声共振

独特的超声波技术

Acoustic Resonance

The unique ultrasonic technology

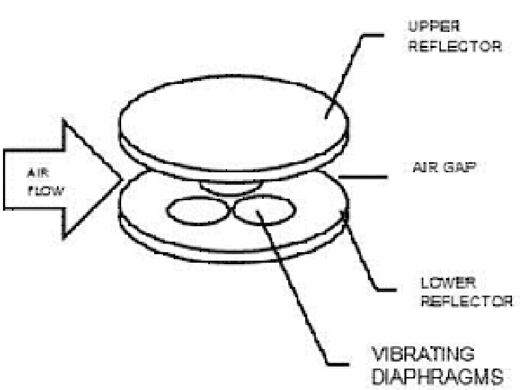
风速与风向的准确测量对风力发电机的安全有效运行至关重要。理想的风传感器每秒可输出4-5次准确的风速及风向测量数据，而且在风力发电机运行寿命范围内不会出现信号中断且无须再校准或维护。简而言之，即“终生免维护”。

如此高灵敏度的设备安装于风力发电机顶部，处于非常恶劣的运行环境下：雨水、结冰、冰雹、雪尘、酷热、严寒、振动及闪电等各种情况经常出现。传统的机械式风传感器需进行周期性维护，否则可能因风沙受损并将容易出现结冰现象。

传统的超声波式风传感器，运用时差测量法，通过测量超声波信号从发射点到达接收点所需的时间来测量风速和风向，可以克服其中一些问题。但是，超声波风传感器的规格和构造使其难以加热且容易遭受物理性损坏。

除此之外，还有第三种选择，即声共振超声波测量方式。该测量方式是一种利用在小腔内共振的声波或超声波的专利的固定方式技术。这项技术为传感器带来许多优势：体积小、结构轻巧、寿命长、机械强度大、数据稳定且使用寿命长、准确度高。该技术提供的传感器不含外置运行元件，因此更为坚固，适用于极端的天气状况。此外，该传感器能耗低，并针对其受环境因素影响的其他技术性能设置了内置补偿。

下图简要显示了声共振传感器的基本配置。



Wind speed and direction measurement is critical for the efficient and safe operation of wind turbines. The ideal wind sensor would provide accurate data four or five times a second for the life of the turbine without any interruption, recalibration or maintenance. It would be "fit and forget".

However the top of a wind turbine is a very hostile environment for a sensitive piece of equipment. There is rain, ice, hail, snow dust, extreme heat and cold, vibration and lightning to deal with. Traditional mechanical wind sensors need regular maintenance, they can be damaged by sand and are not that easy to keep ice free.

Ultrasonic wind sensors that measure time of flight (how long the ultrasonic signal takes to travel from one point to another) can overcome some of these problems. However their size and construction makes them hard to heat and prone to physical damage.

There is however a third option available, Acoustic Resonance Ultrasonic measurement. This is a patented solid-state technology which uses an acoustic (ultrasonic) wave which is resonated inside a small cavity. This gives many benefits: small lightweight construction, long life, high physical strength, high data availability and good accuracy throughout its lifetime. With no exposed parts this technology gives a robust sensor that operates under extreme weather conditions. It has low power consumption and provides built-in compensation against the environmental factors that affect other technologies.

This simplified diagram shows the basic arrangement of an Acoustic Resonance sensor.

AIR FLOW	气流
UPPER REFLECTOR	上反射器
AIR GAP	气隙
LOWER REFLECTOR	下反射器
VIBRATING DIAPHRAGMS	振动膜

采用声共振技术的FT702LT型风传感器
FT702LT Wind Sensor using Acoustic Resonance

声共振传感器包括两块平行板，其中一块设有三个转换器，呈三角形排列。

每个转换器一次只能转换一个超声信号。信号从转换器朝外穿行直至撞到上反射器，经其反射至下反射器，再被下反射器反射。此后，超声在上下反射器之间不断反弹，直到释放所有能量，这个过程需要约200次反射。

反射合相产生垂直准驻波，大幅增加信号强度。在水平面上，准驻波如同一束二维径向行波。

气流测量基于行波的性质。任意一对转换器之间的相位差均可显示转换器轴向的风速和风向。因此，通过测量三对膜片之间的相位差，可计算三角形（由膜片排列而成）边上的气流向量。将这些向量结合起来，即可得出整体风速和风向。

此外，驻波有助于实现对温度、湿度及压力变化造成的声速变化的自动补偿。该技术将调整频率，以使得响应最大化并保持共振。在此情况下，测量不受声速影响。

共振的使用可确保高信噪比，大分贝的信噪比可作为天然的滤波器并具有高度抗干扰性。

声共振技术由总部位于英国伦敦的FT科技公司发明并已申请专利。该技术，即今天众所周知的Acu-Res®，已融入FT科技公司的FT702LT系列风传感器，该系列传感器用于风力发电机控制已有近十年之久。该技术已被中国和世界各地的20余家风力发电机制造商和设计商指定使用。

该传感器的最新版本——版本22已通过25种以上的不同国际测试，充分显示了采用Acu-Res技术的FT传感器的优势和效果。

如欲了解详情，请咨询中国经销商大连尚能科技发展有限公司或登陆www. fttech. co. uk。

The sensor consists of two parallel plates, one of which contains three transducers arranged in a triangular formation.

One transducer at a time transmits an ultrasound signal. This signal travels outwards from it until it hits the upper reflector where it is reflected back and hits the lower reflector and is reflected again. Ultrasound continues to bounce between the pair of reflectors until it looses all its energy; this involves about 200 reflections.

The reflections combine in phase to produce a vertical quasi-standing wave; this gives a dramatic increase in signal strength. In the horizontal plane this behaves like a two-dimensional radial travelling wave.

Airflow measurement is based on the behaviour of the travelling wave. The phase difference between any transducer pair shows the wind speed and wind direction along the axis of the pair. So by measuring the phase difference between all three diaphragm pairs the component vectors of the airflow along the sides of the triangle (formed by the diaphragms) are calculated. These vectors are combined to give the overall speed and direction.

In addition the standing wave enables automatic compensation for variations in the speed of sound caused by changes in temperature, humidity and pressure. The technology adjusts the frequency to maximise the response and maintain resonance. Under these conditions measurements are made independent of the speed of sound.

The use of resonance ensures that the signal to noise ratio is very high, this strong signal is easy to read and highly resistant to interference.

Acoustic Resonance Technology was invented and patented by FT Technologies based in London England. Now known as Acu-Res ®, the technology is incorporated in to their FT702LT series of wind sensors which have been used for turbine control for nearly 10 years. This technology is specified by over 20 turbine manufacturers and designers in China and around the world.

The latest version of the sensor, the Version 22, has passed over 25 different international tests that show the strength and effectiveness of FT sensors that use the Acu-Res technology. ■

More information from the distributor in China: Dalian Shinergy Science & Technology. Development. Co., Ltd. Or www.fttech.co.uk.