**Wearable Sensors for Monitoring of Structural Health and Agricultural Nutrient Conditions**

This thesis illustrates two sensor development projects to use for structural health monitoring and Agricultural nitrate detection. Part 1 involves the development of an all flexible graphene strain sensor with liquid metal interconnects for structural health monitoring and human body motion sensing. The Part 2 presents the sensing of nitrate concentration in agricultural water and in plant. For the purpose of application demonstration, the sensors were attached to concrete, emerged into agricultural water and plant to monitor the important signals indicating concrete stress and nitrate concentration, respectively.

The first part of report presents the development all-flexible strain sensors made of graphene, liquid metal, and stretchable elastomer. These sensors feature a flexible interconnect design, where liquid metal is introduced into microfluidic channels for interconnection and wiring. This design allows enhanced overall structural flexibility and a reduced risk of stress related mechanical failure inside the devices, at the contact areas between the sensing elements and the metal wires. Both a unidirectional strain sensor and a multidirectional rosette strain sensor are developed, by encasing patterned graphene and microfluidic liquid metal channels with a stretchable elastomer. We demonstrate the use of the developed unidirectional strain sensor for structural health monitoring of curved concrete structures, and for tracking the angular motion of a human wrist. The rosette strain sensor is shown to be capable of detecting the amplitude and angle of a primary strain in a multidirectional strain field.

The second part of this thesis demonstrates the development of nitrate sensing in agricultural, including a self-filtration transistor based sensor and in-planta nitrate sensing device. This thesis presents the working principle of a transistor based nitrate sensor and its applications. This sensor contains a nitrate chemical sensitive field effect transistors (chemFET), and a temperature sensor. By integrate a 3D printed case and commercial filter, it is able to realize the direct measurement with unfiltered agricultural water. This sensor is also integrated with the needle shaped PCB and readout circuit, therefore achieved the continuous nitrate ion measurement in plant stalk for week long. In the meantime, this sensor is able to biasing the nitrate concentration information by counts in the temperature effect, to achieve the accuracy and stable nitrate concentration signal for agricultural water and in-planta nitrate detection.