DIGITAL STEPGAUGE MEASUREMENT SYSTEM FOR WAVE RUN-UP MEASUREMENTS IN MODEL AND IN PROTOTYPE

Introduction

A digital stepgauge is typically used for measuring waves and tides. It is also applicable to perform wave run-up measurements on slopes of coastal structures.

Other conventional methods to measure wave run-up are:

- video recording / visual observation,
- a capacitive / resistive wave height meter placed parallel to the slope of the dike,
- a stepgauge.

The advantages of the digital stepgauge are:

- It measures run-up on irregular slope profiles such as a rubble mound breakwater. This is achieved by placing each electrode of the comb at a fixed distance to the slope.
- There is no need to extrapolate the measurements towards the slope position, the output gives directly how many electrodes are submerged.
- The slave units can be placed at a close range to the electrodes, the master unit may be placed up to 250m from the slave units.
- The connection cable between master and slave units is a standard UTP network cable, only 4 wires are required between master and slave units.
- The stepgauge has 64 electrodes, expandable up to 96 electrodes. The standard version has 64 inputs.
- The output signal is available in these formats:
    - an analog voltage representing the sum of the submerged electrodes (0.1 V/electrode).
    - an analog voltage representing the maximum submerged electrode
    - an optional digital output which sends all information of the electrodes via RS232 serial link to the PC for analysis.

Methodology

The principle of a stepgauge system is very easy: each electrode of the stepgauge is connected to a circuit which detects if the electrode is dry or wet.

Description of electronics

The device consists of several parts:

- master controller (Fig. 1),
- slave module (Fig. 2),
- twisted pair cable,
- comb with electrodes (Fig. 3).

A. Master controller

The operation and read-out is accomplished by means of a master controller with a LC-display of 40 x 2 characters and a keyboard. The power supply voltage of the device is 9V DC and is achieved by a separate switch mode power supply. The current requirement is about 0.6 A.

Fig. 1. *Master controller.*

B. Slave module

There are 2 printed circuit boards with each 4 slaves. Each slave has 8 sensor inputs.
The total number of sensor inputs amounts to 64 (=2x4x8) The master and slaves are interconnected with a unshielded twisted pair cable (UTP Cat 5 Network cable). The length of this cable can be up to 250 m.

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The sample frequency is 100 Hz, this is the number of times the analogue outputs of the master controller are updated. The carrier frequency present at each of the sensor inputs is 10 kHz.

The master controller has 2 analogue outputs. The first output gives a voltage which corresponds to the position of the highest electrode that still makes contact with the water. The second output gives a voltage which corresponds to the number of electrodes which make contact with the water. The maximum output voltage can be adjusted with a potentiometer on the master controller (inside the box) and is set to 6.4 V. This corresponds with a voltage increment of 0.1 V per electrode.

The output of the graphical display is only updated a few times per second and gives no accurate impression of rapidly changing phenomena. It is also possible to have a digital output. In this case the state of each electrode is send via a serial link (RS 232) to a PC.

Fig. 2. *Slave module.*

Results

This stepgauge has been used in the OPTICREST project by the following institutes/laboratories:
- Aalborg University, Denmark
- Flanders Hydraulics Laboratory Borgerhout, Belgium
- Universidad Politécnica de Valencia, Spain

We have constructed a large scale version of this system. It uses the same master controller but the slaves are integrated in the “measurement comb” which consists of 3 elements of 3m long. Each element has 24 electrodes.

Fig 3. *Photo of comb on a rubble mound breakwater slope, taken at the Universidad Politechnica de Valencia, Spain.*

This device has been successfully used for run-up measurements in the Large Wave Flume of Hannover, Germany. (Fig. 4)

Fig. 4. *Photo of the digital stepgauge at the Large Wave Flume in Hannover, Germany.*

Contact
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