moving structure, and f_x corresponds to the reflection from the frontward moving body. This signal is input to the signal preprocessing unit 37. This unit 37 separates the moving body speed component from the doppler radar output and obtains a speed signal and level signal (corresponding to the strength of the reflected wave). The output from the speed detector 38 is conducted to the signal processing unit 37 in order to carry out this processing. The speed detector measures its own ground speed. For example, for an automobile, the speed detector is constituted by an encoder that is linked to the wheel axis, and for a boat, the detector is constituted by a [tugboat log] that is corrected for current speed. The output V_0 of this speed detector 38 is conducted to the aforementioned signal preprocessing unit 37 and is also conducted to the system activation control part 39. This system activation control part keeps the system in an operating state when the "self" speed V_0 exceeds a set value. Alternatively, a system may be used in which a signal from land is received when the moving body passes through a gateway, and the system is placed in an operational state.

The speed signal 40 (P_x) obtained from the aforementioned processing unit 37 and a difference signal 41 (E_x) corresponding to the strength of the reflected wave are output to the risk evaluation unit 42. The risk evaluation unit 42 then performs real-time evaluation of the degree of risk during operation from the state signals of the automobile (boat) using a signal processing process including fuzzy logic. The state signal from the automobile (boat) includes the "self" ground angle [*sic*] as V_0 from the aforementioned speed detector 38 along with the rotation rate detected by the main engine rotation rate detector 43. Moreover, in this example of embodiment, the detection data from the control operation detection part 44 is also used as a fuzzy input value. The control operation detection part 44 detects clearly intentional operations, for example, when there is a deviation in the rudder operation mechanism that is at or above a set value.

The output of the risk evaluation unit 42 is output to the warning device 45 and monetary amount file part 46. The warning device 45 warns of the presence of risk using an alarm, voice, or vibration through operation of the risk evaluation unit 42. The monetary amount file part 46 has a memory that stores the prepayment balance. This monetary amount file part 46 erases, from the prepayment money balance, the insurance premium change corresponding to the risk evaluation value output from the risk evaluation unit 42. This monetary amount file part 46 may also be constituted by a transmission-side currency on-line system. Moreover, by providing a data communications terminal, credit processing can also be carried out.

In the above configuration, states in the operator or moving body used as the subject of risk evaluation which contribute to risk are respectively detected by the doppler radar main unit 30, the speed detector 38, the main engine rotation rate detector 43, and the control operation detection part 44. The risk evaluation unit 42 continually evaluates risk using fuzzy logic on fuzzy input values which are input as signals that express these risk contributing states. When the risk value exceeds a set value, a warning is sent by a warning device 45 to the operator. By using this type of configuration, it is possible to evaluate risk in accordance with empirical evaluation of individuals without calculating absolute values for object distance. Consequently, erroneous risk evaluation due to false signals will not occur. A configuration may also be used wherein only the moving state of the moving body is used as the input value for fuzzy logic. In this example of embodiment, because the control operation density evaluation value of the moving body is also used as a fuzzy input, the results of fuzzy logic are more accurate. In addition, in this example of embodiment, an insurance premium determination system is used in addition to risk evaluation, which allows risk evaluations that change from hour to hour during travel to be reflected in the insurance premium.

Fig. 7, etc., show a detailed configuration diagram for the main parts of the system shown in Fig. 5.

Fig. 7 is a concrete configuration diagram of the signal preprocessing unit 37.

50 is a balance modulator which is constituted, for example, by a ring modulator. Integrated values for the signal waves of (f_0, f_x) and f_{v0} are output. Fig. 8 shows the spectra of the respective signals in the signal processing part. In the figure, f_x denotes the doppler component due to the frontward moving body. f_0 denotes the doppler component due to a non-moving structure. In addition, $f_{v0}+f_x$ is the upper band wave of f_x. This signal is blocked by a channel band pass filter in accordance with the f_{v0} division range. f_0-f_{v0} is the lower bandwidth frequency resulting from the difference relative to a false transmission wave. Under ideal measurement conditions, the signal is not generated unless there is slide or slip of wheels. By using this signal, it is possible to detect vehicle sliding or slip by means of phase comparison.

51 is a variable frequency oscillator. This variable frequency oscillator 51 takes the analog signal expressing the "self" ground speed V_0 as an input

signal and outputs a linear-relationship frequency. For example, this component is constituted by an LC oscillator having a variable capacitance diode. Moreover, when this signal representing the "self" ground speed is a pulse rate analog signal, this variable frequency oscillator 51 may be constituted by a frequency multiplier. The frequency produced by this variable frequency oscillator 51 is conducted to the balance modulator 50.

The output of the balance modulator 50 is output to a variable band pass filter 52, where it is subjected to filtering. The filter 52 may be constituted, for example, by a switched capacitor filter. f_{v0}-f_x is separated from f_{v0}+f_x, f_{v0}-f_0, and f_{v0}+f_0 and output. The filter can be constituted by a PLL wave detector. 53 denotes a channel selection part, which discretely selects the pass band of the variable band pass filter 52 in accordance with the value range of the ground speed V_0. 54 is an AM detector. This detector detects the analog signal representing the intensity of the f_{v0}-f_x signal wave amplitude component, specifically, the reflected wave from the frontward moving body, and outputs it to the risk evaluation unit 42 as P_x. In addition, 55 is an FM detector which outputs the analog signal representing f_{v0}-f_x, specifically, the ground speed of the frontward moving body, as E(f_{v0}-f_x). An operational amplifier 56 receives this signal and the analog signal V_0 representing the "self" ground speed, extracts the analog signal E(x) representing the speed relative to the frontward moving body, and outputs it to the risk evaluation unit 42.

Fig. 9 is a concrete configuration diagram of the risk evaluation unit 42. 60 denotes an integrator. This integrator 60 integrates the signal E(x) representing the relative speed of the moving body and calculates the approximate distance from the relative speed. An initializer 61 monitors the reflected wave level on the signal P_x, and when this reflected wave level is at or below a set value, generates a reset signal to reset the integrator 60. 62 is a first fuzzy logic part. This first fuzzy logic part has a function whereby it carries out defuzzification subsequent to balancing the MIN-MAX outputs.

Another integrator 63 integrates and smoothes the impulse waveform with the output from the control operation detection part 44 defined in advance as an event signal. Subsequently, an operation frequency index is determined from the smoothed value. This value is output to the second fuzzy logic part 64 as a fuzzy input value for risk evaluation. In addition, the ground speed signal V_0 and main engine rotation rate are also input as fuzzy input values into the second fuzzy logic part 64. As a result, the second fuzzy logic part 64 infers the risk evaluation value related to "self" internal states. Moreover, the first fuzzy logic part 62 infers the risk evaluation value related to the frontward moving body.

The output of the first fuzzy logic part 62 and the second fuzzy logic part 64 are conducted to a third fuzzy logic part 65 as fuzzy input values. The risk evaluation value resulting from a comprehensive determination carried out at this third fuzzy logic part 65 is then output to the output controller 66, where the logical output level and the output in accordance with the hold time level are sent to the warning device 45 and the monetary amount file 46.

Fig. 10(A) to (E) show the respective language value membership functions of the fuzzy logic parts 62, 64, and 65. (A) shows the input function of the first fuzzy logic 62, and (B) shows the output function of the first fuzzy logic part 62 and the first input function of the third fuzzy logic part 65. By using these functions, risk evaluation values are obtained for the frontward moving body. (C) shows the input function for the second fuzzy logic part 64. (D) shows the output function of the second fuzzy logic part 64 and the second input function of the third fuzzy logic part 65. With these functions, risk evaluation values are obtained for the "self" internal state. (E) shows the output function of the third fuzzy logic part 65. With this function, risk evaluation values are obtained for the final overall determination.

Fig. 11(A) to (C) show the rules for the respective fuzzy logic parts. In the figure, "*" denotes that the consequent part is not present.

As a result of the configuration of the example of embodiment described above, even if a pulse radar system is not used, it is possible to carry out risk evaluation by a cognition pathway involving empirical evaluation, and when this evaluation value is at or above a set value, a warning can be sent to the operator. Moreover, because of combination with an insurance premium determination system, it is possible to make settlements by erasing the amount of the insurance premium change in accordance with risk that varies hourly. Consequently, a fairer insurance system can be constructed in contrast to conventional casualty insurance clerical work.

(g) EFFECT OF THE INVENTION

In accordance with the risk evaluation device of the invention, it is possible to include empirical evaluations in risk evaluations carried out using fuzzy logic, and thus risk evaluation values can be expected to be more accurate, because they are not susceptible to external noise and the like. In this case, when a risk evaluation device was used in the moving body, because it is not necessary to use a pulse radar system as in the past, circuitry is not complicated, and the system is not influenced by multiple reflected transmission pathways. For this reason, safety devices can be configured that can provide more accurate warnings. The accuracy can be further improved by detecting control operation density evaluation values in the moving body as well as the moving state of the moving body. Moreover, when the evaluated risk level is at or below a set value, no warning is provided, and the influence of noise can be further decreased. In addition, sporadic warnings that allow immediate recurrence can also be avoided. Moreover, by using the risk evaluation device employing a risk evaluation part that operates by fuzzy logic together with an insurance premium determination system, change in insurance premiums in accordance with continually varying risk evaluation values can be settled in real time, thereby allowing insurance to be more equitable. Because the insurance premium difference can be settled by payment or credit, conventional systems involving prepaid cards or credit cards can be utilized without modification, thus facilitating use.

In the invention, by using a risk evaluation device that has a risk evaluation means that evaluates risk along with a means for determining changes in insurance premiums, insurance premiums can be determined in accordance with the degree of risk in subjects of risk evaluation which changes over time. The invention thus has the advantage of being a more equitable insurance system. In this case, the risk evaluation means need not contain an evaluation part that operates by fuzzy logic. The insurance premium determination system allows the use of conventional prepaid card and credit card systems without modification, as mentioned above, and a system that is easy to use can be constructed with a simple configuration.

4. BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a configuration diagram of the insurance premium determination system of an example of embodiment of the invention. Fig. 2 is an external diagram of a diving watch for a case in which the insurance premium determination system is used in combination with a diving watch. Fig. 3 is a configuration diagram of the diving watch. Fig. 4(A) to (C) are flow charts depicting operation of the diving watch. Fig. 5 shows a second example of embodiment of the invention and shows a configuration diagram for a case in which the risk evaluation device and the insurance premium determination system are used in combination. Fig. 6 shows the spectra of the transmission wave and receiving wave in this example of embodiment. Fig. 7 is a configuration example of the signal preprocessing unit. Fig. 8 shows the spectrum in the signal preprocessing unit. Fig. 9 is a configuration diagram of the risk evaluation unit. Fig. 10(A) to (E) are diagrams showing the membership functions used in the fuzzy logic parts of the risk evaluation unit. Fig. 11(A) to (C) are diagrams showing the fuzzy rules.

1 – External sensor, 2 – Internal sensor,
3 – Fuzzy logic part, 4 – Fuzzy memory
6 – Monetary amount calculation part
7 – Output interface part
8 – Monetary amount file part

Applicant: Omron Corp.
Agent: Patent Attorney, Hisao KOMORI

Fig. 1

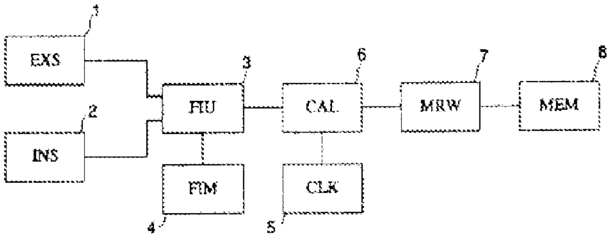


Fig. 3

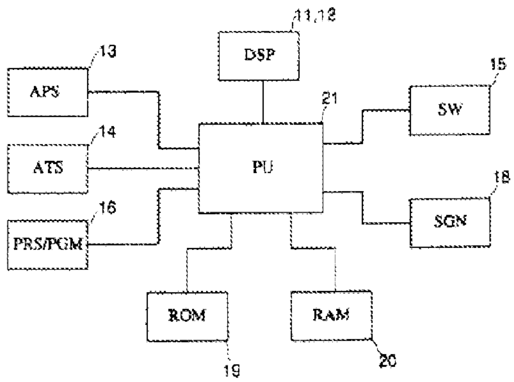


Fig. 2

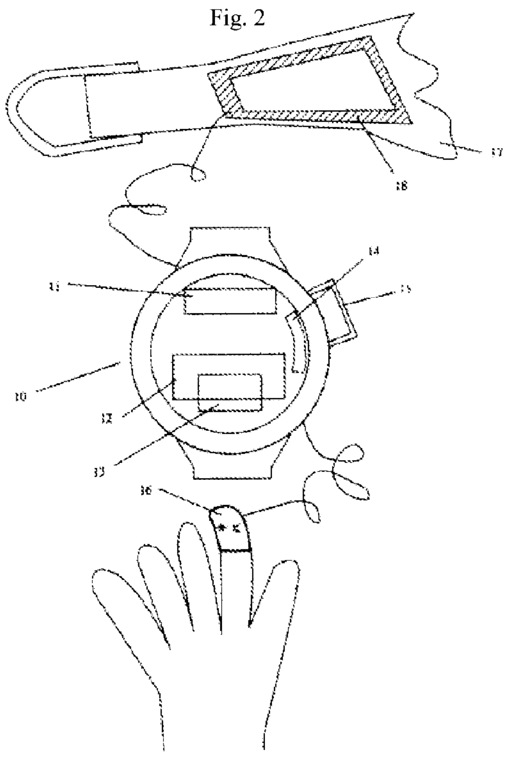
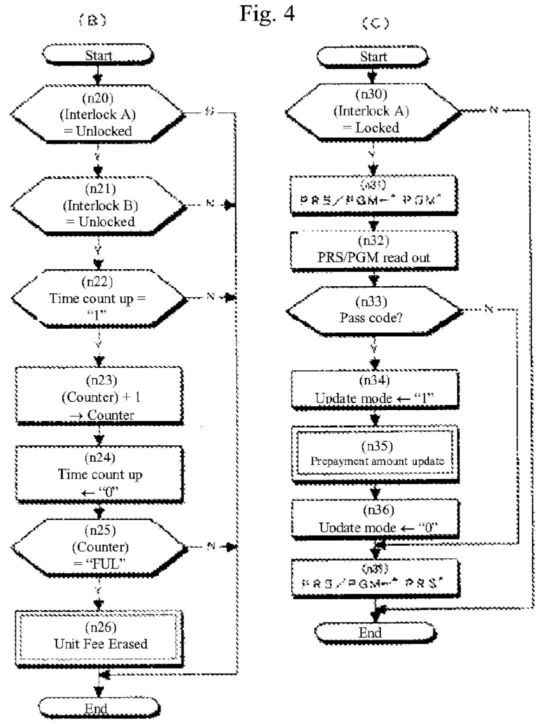


Fig. 4



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