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Adaptive Cruise Control Collision Warning with Brake Support

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Abstract — This project consists of a handheld range finding device using ultrasonic transducer and an LPC2148. A two-line LCD display is used to display the measurements. There is a 40 kHz transmitter and receiver. The 40 kHz-transmission signal is generated via a square wave outputted from the LPC2148 . The LPC2148 is then used to calculate the time of flight (TOF) for the sound wave that is bounced off of distant objects. The return signal is amplified using two opamp amplifiers. There are three potentiometers that need to be calibrated for correct operation. One controls the contrast of the LCD display. Another controls the amplification of the third stage of the amplifier system. The third controls the voltage offset that connects to the base of a NPN switching transistor. The measurement range of the device is one to ten feet. Further distances can be measured, but due to circuit noise erroneous measurements can be obtained for longer distances. The absolute maximum range that can be measured is about twenty feet.

Keywords— Cruise Control, Collision Avoidance

I. Introduction

The Intelligent Vehicle Initiative (IVI) provides vehicle-based tools that could assist drivers in reacting both more rapidly and effectively to a range of external stimuli. Intelligent or adaptive cruise control systems (ICC or ACC), for example, attempt to assist drivers in better maintaining a safe headway under normal driving conditions. In addition, automatic braking systems may provide additional safety benefits by assisting drivers to respond more quickly to unexpected events. The focus of this project is to describe the research that has been conducted to date in order to evaluate the safety impacts of ACC type of control. Initially, the various types of ICC systems that have been described in the literature to date are presented. The intent of this overview is to demonstrate that the term ICC or ACC may differ depending on the source of information. For example, some ACC systems have no braking capabilities while others do. Consequently, results need to be interpreted within this context.

The Adaptive cruise control collision warning with brake support integrated system allows the driver to set the vehicle's speed and maintain it without using a acceletor pedal and uses radar sensors to detect moving vehicles ahead and warns driver collision risks. Cruise control (sometimes known as speed control or auto cruise) is a system that automatically controls the speed of a motor vehicle. This project consists of a handheld range finding device using ultrasonic transducer and an LPC2148. A two-line LCD display is used to display the measurements. There is a 40 kHz transmitter and receiver. The 40 kHz-transmission signal is generated via a square wave outputted from the LPC2148. The LPC2148 is then used to calculate the time of flight (TOF) for the sound wave that is bounced off of distant objects. The return signal is amplified using two operational amplifiers. There are three potentiometers that need to be calibrated for correct operation. One controls the contrast of the LCD display. Another controls the amplification of the third stage of the amplifier system. The third controls the voltage offset that connects to the base of a NPN switching transistor. The measurement range of the device is one to ten feet. Further distances can be measured, but due to circuit noise erroneous measurements can be obtained for longer distances.

II. Literature Survey

Road accidents are undoubtedly the most frequent and overall the cause of most damage. The reasons for this are the extremely dense road traffic and the relatively great freedom of movement given to drivers. Accidents involving heavy goods vehicles(especially coaches and lorries with trailers) occur all too frequently despite calls for responsible behaviour,for respect of the loading regulations and the highway code, as well as the obligation for drivers to adapt their speed, which affects stopping distances, to the traffic and weather conditions(rain,ice,fog,etc).

A. *Conventional Cruise Control* Conventional cruise control takes over the accelerator operation at speeds over 48 km/h (30 mph) when it is engaged. Activation requires that the ON button is pressed and the desired speed set. The driver has to press the ON button to activate the system each time the engine is started. Once the cruise control is ON, the driver can set a speed by driving at the desired speed and then pressing the SET button.
In order to deactivate the system while maintaining the set speed in memory, the driver has the choice to either make a soft tap on the brake pedal or press the CANCEL button. Pressing the OFF button or turning off the ignition turns the speed control system off and erases the memory. In order to resume to a previously set speed, the driver needs only to press the RESUME button as long as the speed exceeds 40 km/h (25 mph). The driver can also vary the speed setting by either pressing and holding the ACCEL button and releasing the button when the

new set speed is established, or by tapping the ACCEL button. Each tapping of the ACCEL button results in a 3.2 km/h (2 mph) increase in the vehicle speed.

Initially, the various types of ICC systems that have been described in the literature to date are presented. The intent of this overview is to demonstrate that the term ICC or ACC may differ depending on the source of information. For example, some ACC systems have no braking capabilities while others do. Consequently, results need to be interpreted within this context.

Following a description of the various types of ACC applications, this chapter synthesizes the results of evaluation studies of these ACC systems. The intent of this synthesis is to describe what has been done so far in the area of evaluating ACC type of control in order to set the stage for the subsequent chapters that describe how ACC was evaluated in this thesis. In order to decrease the speed while the speed control is ON, the driver needs to hold the COAST button and release it when the desired speed is reached. It must be noted that pressing the accelerator does not alter the set speed. Consequently, when the accelerator pedal is released, the vehicle returns to the previously set speed. In addition, the conventional cruise control can downshift to third gear if it is necessary to maintain the vehicles set speed.

B. *Intelligent Cruise Control*

While conventional cruise control (CCC) maintains a fixed vehicle speed during operation, the idea of the ICC system is to maintain a chosen headway distance (Martin 1995, 83). The operation of ICC is not always different, however, from CCC. While not in traffic, the ICC system acts as a CCC system (Koziol and Inman 1997, 146). The ICC system can downshift in order to maintain a selected headway or to maintain a set speed as is the case of conventional cruise control. The intent of the ICC system is that the number of times that a driver engages disengages or changes the cruise control settings while in traffic decreases compared to CCC (Koziol and Inman 1997, 145).

C. *Summary of literature survey*

From the above literature survey it can be summarized that it is possible for creating a quick and effective Adaptive cruise control collision warning with brake support. After doing the observation of number of accidents we cleared that frequency of crashes is because of unsafe drivers. Driving under the influence of alcohol or drugs, which is responsible for about one-third of all road accidents. Every year people are injured or killed on the road because another driver was driving under the influence. Defensive drivers never drink nor take drugs and drive. They understand that alcohol and drugs impair your- Ability to determine distances, Reaction time, Judgment and vision. None of this above detects Driver or Passenger misbehavior

III. PROBLEM STATEMENT

A. *Aim*

To design Adaptive Cruise control collision warning with brake support.

B. *Objectives*

The Adaptive cruise control collision warning with brake support integrated system allows the driver to set the vehicle's speed and maintain it without using a acceletor pedal and uses radar sensors to detect moving vehicles ahead and warns driver collision risks.

C. *Software Requirement*

- PROTEUS 8.0
- Keil 5 (embedded C)

D. *Hardware Requirement*

- ARM7 (LPC2148)
- RF receiver and transmitter
- Power supply
- LCD,DC motor
- Ultra sonic sensors

IV. DEVICE OVERVIEW

LPC2148

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-CPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2141/42/44/46/48 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

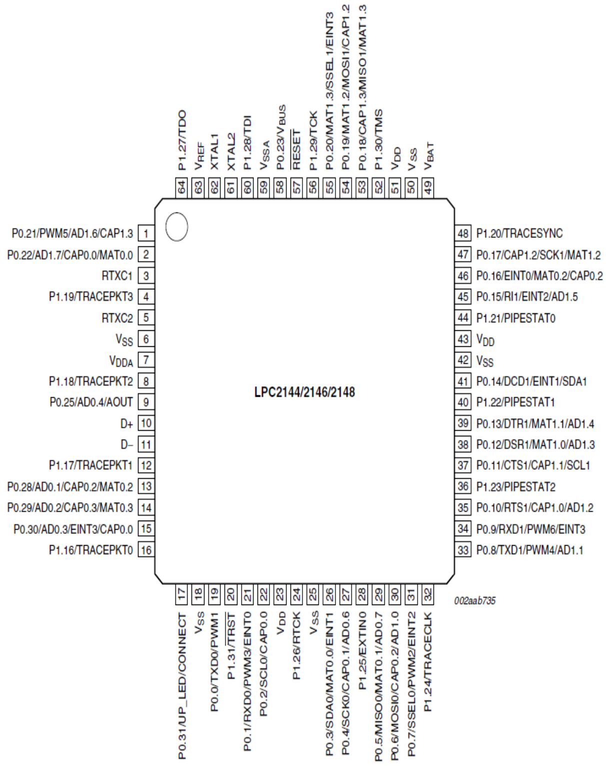


Fig. Pin diagram LPC2148

Features

1. **Key features**

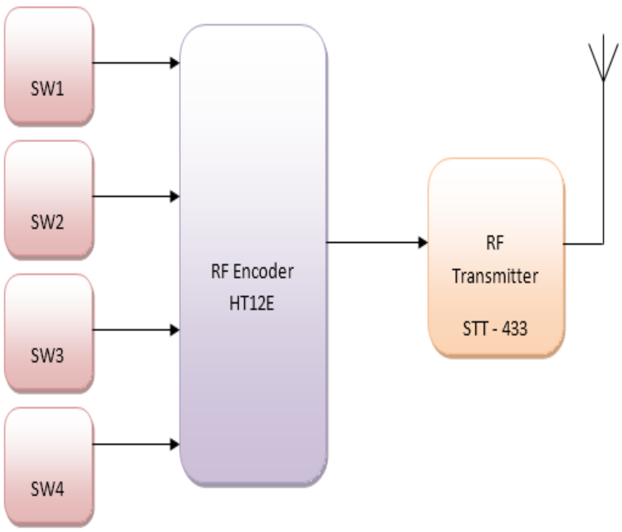
- 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash memory.
- 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader
- Software. Single flash sector or full chip erase in 400 ms and programming of
- 256 bytes in 1 ms.
- EmbeddedICE RT and Embedded Trace interfaces offer real-time debugging with the
- On-chip RealMonitor software and high-speed tracing of instruction execution.
- USB 2.0 Full-speed compliant device controller with 2 kB of endpoint RAM.
- In addition, the LPC2146/48 provides 8 kB of on-chip RAM accessible to USB by DMA.
- One or two (LPC2141/42 vs. LPC2144/46/48) 10-bit ADCs provide a total of 6/14
- analog inputs, with conversion times as low as 2.44 μs per channel.
  - Single 10-bit DAC provides variable analog output (LPC2142/44/46/48 only).
  - Tw o 32-bit timers/external event counters (with four capture and four compare
  - Channels each), PWM unit (six outputs) and watchdog.
  - Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input

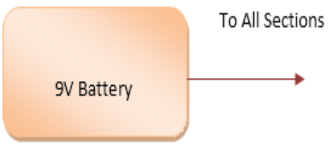
- Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 kbit/s),
- SPI and SSP with buffering and variable data length capabilities.
- Vectored Interrupt Controller (VIC) with configurable priorities and vector addresses.
- Up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package.
- Up to 21 external interrupt pins available.
- 60 MHz maximum CPU clock available from programmable on-chip PLL with settling
- Time of 100 µs.
- On-chip integrated oscillator operates with an external crystal from 1 MHz to 25 MHz.
- Power saving modes include Idle and Power-down.
- Individual enable/disable of peripheral functions as well as peripheral clock scaling for
- Additional power optimization.
- Processor wake-up from Power-down mode via external interrupt or BOD.
- Single power supply chip with POR and BOD circuits:
- CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V tolerant I/O

2. **ARM has 37 registers all of which are 32-bits long.**
   - 1 dedicated program counter
   - 1 dedicated current program status register
   - 5 dedicated saved program status registers
   - 30 general purpose registers
   - The current processor mode governs which of several banks is accessible. Each mode can access
   - a particular set of r0-r12 registers
   - a particular r13 (the stack pointer, sp) and r14 (the link register, lr)
   - the program counter, r15 (pc)
   - the current program status register, cpsr
   - Privileged modes (except System) can also access

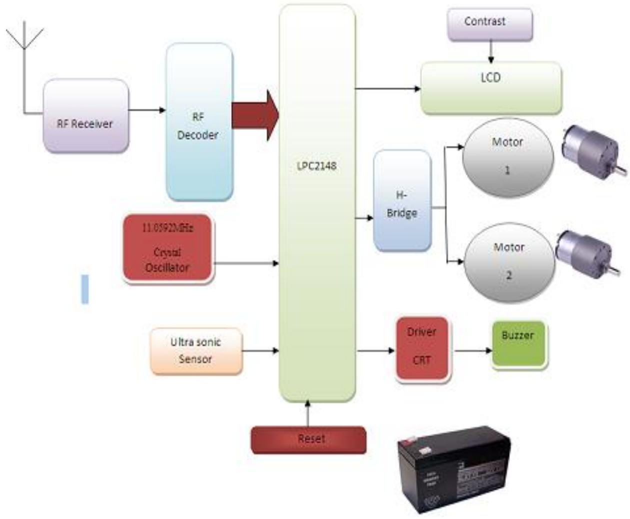
V. System Design

A. *Transmitter*





B. *Receiver*



C. *Ultrasonic Waves*

Ultrasonic sensors (also known as transceivers when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.

This technology can be used for measuring: wind speed and direction (anemometer), fullness of a tank and speed through air or water. For measuring speed or direction a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water. To measure the amount of liquid in a tank, the sensor measures the distance to the surface of the fluid. Further applications include: humidifiers, sonar, medical ultrasonography, burglar alarms and non-destructive testing.

Systems typically use a transducer which generates sound waves in the ultrasonic range, above 18,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed.

The technology is limited by the shapes of surfaces and the density or consistency of the material. For example foam on the surface of a fluid in a tank could distort a reading..

Calculation for target finding:

The time from transmission of the pulse to reception of the echo is the time taken for the signal energy to travel through the air to the object and back again. Since the speed of signal is constant through air measuring the echo reflection time lets you calculate the distance to the object using the DST equation:

Distance = (s * t)/2 (in meters)

You need to divide by 2 as the distance is the round trip distance i.e. from transmitter to object and back again.

Where:

s [m/s]	the speed of sound in air
t [s]	The round trip echo time.

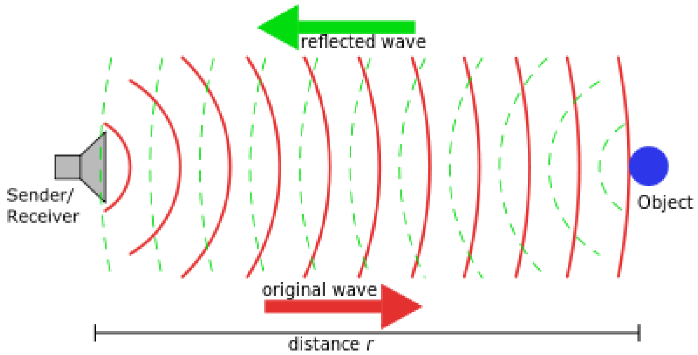
Some delay times:

Round trip echo time	Distance
t = 588us	10cm
t = 5.8ms	1m

The speed of sound in air is more or less constant at 330m/s (@ 0ºC) - it varies mainly with temperature (~340m/s @ 20ºC). In this project I am using a value of 340m/s i.e. it is assumed that the project is used indoors. You can change it to whatever you like by modifying the code.

You can get ultrasonic transducers optimized for 25 kHz, 32 kHz, 40 kHz or wide bandwidth transducers. This project uses a 40 kHz transducer but it will still work with the others if you make simple changes to the software (where it generates the 40kz signal). The receiver and generator circuits will work as they are. If you use a different transducer you must change the software to generate the correct frequency for the transducer as they only work at their specific operating frequency. The 40kz signal is easily generated by the microcontroller but detection requires a sensitive amplifier. I have used a three transistor amplifier for the receiver.

This is followed by a peak detector and comparator which set the sensitivity threshold so that false reflections (weaker signals) are ignored.



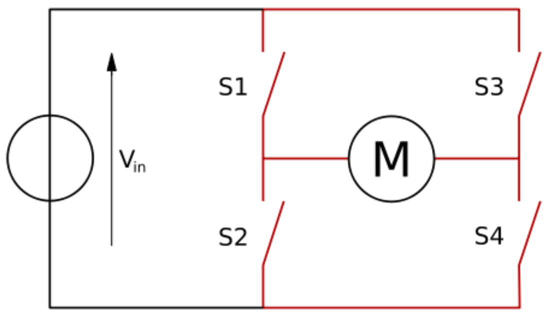


Fig. Distance Measurement

D. *H-Bridge*

H-bridge is an electronic circuit which enables DC electric motors to be run forwards or backwards. These circuits are often used in robotics. H-bridges are available as integrated circuits, or can be built from discrete components The two basic states of a H-bridge. The term "H-bridge" is derived from the typical graphical representation of such a circuit. An H-bridge is built with four switches (solid-state or mechanical). When the switches S1 and S4 (according to the first figure) are closed (and S2 and S3 are open) a positive voltage will be applied across the motor. By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the motor. Using the nomenclature above, the switches S1 and S2 should never be closed at the same time, as this would cause a short circuit on the input voltage source. The same applies to the switches S3 and S4. This condition is known as shoot-through.

E. *RF Technology*

Radio frequency (**RF**) is a frequency or rate of oscillation within the range of about 3 Hz to 300 GHz. This range corresponds to frequency of alternating current electrical signals used to produce and detect radio waves. Since most of this range is beyond the vibration rate that most mechanical systems can respond to, RF usually refers to oscillations in electrical circuits or electromagnetic radiation. RF is widely used because it does not require any line of sight, less distortions and no interference.

F. *LCD*

LCD stands for **L**iquid **C**rystal **D**isplay. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the following reasons:
1. The declining prices of LCDs.
2. The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.
3. Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU to keep displaying the data.
4. Ease of programming for characters and graphics.
These components are “specialized” for being used with the microcontrollers, which means that they cannot be activated by standard IC circuits. They are used for writing different messages on a miniature L

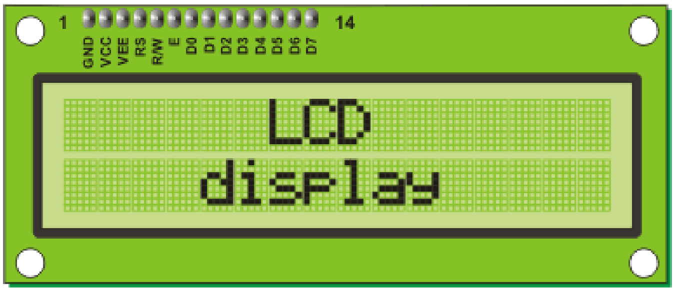
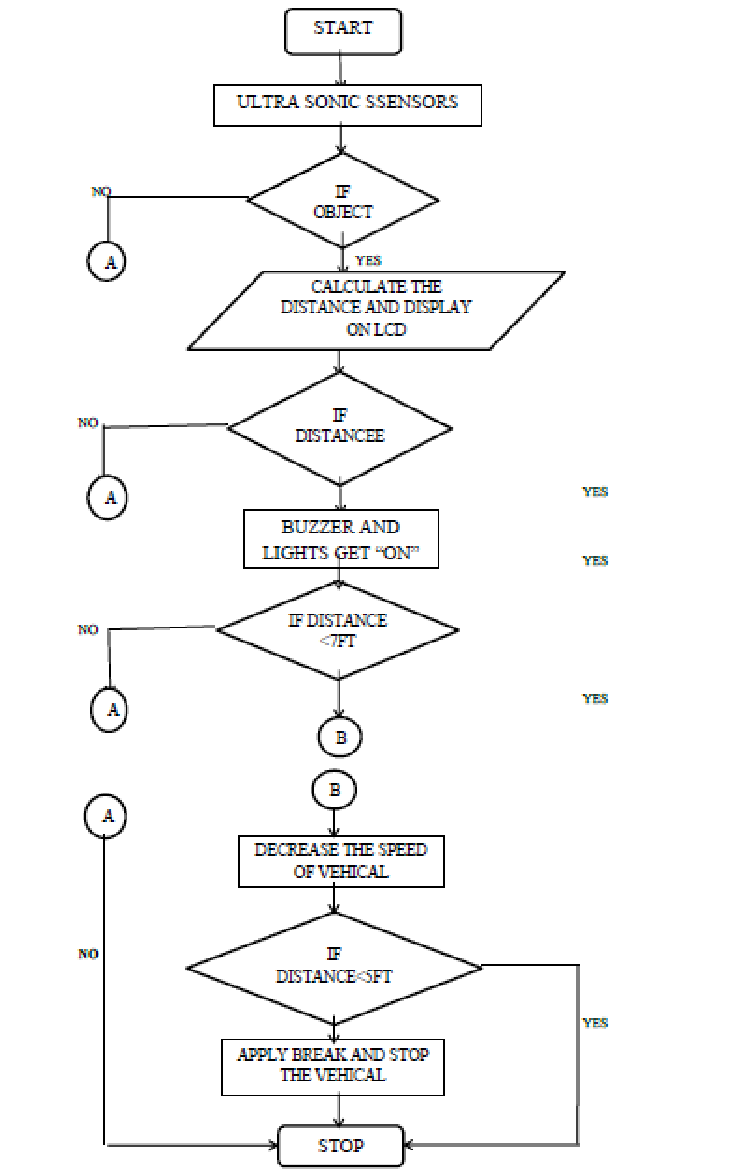


Fig. LCD Display

LCD screen:

LCD screen consists of two lines with 16 characters each. Each character consists of 5x7 dot matrix. Contrast on display depends on the power supply voltage and whether messages are displayed in one or two lines. For that reason, variable voltage 0-Vdd is applied on pin marked as Vee. Trimmer potentiometer is usually used for that purpose. Some versions of displays have built in backlight (blue or green diodes). When used during operating, a resistor for current limitation should be used (like with any LE diode).

G. *Flowchart*



VI. ADVANTAGES

When used for sensing functions, the ultrasonic method has unique advantages over conventional sensors:

- Discrete distances to moving objects can be detected and measured.
- Less affected by target materials and surfaces, and not affected by color. Solid-state units have virtually unlimited, maintenance free life. Can detect small objects over long operating distances.
- Resistance to external disturbances such as vibration, infrared radiation, ambient noise, and EMI radiation.
- Sound navigation and Ranging—SONAR—is used to find and identify objects in water. It is also used determine water depth (bathymetry). Sonar is applied to water-based activities because sound waves attenuate (taper off) less in water as they travel than do radar and light waves. Sonar was first used during World War I to detect submarines.
- Spontaneous output.

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