

Claims

1. ~~A sensor for characterizing microorganism particles in a fluid sample comprising:~~

~~a microfluidic channel for receiving the fluid sample;~~

~~an acoustic transducer module configured to generate a standing wave for concentrating the particles in at least one region of the microfluidic channel;~~

~~an optical detection module configured to detect optical signals scattered by the particles upon illuminating the at least one region of the microfluidic channel with a light source;~~
~~and~~

~~a data processing module configured to characterize the particles of the fluid sample based on the optical signals using a classifier.~~
2. ~~The sensor according to claim 1, wherein the standing wave generates a pressure differential across different positions in the microfluidic channel thereby altering a path along which the particle flows through the microfluidic channel at the respective positions.~~
3. ~~The sensor according to claim 1 or claim 2, wherein the acoustic transducer module has an ultrasound transducer.~~
4. ~~The sensor according to any of claims 1-3, wherein the microfluidic channel has two major opposing walls separated by a distance $\{d\}$, the acoustic transducer module is configured to generate a standing wave of a wavelength $\{\lambda\}$ of $2d$.~~
5. ~~The sensor according to any of claims 1-4, wherein the acoustic transducer module is configured to generate a first standing wave oscillating in a direction orthogonal to that of a second standing wave in the microfluidic channel; said first and second directions being orthogonal to a direction of the microfluidic channel along which the fluid is configured to flow; wherein the first standing wave produces a pressure node which coincides with that produced by the second standing wave.~~
6. ~~The sensor according to any of claims 2-5, wherein the pressure differential causes the particles to converge along a pre-defined path in the microfluidic channel.~~

- ~~7. The sensor according to claim 6, wherein the pre-defined path is a center path defined by the geometrical centers of a plurality of cross-sections of the microfluidic channel; said plurality of cross-sections being orthogonal to a direction of the microfluidic channel along which the fluid is configured to flow.~~
- ~~8. The sensor according to any preceding claim, wherein the optical detection module comprises a first sensor module configured to detect a forward scattering pattern of the particle.~~
- ~~9. The sensor according to any preceding claim, wherein the optical detection module comprises a second sensor module configured to detect a side-scattering signal of the particle.~~
- ~~10. The sensor according to claim 9 when depend on claim 8, wherein the first sensor module is configured to be activated by at least one of (a) the second sensor module and (b) the side-scattering signal.~~
- ~~11. The sensor according to any preceding claim, wherein the optical detection module is integral to the sensor.~~
- ~~12. The sensor according to any preceding claim, wherein the microfluidic channel comprises a plurality of outlets for selectively discharging the fluid sample and the particles.~~
- ~~13. The sensor according to any preceding claim, wherein the particles are microorganism particles.~~
- ~~14. The sensor according to claim 13, wherein the classifier is configured to identify the species of the respective microorganism particles.~~
- ~~15. The sensor according to claim 14, wherein the classifier is configured to further identify if the microorganism particles are viable.~~
- ~~16. The sensor according to any preceding claim, wherein the classifier characterizes the particles based on a comparison between the optical signals and a plurality of reference signals representing signal profiles of known particles.~~
- ~~17. The sensor according to claim 16, wherein the plurality of reference signals are obtained based on measured scattering signals of known particles.~~

- ~~18. The sensor according to any preceding claim, wherein the classifier employs a machine learning algorithm to extract features of the optical signals of the particles and assign the respective particles into respective categories based on the features.~~
- ~~19. A method of characterizing particles comprising:~~
- ~~receiving a fluid sample containing the particles into a microfluidic channel;~~
 - ~~generating a standing wave to concentrate the particles in at least one region of the microfluidic channel;~~
 - ~~detecting optical signals scattered by the particles upon the at least one region of the microfluidic channel being illuminated with a light source; and~~
 - ~~characterizing the particles based on the optical signals using a classifier.~~
- ~~20. A method of identifying a species of a microorganism particle in a fluid sample comprising:~~
- ~~illuminating the particle with a light source;~~
 - ~~detecting optical signals scattered by the particle; wherein the optical signals comprises a forward scattering pattern; and~~
 - ~~characterizing the particle into one of a plurality of categories based on the forward scattering pattern.~~
21. A method of managing water risk comprising:
- (a) receiving optical signals scattered by a microorganism particle in the fluid; said optical signals comprising a forward scattering pattern;
 - (b) characterizing the microorganism particle into one of a plurality of categories based on the forward scattering pattern using a classifier that employs a machine learning algorithm;
 - (c) updating a record data representing the number of microorganism particles of the plurality of categories;

- (d) determining a risk level based on the record data;
- (e) comparing the risk level to a reference level; and
- (f) depending on the result of the comparison, producing a warning signal indicating an elevated risk of pathogens in the fluid

wherein the machine learning algorithm extracts features of the detected optical signals of the particles, assigns the respective particles into respective categories based on the features, and forms a database based on the features,

wherein the machine learning algorithm includes at least one parameter chosen from: image quality, statistical evaluation, radiometric correction, geometric correction, image enhancement and sharpening, phase correlation, and rotational and scale parameter, and

wherein the database includes both forward scattering signatures and side scattering signatures.

222. A fluid risk management system comprising a computer processor and a data storage device, the data storage device storing instructions operative by the processor to cause the processor to perform the method of claim 211.