Editorial: Embedded Computing and Society

SANDEEP K. SHUKLA, Indian Institute of Technology Kanpur

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Additional Key Words and Phrases: Climate Crisis and embedded computing, inequality and computing, democracy and computing, socially responsible computing

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My tenure as the Editor-in-Chief of this prestigious journal is coming to an end. This is going to be my last editorial for ACM TECS. In the past 6 years, I have tried to write these editorials with a bias toward bringing the readers' attention to the societal responsibility of embedded computing professionals, which we often overlook in our zeal to invent new techniques, methodologies, algorithms to optimize computing processes, and artifacts. We overlook because it may not be rewarding to integrate these complex issues in our problem formulation or may be because as we grew in our career—these issues did not confront us in the form of global crisis. But the crisis has been looming over us for some time now, probably a few decades. Now probably it is coming to a crescendo, or maybe it will reach its peak soon. Nevertheless, I want to point out some of the issues that I have written about in the past—hoping that these would make an impression on some readers—and may be a slight nudge in our thought process that could leave some mark helping us consider these issues in our research and teaching.

In recent times, we have been seeing an upsurge in the number of school children coming out in protest their parental generation's inaction in the face of looming environmental crisis, as they are the ones who will be facing the consequences of our inaction or harmful policies. However, developing countries are continuing to build fossil fuel-based power plants to compensate for their increasing energy demands as their economy is trying to move upward, which is also important for eradication of poverty, unemployment, and the immediate public health crisis. Even developed countries are not moving toward a renewable energy-based economy as probably is needed to reduce carbon emissions drastically. On top of that, bitcoin, Ethereum, and other public blockchain-based cryptocurrency are gaining traction, leading to further energy demands, which is coming mostly from fossil fuel—for example, the large-scale bitcoin mining in certain countries is requiring so much energy that can supply the full load demand of many countries. The supercomputing community is going strong, reaching hundreds of petaflops necessitating a large energy footprint.

Author address: S. K. Shukla (Editor-in-Chief), Computer Science and Engineering Department, Indian Institute of Technology Kanpur, Kanpur, UP 208016, India; email: sandeeps@cse.iitk.ac.in.

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There are billions of desktops, laptops, tablets, and high-power-consuming mobile devices, leading to further energy demands. The electric vehicle industry is being touted as a way out of our fossil fuel dependence, but it is not clear if the energy consumed in the entire life cycle of an electric vehicle is saving much fossil fuel in the long run. Internet of Things devices for more intelligent living, healthcare, and structural health of buildings and bridges are also a growing trend. Thus, energy demand is always on the rise.

A lot of research in low-power computing has taken place in the embedded computing domain, but in most cases the goal has been to enhance the battery life rather than to minimize overall energy usage. Green computing got some traction about a decade ago, and a green list of supercomputers started being published—but these days, the field does not seem to have a lot of traction.

The question that comes to my mind is, as embedded computing professionals, how can we contribute to the alleviation of this looming crisis brought over by our insatiable demand for energy—coming from fossil fuel—leading to carbon pollution of our environment and slowly rendering the planet unlivable for the future generation?

There are many other issues confronting the society—electronic voting is one such issue close to my heart. It is believed in some of the largest democracies that have switched to electronic voting machines that the election process is being subverted. Voting machine vulnerabilities in countries where the machines are commercially available have been exposed, such as in the United States. In countries like India, where the technology, architecture, and the design are being closely guarded as a secret, a huge mistrust about the entire election process is building up, and this is leading to slow decimation of the major ingredient of democracy—a trusted voting system. As voting machines are embedded computing devices, it is incumbent on us to investigate this not only from a security perspective but also overall transparency and societal trust deficit perspective.

The growing inequality in the share of a country's economy among its people is another huge societal concern. According to a Credit Suisse report in 2018, the top 10% owned 77.4% of the country's overall wealth in India. In the United States, it is even worse, with the top 5% owning 66% of the nation's wealth. Globally, *Forbes* magazine's top 10 billionaires own as much wealth as the entire country of Switzerland. Although the accelerating technological progress should have made the wealth more equitable, in fact it is doing the opposite. With growing use of artificial intelligence and Industry 4.0, deep pockets with the wherewithal of innovation in these technologies are slated to gain more, leaving most behind. Industry 4.0 is a confluence of embedded and cyber-physical systems, as well as artificial intelligence and machine learning. I believe that a lot of us are engaged in building formal and informal models, simulation, optimization, and predictive analytics aspects of Industry 4.0, but what about the availability of these technologies in a more equitable manner so that any industry—large or small—can benefit from these technologies without having to pay a premium for innovation? Although innovation is important for overall growth of our economy, is it not the time to make innovation open for equitability? Otherwise, only a few large corporations will benefit from our work, whereas most of the industry and hence people employed in most of these industries would be left behind.

Having said all that, it is not easy to foray into these hard-to-charter territories being trained to be computing professionals. I myself have not been able to do a whole lot along the line that I have sermonized earlier. But I hope to do more—and certainly make my students aware of these issues more in the future so that we have a shift in their thought process while formulating their problems—while innovating new products and techniques.

The present issue (Vol. 18, No. 6) has a few regular articles, along with articles that were given a longer revision cycle on their ESWEEK submissions and did not make it to the ESWEEK proceedings. The ESWEEK proceedings were published as Volume 18, Number 5, and the papers that did not get into ESWEEK or regular issues—a selected bunch of them—were recommended to us

for further review. Some of these are in this issue, and a few took even longer and thus will be published in future issues.

Considering that this is the last issue of Volume 18, I would like to acknowledge the tireless efforts of Ms. Laura Lander in making the publication of ACM journals, particularly this journal, smooth and timely. I also would like to thank Ms. Arriane Bustillo for always being there to help as our journal assistant. Finally, our publisher, Ms. Kelly Crooks, must be thanked for her meticulous editing of each single issue and bringing them out on a timely schedule.