An Innovative CW radar based technology for blind mobility

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ABSTRACT

Humans have 5 different senses: sight (ophthalmoception), hearing (audioception), taste (gustaoception), smell (olfacoception or olfacception), and touch (tactioception). Loss of one sense organ leads to innumerable problem in day-to-day life. For example: how difficult it becomes to even tie shoe lace with closed eyes. Blinds have to face zillions of problems like this every day. This not only make them dependent but also outside world unsafe for them. Every year around thousands of visually impaired lose their lives in road accidents. Crossing road in small cities which lack traffic signals is still one of the most challenging and dangerous task for them. Technology has advanced to a great extend but this problem of blinds couldn't attract any attention. This project aims at solving this problem by Doppler's effect phenomena using Doppler's radar.

INTRODUCTION

As per the data released by World Health Organization in 2012 there are 285 million people are visually impaired worldwide: 39 million are blind and 246 have low vision. About 90% of the world's visually impaired live in low-income settings. Globally, uncorrected refractive errors are the main cause of moderate and severe visual impairment; cataracts remain the leading cause of blindness in middle-and low-income countries.The number of people visually impaired from infectious diseases has reduced in the last 20 years according to global estimates work.80% of all visual impairment can be prevented or cured.

Technology has helped the blind to get a sense of the environment around him and also to walk past obstacles without facing much difficulties. At present the most commonly used aid for a blind is the white cane as it is inexpensive, lightweight and weight and small. However, the cane is only capable of short range probing of the environment. It also requires around 100 hours of training. The second most successful blind aid is the blind dog. They are an effective form of blind aid, but can be very expensive – approximately $35,000 to train one and also guide dogs are very limited in country like India, so is not easily accessible by everyone and some places are restricted to dog, where blind face many problem. Blind eyes are one of the latest discovery but this is out of reach of general middle class family.

Electronic eye developed by students of Kyoto Institute of Technology in the year 2004 was an amazing innovation idea for blind mobility but they failed to help the one who live in remote area and outside Japan. The electronic eye can identify Japanese pedestrian crossings by recognizing the white stripes painted across the center of a road. It can also tell when the signal is flashing to indicate that it is safe to cross. In testing, it successfully identified a crossing 196 times out of 198 and never "found" a crossing where there was not one. Furthermore, the system can measure the distance of a crossing to within the accuracy of a single step. The length of the crossing – the width of the road – is calculated using projective geometry

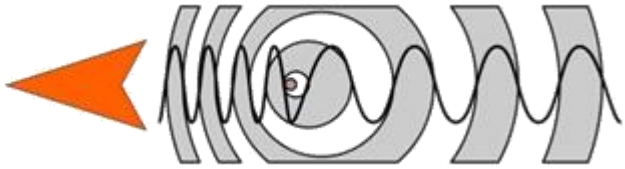
AIM

There are thousands of different type of canes in the market for convenient and easy blind mobility. Smart canes are the latest and the most updated ones but none of them has solved all the complications and hurdles of the blind mobility. Even today when it comes to crossing a road one has to depend on human hands. Heavy traffic, fast moving cars on road are one of the biggest threat to independent blind mobility. Every year thousands of visually impaired lose their lives in road accidents. The major reason behind these accidents is that blinds come in way of vehicle as they are not completely aware of environment around. Using the phenomena of Doppler's effect this project aims to prevent blinds from coming in way of a moving vehicle and cross the road easily without human help, making blind mobility safer and more independent.

BACKGROUND

Doppler's Effect

Doppler's effect (Doppler's shift) can be defined as phenomena of apparent shift of frequency of waves (or other periodic function) for an observer moving relative to the source. This is not actual shift in frequency. The change in frequency is result of movement of either source or observer or both. As the distance between source and observer increases or decreases the time taken by a wave decreases or increases at the same rate which lead to changed frequency.



With an observer stationary relative to the medium, if a moving source is emitting waves with an actual frequency f0 (in this case, the wavelength is changed, the transmission velocity of the wave keeps constant note that the transmission velocity of the wave does not depend on the velocity of the source), then the observer detects waves with a frequency f given by:

$$f = \left(\frac{c}{c + v_s}\right) f_0$$

A similar analysis for a moving observer and a stationary source (in this case, the wavelength keeps constant, but due to the motion, the rate at which the observer receives waves - and hence the transmission velocity of the wave [with respect to the observer] yields the observed frequency:

$$f = \left(\frac{c + v_r}{c}\right) f_0$$

These can be generalized into the equation that was presented in the previous section.

$$f = \left(\frac{c + v_r}{c + v_s}\right) f_0$$

Doppler Radar

Doppler radar is one of the unique type of radar which uses Doppler's effect to detect the velocity of a moving object. It does so by reflecting the radio waves from the desired target. The variation in reflected signal gives helps analyze the object's motion and gives highly accurately measurements of radial component of targets velocity relative to the radar. It is used for various purposes such as in aviation, meteorology, radiology, health care, missiles.

Four types of radar are presently in use as follows:

1. **Continuous wave (CW):** Continuous-wave radar is a type of radar system where a known stable frequency continuous-wave radio energy is transmitted and then received from any reflecting objects. These are generally used by surface to air missile system with high accuracy rate. CW radar are again of two types unmodulated continuous-wave (used in sports) and modulated continuous-wave (used by army in missiles). Unmodulated continuous wave radars are not capable of calculating the distance whereas modulated continuous wave radar can calculate the distance.
2. **Coherent pulsed (CP):** a coherent pulsed radar transmits pulses with all defined phase angle to a reference.
3. **Pulse-Doppler radar:** A pulse-Doppler radar is a radar system that determines the range to a target using pulse-timing techniques, and uses the Doppler effect of the returned signal to determine the target object's velocity. It combines the feature of continuous wave radar along with pulse Doppler radar. It is basically used in fighter aircraft, meteorological radar etc.
4. **Frequency modulation (FM):** This type wave is used in telecommunication and signaling process. FM is widely used in radio broadcasting by encoding of information in a carrier wave by varying the instantaneous frequency of the wave.

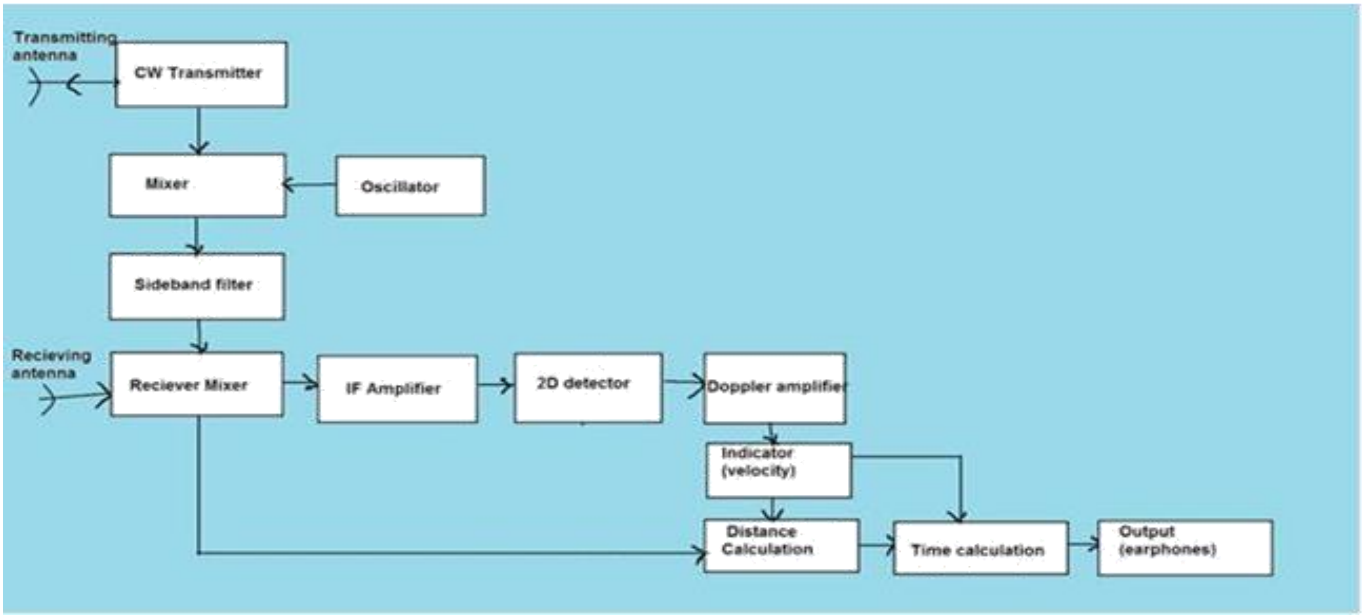
Continuous Wave Radar utilize Continuous waveforms, which may be considered to be a pure sine wave of the form cos(2 pi f0t). Spectra of the radar echo from stationary targets and clutter will be concentrated at the centre frequency f0 for the echoes from moving targets will be shifted by , the Doppler frequency. Thus by measuring this frequency difference CW radars can very accurately extract target relative velocity. Because of the continuous nature of CW emission, range measurement is not possible without some modifications to the radar operations and waveforms.

IMPLEMENTATION

The device would be based on Doppler radar which uses the phenomena of Doppler's effect. This device would consist of a CW radio transmitter and a receiver generally made up of semiconductors. The transmitter send out Ka band waves of frequency 25-30GHz in a narrow beam with constant amplitude and then receives the same signal back after it bounces off the target object. Due to the phenomena of Doppler's effect, there is change in frequency of the reflected radio signal. This change is sensed by the superheterodyne sensor attached to the device and hence the frequency shift is used to calculate the speed of the moving vehicle.Distance is calculated. Both the distance and velocity is used to find the time taken by approaching object to reach the observer. An algorithm is designed to warn the person before it hits any moving object.

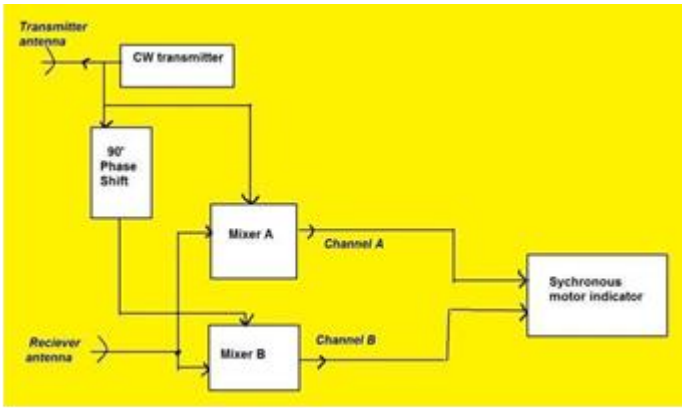
- Accuracy +/- 0.2% Microwave +/- .15 MPH internal signal processing
- +1/4, -3/4 mph readout truncation system accuracy at 100 MPH +0.6/-1.1 mph
- Target Speed Range Stationary/Moving 15 mph thru 199 mph
- Target detection distance: Approx. 1000m.
- The radar gun doesn't recognize the non shifted part , and strips it off, leaving only the shifted part.

The block diagram for the device has been given below.



CW radar tend to lose the sign of doppler shift during the mixing i.e. it becomes difficult to find whether the moving object is approaching or receding. The sign can be obtained using the given mechanism.

- If output of channel B leads to the output of channel A, the shift is positive. Hence, the object is approaching.
- If output of channel B lags to the output of channel A, the shift is negative. hence , the object is receding.



LIMITATIONS

1. Environment around can play a major role. If standing near airport then speed of airplane in range can also be detected.

2. If two or more vehicle come in range then the speed of the one which reflects stronger signal is detected.

3. The device needs adjustment/ calibration every 4-5 months.

CONCLUSION

This device can serve the function of obstacle tackling device, making blind mobility more safe and independent. With pace of advancement of technology this device can confidently overcome the limitation.Also, the making cost of device won't be much making it affordable to a common man.

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