It is an aim of the present invention to measure and deliver accurate and reliable fluid level data within a network of sewers or other open-channel flow applications across a wide range of operating conditions.

Summary

According to the present disclosure there is provided an open channel flow monitoring apparatus for measuring a fluid level as set forth in the appended claims. Other features of the invention will be apparent from the dependent claims, and the description which follows.

According to a first example, there is provided an open channel flow monitoring apparatus for measuring a fluid level, the apparatus comprising: a first sensor configured to obtain data indicative of a fluid level below a first threshold level; a second sensor configured to obtain data indicative of fluid level above a second threshold level, which is lower than the first threshold level; wherein both the first sensor and the second sensor are configured to obtain data indicative of the fluid level when the fluid level is between the first threshold level and the second threshold, the first sensor and the second sensor are configured to output data indicative of the sewage level on a single data line, wherein the output data transitions seamlessly from data obtained from the first sensor to data obtained from the second sensor.

The provision of a first sensor and a second sensor which have an overlapping range in which they are both configured to obtain data indicative of a fluid level means that the apparatus is effective during both normal conditions and abnormal conditions of fluid levels. That is to say that there is no “dead-band” where neither of the sensors are able to measure the fluid level. Further, the single data line significantly simplifies the apparatus.

In one example, the apparatus is configured to calibrate the data indicative of fluid level obtained by the second sensor based on the data obtained by the first sensor indicative of the fluid level. As such, the apparatus is able to deliver a single, continuous level data

set the derivation of which transitions seamlessly from the data obtained by the first sensor to the data obtained by the pressure sensor.

In one example, the apparatus is configured to calibrate the data indicative of fluid level obtained by the second sensor using the data indicative of the last stored fluid value obtained by the first sensor as the fluid level rises above the second threshold.

In one example, the apparatus is configured to use an algorithm to calibrate the data indicative of fluid level obtained by the second sensor.

The apparatus is simple to install and ultra-low maintenance by design as it requires no physical external atmospheric breather for the second sensor.

The apparatus may include a housing comprising a skirt portion that defines a recess within the housing, wherein the first sensor is substantially located within a recess defined by the skirt portion. The provision of the recess defined by the skirt portion means that the first sensor is less likely to become submerged in the fluid as the fluid level rises, thereby reducing the requirements for cleaning and maintenance.

The first sensor may be an ultrasonic sensor. The second sensor may be a pressure sensor. Due to the overlap of monitoring ranges of the first sensor and the second sensor and the fact that the second sensor may be calibrated based on the data obtained by the first sensor, a reference to atmospheric pressure by the pressure sensor is not required. This significantly reduces the complexity of the apparatus.

In one example, the pressure sensor comprises a pressure probe configured to project to the second threshold level.

The apparatus may comprise a temperature sensor. The local temperature may affect the speed of the sonic velocity of the ultrasonic waves. Therefore, the apparatus may use the local temperature to calibrate the ultrasonic sensor to account for the local temperature.

In one example, the apparatus includes a data logger configured to log the obtained data indicative of the fluid level.

In one example, the apparatus includes a transmitter configured to transmit the obtained the obtained data indicative of the fluid level.

The open channel flow may be a sewer and the fluid level may be a sewage level.

According to one example, there is provided a method of measuring a fluid level in an open-channel system, the method comprising: obtaining, at a first sensor, data indicative of the fluid level below a second threshold level, which is lower than the first threshold level; obtaining, at both the first sensor and a second sensor, data indicative of fluid level between the first threshold level and the second threshold level,; and obtaining, at the second sensor, data indicative of fluid level above the first threshold level.

The method may include the step of calibrating the data indicative of the fluid level obtained by the second sensor based on the data obtained by the first sensor indicative of the fluid level.

According to one example, there is provided a computer-readable storage medium comprising instructions, which when executed by a computer, cause the computer to carry out the method of measuring a fluid level in an open-channel system identified above.

According to one example, there is provided a computer program product comprising instructions, which when the program is executed by a computer, cause the computer to carry out the method of measuring a fluid level in an open-channel system identified above.

The first sensor is configured to measure the fluid level between a first range of fluid levels. The second sensor is configured to measure the fluid level between a second range of fluid levels. The first range of fluid levels and the second range of fluid levels overlap. That is to say that there is an overlapping range of fluid levels where both the first sensor and the second sensor are both configured to measure the fluid level. The overlapping range means that the apparatus is able to effectively "hand-over" responsibility from the first sensor to the second sensor before the fluid level moves out of the first range of fluid levels. Providing this overlapping range means that the apparatus is able to monitor the fluid level throughout all of the conditions of the fluid levels. In one example, the fluid is a liquid. For example, the fluid may comprise sewage or storm-water.

The obtained data from the first sensor may be used to effectively calibrate the data from the second sensor in the overlapping range, thereby eliminating the requirement for separate reference conditions for the second sensor.

Figure 1 shows an example of an open channel flow monitoring apparatus 100. The apparatus 100 includes a first sensor 102 configured to obtain data indicative of a fluid level below a first threshold level 104. The first threshold level 104 may be level with an underside of the first sensor 102. In other words, the first sensor 102 may be able to monitor the level of the fluid in an open channel when the fluid level is below the first sensor 102.

The apparatus 100 also includes a second sensor 106 configured to obtain data indicative of fluid level in an open-channel above a second threshold level 108, which is lower than the first threshold level 106. In one example, the second threshold level 108 is level with the underside of the second sensor 106.

In normal conditions, the fluid level in the open channel is below the second threshold 108. As such, in normal conditions, only the first sensor 102 is used to obtain data relating to the fluid level. If the fluid level rises, for example due to rainfall, then the fluid level may raise above the second threshold level 108.

CLAIMS

1. An open channel flow monitoring apparatus for measuring a fluid level, the apparatus comprising:

a first sensor configured to obtain data indicative of a fluid level below a first threshold level; and

a second sensor configured to obtain data indicative of fluid level above a second threshold level, which is lower than the first threshold level;

wherein both the first sensor and the second sensor are configured to obtain data indicative of the fluid level when the fluid level is between the first threshold level and the second threshold,

wherein the first sensor and the second sensor are configured to output data indicative of the sewage level on a single data line, wherein the output data transitions seamlessly from data obtained from the first sensor to data obtained from the second sensor.

2. The open channel flow monitoring apparatus according to claim 1, wherein the apparatus is configured to calibrate the data indicative of fluid level obtained by the second sensor based on the data obtained by the first sensor indicative of the fluid level.

3. The open channel flow monitoring apparatus according to claim 2, wherein the apparatus is configured to calibrate the data indicative of fluid level obtained by the second sensor using the data indicative of the last stored fluid value obtained by the first sensor as the fluid level rises above the second threshold.

4. The open channel flow monitoring apparatus according to any one of claims 1, 2 or 3, the apparatus comprising a housing comprising a skirt portion that defines a recess within the housing, wherein the first sensor is substantially located within a recess defined by the skirt portion.

5. The open channel flow monitoring apparatus according to any one of the preceding claims, wherein the first sensor comprises an ultrasonic sensor.

6. The open channel flow monitoring apparatus according to any one of the preceding claims, wherein the second sensor comprises a pressure sensor.

7. The open channel flow monitoring apparatus according to claim 6, wherein the pressure sensor comprises a pressure probe configured to project to the second threshold level.

8. The open channel flow monitoring apparatus according to any one of the preceding claims, the apparatus comprising a temperature sensor.

9. The open channel flow monitoring apparatus according to any one of the preceding claims comprising a data logger configured to log the obtained data indicative of the fluid level.

10. The open channel flow monitoring apparatus according to any one of the preceding claims comprising a transmitter configured to transmit the obtained the obtained data indicative of the fluid level.

11. The open channel flow monitoring apparatus according to any one of the preceding claims, wherein the open channel flow is a sewer or a storm drain and the fluid level is a sewage or storm water level.

12. A method of measuring a fluid level in an open-channel system using the apparatus of any one of the preceding claims, the method comprising:

obtaining, at a first sensor, data indicative of the fluid level below a second threshold level, which is lower than a first threshold level;

obtaining, at both the first sensor and a second sensor, data indicative of fluid level between the first threshold level and the second threshold level; and

obtaining, at the second sensor, data indicative of fluid level above the first threshold level.

13. The method of claim 12, comprising:

calibrating the data indicative of the fluid level obtained by the second sensor based on the data obtained by the first sensor indicative of the fluid level.

14. A computer-readable storage medium comprising instructions, which when executed by a computer, cause the computer to carry out the method of any of claims 12 or 13.