Garrett Chinsomboon
L03, Dr. Koblasz/Maxwell
Team Road Rage
Indoor Sonar Rangefinder and Available Products

Introduction

Commonly used in maritime navigation systems, the sound pulse-based sonar technology is utilized for object detection, communication and navigation [1]. The uses of acoustic location or 'echo-location' have become popular in environments where human vision appears to be ambiguous. Just as bats aerial navigate through dark caves and dolphins journey across oceans, humans learn to develop sonar into a visual aid both under and above water to detect obstacles and determine range. Over the years, sonar has proved to be substantial in the military, medical, petroleum and automobile industries [2]. Today, applications of this technology include seismic exploration, anti-collision detection, ocean surveillance and ultrasonography [3]. Indoor sonar rangefinder devices can be implemented to generate real-time sonar ranging images through MATLAB by integrating the commercially available sonar rangers with microcontrollers.

Indoor Sonar Range Detection Products Available

Parts for monostatic range detection operation, where both the emitting and receiving unit are in the same location, is widely available. One set of models is offered by Acroname Robotics and manufactured by Devantech Ltd [4]. These sonar rangers all emit pulses at 40 kHz frequency but draws slightly different voltage (from 3V to 14V) and current levels (from 10mA to 50mA). The R334-SRF485WPR model provides a RS485 serial connection and is interfaced with a water resistant transducer; it yields a detection range of 60 cm to 5 m and costs $59.50 per unit [5]. The R93-SRF04 model (unit price of $29.50) only has a maximum range of 3 m but is highly sensitive; it is able to detect a small stick of 3 cm diameter more than 2 m away [6]. The R145-SRF08, priced at $64.00, has a detection range of up to 6 m and incorporates a front facing light sensor. It outputs data through an I^2C bus or the "two-wire interface", providing a method to obtain information through the bidirectional Serial Data Line (SDA) and Serial Clock (SCL) [7]. The R322-SRF01 also has a detection range of up to 6 m but provides a one-pin UART serial 9600 baud connection; it costs $36.00 per unit [8].

MaxBotix Inc. also produces a series of sonar equipment; the MaxSonar EZ0 product line. Some models have a wide field-of-view and high beam-intensity manufactured to detect people and smaller objects; other models have high noise-tolerance with a narrower beam for large targets but provide less sensitivity [9]. The MB1000 model has zero-distance object detection ability with maximum range of 6.4 m and has a reading rate of 20 Hz with a 42 kHz sensor. Data is obtained through the serial, 81N and 9600 baud connections; the MB1000 has a unit price of $29.95 [10]. The MB1040 model is sold at the same price as the MB1000 and provides much of the same features but it offers higher noise tolerance, making it more suitable for large-object detection. The MB 1200 series has a higher price range of $29.95 to $54.95, but provides real-time automatic calibration and better firmware filtering for clutter rejection [11]. Through lowering the voltage supplied to MaxSonar devices, the detection range and the field-of-view of the sonar will also decrease accordingly [12]. In general, the minimum range of the sonar rangefinder is determined by the time it takes to emit pulses and eliminate unwanted ringing, whereas the maximum detection range is mainly controlled by the power of the sound pulses.

Underlying Technology of Indoor Sonar Rangefinder

Active sonar devices determine range by emitting an initial pulse and measures the time until the echoed signals are received; the distance to object is calculated using the response time and the speed of sound. In active sonars, either a chirp (frequency sweep) or a constant frequency can be released by the emitter. One of the first uses of sonar is the application for submarine detection, as early as 1915, with the earliest version being passive listening device where no sound pulses were emitted [13]. Passive sonar compares the received signals against a known database to determine the type of object detected.

Indoor sonars are commonly used in conjunction with the PIC or Arduino microcontrollers. Typically, two 40 kHz transducers or are utilized, one being the emitter and the other being the receiver. If a multidirectional sonar is desired, the transducers should be mounted on an R/C servo which will result in a greater field-of-view. Many have opted for a ranging module instead of a circuit board, to produce and process the signal at the transducer into standard digital logic signals. In terms of a chirp-signal analysis, the recorded waveform is multiplied to the original chirp generated in order to identify peaks or objects in the echo [14]. For some sonar rangers, multiple readings will significantly increase the signal accuracy therefore a slower R/C servo rotation speed is desired to allow time for the sound pulse to echo and register at the receiver. In addition, an average reading is taken to build a consistent sonar image. In order to capture more accurate details in the low level returns, a logarithmic scale can be utilized, however, the response must also be scaled due to the lack of sensitivity time control (STC). With this design, the minimum detection range is limited by the coupling of the two transducers. Only one transducer could have been employed for a functional sonar, unfortunately that configuration would greatly amplify the close-in blind period [15]. A simple way to generate the sonar images is through MATLAB, nonetheless, the R/C servo rotation is controlled by a low-level language such as C. The operational range, visual clarity and consistency of the sonar images will vary with the quality of components used to assemble the sonar range detector.

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