Autonomous Nutrient Detection for Water Quality Monitoring
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Introduction
The ever increasing demand for real time environmental monitoring is currently being driven by strong legislative and societal drivers [1]. Low cost autonomous environmental monitoring systems are required to meet this demand as current monitoring solutions are insufficient. This paper presents an autonomous nutrient analyser platform for water quality monitoring. Results from a long term field trial of the nutrient analyser are reported and the advantages over manual monitoring techniques highlighted.

Methods
The nutrient analyser is a compact and portable device (1.7kg) as shown in Fig. 1. The system contains all reagents, calibration standards and fluid handling components necessary to perform reagent based chemistry in remote locations. The first generation of this nutrient analyser has been extensively developed and field trialled as reported in [2]. The analyser detection system is based on colorimetric chemical detection. A sample and one or more reagents are mixed in the microfluidic chip. The resulting colour change is measured using an ultra violet light emitting diode (LED) and photodiode. The analyser also implements a two-point calibration protocol at each measurement point using standard orthophosphate solutions.

Results
The nutrient analyser was deployed at a waste water treatment plant (Fig. 2) for a long term field trial (approximately 2 months). The system measured phosphate levels in the treatment plant effluent outflow tank. The analyser was set-up to take samples at hourly intervals. Measurement data was transmitted wirelessly in real time to a local database which could be remotely accessed. Validation of the nutrient analyser was carried out by collecting regular grab samples using an auto-sampler. The graph in Fig. 3 shows the phosphate concentrations reported by the phosphate analyser over a five day period. The analyser data is plotted alongside the phosphate values obtained from the manual laboratory analysis of the grab samples.

Fig. 1. Nutrient analyser design; (1) Sample inlet; (2) Control board and microfluidic chip (insert); (3) Peristaltic pumps; (4) Reagent bags; (5) IP68 enclosure

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Discussion and Conclusions
The system reported phosphate levels which were in reasonable agreement with those obtained from manually analysed samples. The phosphate analyser is seen to track the general downward trend in phosphate concentrations over the last 3 days of the trial. Compared with manual monitoring methods, the nutrient analyser offers a very low cost per sample coupled with a long service interval. Despite the frequent sampling interval, the system only required servicing every 3–4 weeks (after approximately 700–800 assays) to replenish reagents and replace the inlet filter membrane. The frequency of data is also far beyond what could be achieved using manual sampling techniques. This is key when data is required to identify trends and events related to nutrient levels.

The nutrient analyser platform is under constant development. Current work is focused on the detection of nitrate, ammonia and chemical oxygen demand while initial field trials of nitrite and pH analysers have been carried out. Progress is also being made in the development of the next generation analysers which will use novel pumping techniques and low cost detection systems [3].

References

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