Re: measuring distance between two cars using infrared circuits

Source: http://sci.tech−archive.net/Archive/sci.electronics.design/2005−01/6861.html

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From: Mac (*foo_at_bar.net*)
Date: 01/25/05

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Date: Tue, 25 Jan 2005 07:02:49 GMT
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On Sun, 23 Jan 2005 22:59:46 −0500, keith wrote:

> On Mon, 24 Jan 2005 00:09:10 +0000, Mac wrote:
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>> On Sun, 23 Jan 2005 14:07:55 −0500, keith wrote:
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>>> On Sun, 23 Jan 2005 17:51:45 +0000, Mac wrote:
>>>
>>>> On Sat, 22 Jan 2005 23:41:45 −0500, keith wrote:
>>>>
>>>>> On Sat, 22 Jan 2005 07:32:19 +0000, Mac wrote:
>>>>>
>>>>>> On Fri, 21 Jan 2005 04:24:38 −0800, Andrew Holme wrote:
>>>>>>
>>>>>>>
>>>>>>> gaurav.patil@gmail.com wrote:
>>>>>>>> hello,
>>>>>>>> i want to construct a circuit which will be able to measure distance
>>>>>>>> between two moving cars.The two cars are needed to maintain a fixed
>>>>>>>> distance between each other.
>>>>>>>> if the distance between them increases or decreases the circuit
>>>>>>>> should be able to detect this change and notify the amount of change
>>>>>>>> in the distance to both cars.
>>>>>>>> i want to construct this circuit using infrared LEDS ,so if any one
>>>>>>>> can help me out with this(circuit idea) please mail it to me .
>>>>>>>
>>>>>>> It might be easier with microwaves than infra−red:
>>>>>>>
>>>>>>> Measure relative velocity using the Doppler effect. By integrating
>>>>>>> this, you get a running estimate of the change in distance. Weird
>>>>>>> things might happen when you go around corners!
>>>>>>>
>>>>>>> Unfortunately, absolute measurement of short distances using
>>>>>>> electromagnetic waves is difficult / impossible due to the speed of
>>>>>>> light.
>>>>>>

>>>>>> It is not difficult at all. It just requires bandwidth. Before anybody
>>>>>> jumps on my case about detecting short CW pulses, let me point out that
>>>>>> short CW pulses have a LOT of bandwidth, and the shorter they are the more
>>>>>> bandwidth they have.
>>>>>
>>>>> Ok, what's the bandwidth of a kHz modulated ~2GHz carrier (wherever there
>>>>> is some free bandwidth). It should be trivial to measure the round−trip
>>>>> delay to withing a nS, which is about six inches. At a kHz,
>>>>> that gives us a distance measuremnt every millisecond, which should be
>>>>> enough for distance and differentiate to give a relative velocity
>>>>> number.
>>>>
>>>> Are you talking about on/off modulation of a 2GHz carrier at a 1KHz
>>>> rate? How long is the "on" time?
>>>
>>> Yes, pick your poision.
>>
>> It looks like it doesn't really matter, anyway. The Fourier transform is
>> just a sum of two sinc() functions, one shifted right and one shifted left
>> by the carrier frequency. The pulse duration controls the magnitude of the
>> FT.
>
> Sure. I'm looking at launching a ~2GHz (wherever the FCC allows) CW pulse
> and measuring its time in flight. At a ns/ft that's 6"/ns round−trip.
> Some tricks should be able to get this down significantly less than this.
> A ns is a long time these days.
>
>> I believe the total bandwidth is infinite, but any finite signal
>> has infinite bandwidth, so that doesn't really help us.
>
> Sure. I don't see a few kHz on either side of 2GHz to be a big deal
> though. It might be a challenge to gate an uwave tranmsitter on in a
> millisecond, but...
>

It is not difficult to turn on a low power transmitter in a millisecond.
But I don't think a few kHz of bandwidth is anywhere near enough. I was
too busy today to talk this over with people who would know.

>> Unfortunately, I'm not sure I know how to answer the question myself.
>>
>> I'll try to remember to ask some people who might know tomorrow and get
>> back to you. (It also might pay to ask in the radar/sonar newsgroup.)
>
> RADAR was my primary interest here. Measuring ns delays is rather trivial
> these days. ...and that gets us to 6" distance resolution. Put enough of
> these together with a (very) little computation and we get velocity. I
> don't see how the mechanics of a couple of cars will exceed the physics or
> computational needs.
>

Well, measuring a ns delay can be somewhat challenging in a digital
circuit. It is easy for a good oscilloscope, of course. But even if you
use an ADC, followed by a DSP, the ns resolution implies a sample rate of
1 GHz, in some sense.

I have seen programmable delay circuits which were adjustable in
small steps (picoseconds) but they incorporated clever analog stuff
along with digital clocks.

In the application you are talking about, you would need to have some kind
of analog detection (time to voltage circuit, perhaps) which would then be
sampled.

>> But the more you constrain the bandwidth, the more difficult it will be
>> to identify exactly where the pulse starts or stops. So for precise
>> ranging, you need more BW, regardless of pulse duration.
>
> Ok. We can measure more points of the envelope. The question is where is
> the bandwidth limitation. I suspect it will be in the transmitter,
> though I don't know. Again, a few kHz isn't a lot of bandwidth.

Well, the transmitter doesn't have to be high bandwidth. You just need a
high bandwidth (fast) switch between it and the antenna. The antenna does
need to have high bandwidth.

The receive chain, including the antenna, I think, does need to be
wideband. That opens you up to all kinds of noise, which is
problematic. I'm not saying its impossible, I'm just saying that it isn't
trivial or easy.

Another problem with 2GHz is that it is difficult to get a narrow beam
antenna that can fit unobtrusively into the car's styling.

[snip]
>>>>>> Ultrasound might work well. You could have a transponder on the back
>>>>>> of the car in front and a range−finder on the front of the car in
>>>>>> back.
>>>>>
*>>>>> It's *is* done without any transponder, which would make the idea*
>>>>> useless.
>>>>
>>>> I admit that the transponder is not essential. It just makes it easier
>>>> to detect the signal, and increases the range over which the system
>>>> would work.
>>>
>>> It also adds an unknown and significant delay into the path.
>>
>> Depending on exactly how the system is set up, the delay could be
>> completely neutralized by using a PLL.
>
> How? The PLL has to capture the signal and then re−launch the "answer".

> *That's time. If we're measuring the round−trip delay of two cars ten*
> *meters apart on the Autobahn, the capture/retransmit time is an error I'd*
> *rather not make.*

You could use a dual frequency scheme where you send out a pulse at f1, during which the PLL can lock, then abruptly change the frequency to f2. As soon as the transponder PLL detects the step in frequency, it can turn on its transmit gate.

The transmitter would use the frequency step as the synchronizing time. I don't know that this would work it is just a thought.

−−Mac