Hello YouTubers, here is the guy with the Swiss accent. We all know the ultrasonic range sensors. And we all know the infrared sensors to detect the presence of something. Today, I show you the latest technology which combines the two. A few years ago, this technology costed thousands of dollars, today we can buy it for 10 bucks on Aliexpress. But does it really work? Or is it fake? And can I build a Lidar sensor which prevents my self-balancing robot from driving into obstacles?

Sometime ago I purchased one of these new sensors and presented it in my mailbag. An employee of the manufacturer of the chip offered to send me an evaluation kit to get a head start. Thank you very much! Today, I will use this kit to test whether the sensor works and how accurate its reasings are. In a next episode, I will use it with the Arduino. Only if it works, of course.

But what is so revolutionary?

We all know, how the ultrasonic range sensors work: Their loudspeaker send a ultrasonic sound towards the target we want to know the distance and a microphone listens to the echo. Then, the controller can calculate the distance the sound travelled from the loudspeaker to the microphone. If you divide it by 2, you get the distance to the object. This is possible, because the speed of sound is known, and it is constant if the air pressure does not change a lot. According to google, the speed of sound at sea level is 340 m/second. A distance of one meter leads to a difference of 2/340 m equals roughly 6 milliseconds. Which can easily be detected by our Arduinos. But it means also, that you have to wait 6 milliseconds for the result. Because you do not know how far the obstacle is, and the range can be up to 5 meters, you even have to wait 5 x 6 ms, which is 30 milliseconds to be sure, you will get no echo.

30 milliseconds doesn’t seem to be a lot. But if you have a self-balancing robot driving full speed, this can easily be a few centimeters. And, if you want to measure several directions with the same sensor, you easily need a second to scan 180 degrees. And this is an absolute “no-go”. This is, why I had to use three ultrasonic sensors, one for each direction. All three work in parallel. You find this sensor in episode #42

What would happen, if we replace sound with light? The speed of light is not measured in meters per second, it is measured in kilometers per second and it is 300’000 km/s, which is a staggering 1 million times faster than speed of sound. So, we only have to wait 30 x 10-3 / 106 = 30x 10-9 which is 30 nanoseconds. Great. But it also very difficult to achieve this exact measurement from a technological point of view. But obviously, ST is able to do it, and in addition, for little money. So, let’s now check, if it works. The chip uses invisible light at 940 nm. Unfortunately, light bulbs and sunlight contain also light in this spectrum which disturbs our measurement. That is, why the range of the device depends on if we use it outdoors or indoors, and also which color the target has. Maximum is 2 meters, but I would expect not more than one meter in normal conditions. Which is ok for my robot.

So, let’s start to play with the module. Fortunately, I got a small controller board with a microprocessor and a USB connection, a shield with one sensor and a 7-segment display (which is Arduino compatible), and two additional sensors. In addition, ST provides a program to try these sensors. The setup and installation was very easy and very well documented.

This sensor is mainly made to detect gestures. So, let’s test, if it is able to detect gestures. First gesture is moving towards the sensor. No problem with detection. Now, “flying” over the sensor in either direction: Also no problem.

These gestures could also be detected with Ultrasonic sensors. But now, I do something which is not possible with ultrasonic sensors: I cover the sensor with glass to protect it against the elements. What do you think? Will it still work?

Yes, it still works. This is very important for all sorts of devices. You cannot use ultrasonic sensors in harsh conditions, and in addition, they are much, much bigger.

This device also let me connect two more sensors. With these sensors, I can even distinguish the direction of horizontal movements. But, as said before, I do not want to use more than one sensor.

Now I want to test my main application: Measuring distance. I will not test it on my bench, because I have quite strong LED lamps here. I test it, where the robot will move later on: close to the floor. So, I mounted the sensor on my third hand. Now, I place a A4 sheet of white paper at different locations and read the measurement. The longer the distance, the bigger also the difference of the measurement. But at least, it is reproducible and, if we need a better precision, we could calibrate the device for a few points. For my purpose, this is not so important. Speed is much more important. Luckily, the module can be connected via I2C. So, we could also connect more than one in parallel. Unfortunately, there is no possibility to change the I2C address of 52 hex. Also this is not important for my Lidar. LIDAR stands for “Light Detection and Ranging”. It produces a curve of the distances around the sensor. A famous example is the Lidar on the self-driving vehicles from Google. These devices use laser and cost a fortune. Can we build such a device with our cheap sensor? But for smaller distances, of course. My robot will not drive on a German highway…

But how fast can this sensor measure? In the data sheet, I find, that the fastest measurement is 20 ms. Which is somehow disappointing for me. Speed of light is 1 million times faster and the speed of eh sensor only 50 %. I sent a mail to the manufacturer. Maybe there is a trick…

One decision is, if we want to turn only 180 degrees, or we want the whole 360. Because the robot can move in both directions, 360 degrees would be cool.

What do we need in addition to the sensor? For sure, we need a motor. We can use a small stepper, a servo, which we hack for continuous movement, or a normal small DC motor. Because the sensor has to turn fast, I do not want to stop it and reverse direction. I would prefer, that it can turn only in one direction. But then, we need something which connects this turning platform with the fixed main processor of the robot. Here I have such a mechanical part. We can turn one part, and the other stands still. And it can connect up to 12 electrical connections in parallel. This is more than enough. VCC and ground take two, the I2C another two. Then, we need also a “switch, which indicates a fixed position, for synchronization of the measuring angle. I plan to do this with an infrared sensor. This will use another wire.

And, of course, we have to use it with a Arduino and therefore need a library. Fortunately, Pololu has one.

Summarized, we get with these time-of-flight sensors a new, very promising technology.

The sensors work, also through glas and are very small.

Unfortunately, they do not work as fast as I thought. But still, we should be able to perform 50 measurements per second.

We get them cheaply from our usual source

An Arduino library exists

There is still a lot of work to be done. And It is not sure, if I will be successful.

I hope, this video was useful, or at least interesting for you. If true then like. Bye