Editorial: Science of the Big and Small and Embedded Computing Systems

February 2016 was an exciting time for science—the Laser Interferometer Gravitational-Wave Observatory (LIGO) seems to have detected a gravitational wave, the physical manifestation of a prediction of Einstein’s general relativity. This is not only a groundbreaking discovery but also a first step toward observing cosmic phenomena that we previously have been unable to observe, as electromagnetic waves could not reach us due to the strong gravitational pull. Now new observational mechanisms and engineering will be required to study the phenomena that create gravitational waves, and we will possibly know a lot more about the universe, the creation of the universe, and the nature of the space-time fabric. As I am not a physicist, I can only imagine these phenomena (I cannot vouch for the theoretical underpinnings) but, surely, it has excited the imagination of people around the world, and now India has declared that it will build a LIGO to complement the other LIGO facilities.

In the mid-2010s, another phenomenal success in high-energy physics was the observation of the Higgs Boson at the Large Hadron Collider (LHC). This discovery, which gave physicists more confidence in the standard model of particle physics, has also inspired a young generation to study science and understand the very nature of the world around us.

This is a journal that studies embedded computing systems, so why are we discussing physics? The reason is simple. Engineering, especially the building of sensors, detectors, computation, instrumentation, control, and measurements, have been at the very core of these discoveries. The engineering that went into LIGO and the LHC is phenomenal, and the computation—be it in the instrumentation, signal processing, or crunching the petabytes of data that are generated by the LHC during its particle-smashing experiments—has been extensive. More interesting is the fact that much of this engineering is in the realm of embedded computing. Sensors of various kinds, signal processing, laser stabilization, measuring interference at the level of accuracy required to observe a gravitational wave, control of a large number of electromagnets, the instrumentation and control of various pieces of sensitive equipment, and the application of machine learning on the huge amount of data generated by the LHC are all amazing feats of engineering. Even a decade or two ago, such precision, such a scale of computation, and such minute control of instruments were not possible.

Even though the discussion in the media, and that by other observers, often did not mention the engineering and the embedded computing aspects of these breakthroughs, we cannot help but feel that these achievements are great strides not only in science but also in embedded computing systems and in computing in general. So it is our responsibility to inspire our next generation of engineers to maintain the esteemed tradition of engineering and continue the pace of improvement of technology in all fields, such as optical sensors in computer-controlled instrumentation, large-scale data crunching and machine learning, and control and signal processing. It is only through this synergy of pure science and engineering that we will make further strides towards understanding the science of the small and the science of the large.

Having claimed our collective contribution to these amazing advancements of science, let me focus on the current issue. This is Volume 15, Issue 2, of *ACM Transactions on*

Embedded Computing Systems (ACM TECS). We have three special sections in this issue. The first special section is on *Innovative Design Methods for Smart Embedded Systems*. This special issue has been guest edited by Sara Vinco and Christian Pilato. Smart systems are those that are self-aware and can learn and adapt over their lifetime. In certain areas, such as power management, security, and transportation, smart embedded systems are being considered as the future. The idea of a smart grid, smart transport, or a smart camera are embodiments of this very idea. From 22 submissions, the guest editors have selected seven articles to be included in this special issue/section.

The second special section is on *Methods and Models for System Design*—a special issue based on the 2014 edition of the *ACM/IEEE Conference on Formal Methods and Models for System Design (MEMOCODE 2014)*. This has been edited by Paolo Ienne and Jean-Pierre Talpin. However, the editors issued an open call for papers, and thus the issue is not confined to submissions from the conference itself. To remain within the theme of the conference, they invited papers that deal with formal methods and models for system design. From 12 papers, the editors selected 4 for inclusion in this special issue.

Finally, a special section is dedicated to *Challenges of Embedded Systems as They Evolve into M2M, the Internet of Things (IoT)*. This has been edited by Seungmin Rho, Wenny Rahayu, and Geyong Min. This is our first special issue on IoT, which has been highly discussed, with the vision that in the near future almost all devices, and even some non-devices, will communicate with each other and form a network over which computing and communication would create smartness that would optimize various aspects of our lives, including health care, driving, and even our individual living in general. This issue received 24 submissions, and 6 of them are selected for the special issue.

As we are providing three special issues, no further papers could be accommodated in this issue.

I must thank all of the guest editors for their hard work in creating interesting proposals for this special issue, coordinating the reviews of a large number of papers, and going through two to three review cycles for most papers to make these special issues possible. Individual guest editorials prior to each section will provide further details on each special issue and its contents.

We are in the process of editing the next issue as I write this editorial. We are hopeful that by June 2016, all four issues of *ACM TECS* for this year will be published and reach the hands of readers. This is phenomenal, as we are now publishing all four issues of a particular year within that year.

I hope the authors and readers of *ACM TECS* will keep submitting high-quality papers on interesting research results. A number of new special issues have been announced on acmtecs.acm.org and many of them have deadlines that are quickly approaching.

Sandeep K. Shukla
Indian Institute of Technology Kanpur
Editor in Chief