A Pervasive Network for Environmental and Traffic Monitoring

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The MESSAGE Project - Objectives

- Alternative approach to high cost environmental & traffic monitoring infrastructure.
- Existing installations give poor spatial & temporal resolution.
- Large numbers of low cost, ‘pervasive’ sensors (MOTEs) can be deployed for similar investment.
- Wireless, battery powered devices mounted on street furniture, vehicles or even pedestrians.
MOTE Design Strategy

- Highly modular approach to design.
- Standard CPU and comms module (same for mobile and fixed nodes).
- Add on modules for sensor payload.
- Several power supply options.
- Target cost of £200 per node.
Sensor node architecture

Core module

- 3-axis accelerometer
- Temp sensor
- Real time clock
- Central Processor
- GPS
- ‘Zigbee’ wireless transceiver
- Power Supply

Analog/digital ports

- Chemical sensor module
- Noise sensor module
- Traffic sensor module
- Other future modules?
Chemical sensors

- CO and NO₂ are principle gases to be measured.
- For our budget semiconductor sensors or electrochemical cells are only realistic options.

<table>
<thead>
<tr>
<th></th>
<th>Electrochemical</th>
<th>Semiconductor</th>
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</thead>
<tbody>
<tr>
<td>Cost</td>
<td>~£40</td>
<td>&lt;£10</td>
</tr>
<tr>
<td>Operating life</td>
<td>~2 years</td>
<td>5-10 years</td>
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<tr>
<td>Power consumption</td>
<td>Few µW</td>
<td>100-300mW</td>
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<tr>
<td>Performance</td>
<td>Good sensitivity but drift &amp; cross sensitivity issues.</td>
<td>Less sensitive than electrochem.</td>
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Test response of Electrochemical Carbon Monoxide Sensor

![Graph showing response of sensor to CO over time. The graph has a y-axis labeled CO (ppm) ranging from 0 to 12 and an x-axis labeled Time (min) ranging from 0 to 35. Two lines are shown: one dashed labeled 'Cal' and one solid labeled 'Sensor'. The response of the sensor shows a gradual increase in CO concentration over time, with a sharp increase at around 15 minutes, followed by a plateau and then a slight decrease.]
**Noise sensor module**

- For our budget a low cost electret microphone and conditioning circuit has been designed.

![Diagram of noise sensor module with components: Electret Microphone, Pre-amplifier, Weighting filter, CPU ADC input, Integrator (LP filter), Envelope detector.]
Traffic sensor module

- 40kHz ultrasonic module developed with range 5-10m.
- Low cost (<£10) and power.
- Can be quickly/easily deployed anywhere.
- 30 degree beam width means close queued traffic may not be discriminated.
MOTE Housing & Electronics

- Dimensions 140 x 85 x 65mm
- IP67 weatherproof housing
- Up to 1 yr battery life from single Lithium cell.
Noise and CO from Stationary Vehicle
Field Traffic Measurements (30 sec)
Roadside Noise Data (L weighted, 30 s)
Roadside CO data (30 sec)
Roadside NO$_2$ data (30 sec)
Conclusions & Further work

- 1yr into project, construction of low cost, wireless multi-sensor devices appears feasible.
- Considerable work remains in the validation of low-cost sensor subsystems against precision instruments in the field.
- Large scale deployment (up to 200 nodes) will be demonstrated and evaluated by the end of the project.