Grand Challenges on Bio-inspired Earthquake Predetection and Post-Earthquake Search and Rescue Systems

George C. Lee
University at Buffalo, SUNY
gclee@buffalo.edu

Unusual animal behaviors and environmental phenomena prior (days and hours) to strong earthquakes have been widely witnessed and reported. Many researchers in the past have attempted to seek scientific explanations for the various phenomena observed but with limited success, due to a variety of reasons. Significant challenges include: what physical quantities cause the animals to behave abnormally and how do they sense these (physical) quantities? What are the ranges of the mechanical waves and/or electromagnetic wave that the animals are most sensitive to? Is it possible that the correlation between the unusual animal behaviors and the physical quantities can be replicated and verified in a laboratory? To address these challenging issues, a large amount of measurements and observations around the earthquake-prone fields need to be collected, transmitted, stored and analyzed for a long period of time. The "data-driven" approach is necessary not only for earthquakes but also for all other natural hazards. With respect to the prediction of natural hazards, earthquake is the least successful, primarily because of the incomplete knowledge of the earthquake process and the rapidity in seismic wave propagation. Research on earthquake mitigation measures have been successfully carried out in the past. A case is made here to pay attention to short term actions around the time of a mega earthquake and immediately after the event to minimize the loss of lives and properties through the development of warning systems that detect (the P-waves) and immediately inform the public and guide the first responders to the potential disaster area. A major challenge to deploying a large instrumented data collection and observations of unusual animal behaviors is to cover a sufficiently large area including seismically active crustal boundries with a very large budget as well as a long term, sustained international collaborative effort. Further, these measurements and observations are to be systematically coordinated with laboratory and field observations of animal responses and other environmental phenomena in earthquake active zones.

A second grand challenge research is the development of advice/system for search and rescue after a destructive earthquake. On one hand, we need to understand why

certain dogs have the sensing ability to search for people, drugs, etc. On the other hand, a smart watch/detector system for life signal detection, victim identification and location may be developed. This system includes an embedded human impulse sensor, a body temperature sensor and a radio frequency identification (RFID) tag into a quartz watch. RFID is a rapidly developing technology similar in principle to the bar code identification but without the need for line-of-sight reading, and can be used for a larger distance (e.g. 90ft.). With RFID, the electromagnetic or electrostatic coupling in the RF portion of the electromagnetic spectrum is used to transmit signals. The widely used RFID tags are passive and no batteries are required for the tags. Signals from this smart watch/detector system can be received by three appropriately deployed detectors near the collapse structure site to remotely locate the living victim. Personal health information can be written in/read from the tag (e.g. blood type, medicine allergy, serious sickness records in addition to name, age, gender and address), for emergency medical treatment. Such a search and rescue system is a grand challenge to industry. The “watches” should be low-cost and attractive for the public in dense population centers to wear. When adequately developed, the “watches” can be used by others (e.g. miners).