John Hornik
CPSC 59700
Assignment 1
03/31/2017

**Inquiry 1**

The reading materials assigned for this week covered algorithm analysis, algorithm correctness, and distributed algorithms. Readings pertaining to algorithm analysis largely dealt with estimating the complexity of algorithms in an asymptotic sense. Notations such as Big O, Theta, and Omega were covered thoroughly. There were many examples provided in different programming languages in order to reiterate the concepts covered. I found a lot or review in the sections pertaining to Big O notation and certain complexities (i.e. logarithms), however, the material on Theta and Omega notation was new to me so I found that very informative.

The algorithm correctness reading covered Intel's approach to the formal verification of algorithms. This discussed the broad overview of the cost of bugs in their proprietary products, testing for bugs, and the verification process (including the levels of verification). It also went over HOL Light, which is an interactive theorem-proving computer program. This is used to prove mathematical theorems in higher order logic (which I thought is something the author must work with frequently as he mentions that his job involves verifying higher-level floating-point algorithms).

I found the readings on distributed algorithms to be the most interesting. They provided a comprehensive and in-depth introduction into distributed systems and algorithms. Essentially, these are algorithms which are designed to execute on hardware consisting of several interconnected processors. In simpler terms, they are a collection of independent computers that appear to the users of the system as a single computer. The first paper was essentially split up into two main topics: distributed networks and parallel algorithms. It covered many aspects of these topics such as models, complexity measures, trees (breadth-first searches), broadcast/unicast/multicast routing, and SIMD/MIMD computers.

The second paper focused on distributed algorithms for sensor networks. This also covered introductory concepts of distributed algorithms, however, it then went into wireless connectivity/interfaces as well as clock synchronization. I found this topic especially interesting because implementing these concepts into my workplace would allow for a much more efficient manufacturing process.

**Inquiry 2**

I work for Siemens Medical Solutions in Hoffman Estates, IL. At our location, we focus on Molecular Imaging; more specifically we design and manufacture SPECT (single-photon emission computed tomography) devices which are implemented in nuclear medicine. These devices are used to give 3D images of tumors, infections, thyroid images, etc. as well as localized functions in internal organs such as the heart or the brain. SPECT scanners are mainly comprised of mechanical and electrical systems, however the software within them is what provides the true basis of how they operate. Because of this, Computer Science plays a very important role in the development of these machines and it can be used to solve many potential issues associated with these devices. The engineers that develop the software for the SPECT scanners need to focus on human-machine interfaces, image processing, data correction, reconstruction algorithms, etc. There are also the embedded software engineers who need to focus on how the electronic components work with the mechanical systems in order to be efficient and most importantly safe for the patient. I have heard of instances where faulty medical scanners have caused brain damage, memory loss, etc. There is also the case of the Therac-25; a radiation therapy device which malfunctioned due to programming errors. This resulted in at least six people receiving massive overdoses of radiation.

These issues could've been entirely avoided had the systems been more closely tested and if more research had been performed before the final product was released. Using a research-based approach is the only way for designers to learn from past mistakes and create products that are virtually reliable. Based on my knowledge, the devices have advanced due to the past research which has been performed. Research in biology and medicine throughout the years has helped in developing systems that are most efficient in diagnosing diseases in patients. Research in biomedical, electrical/computer, and mechanical engineering has been implemented in developing the devices from the ground-up so that they can most effectively navigate a patient's body during a scan. Algorithms which have been developed throughout the years have been implemented into the software which runs on the computers within the devices in order to perform high-precision calculations. All of these aspects together are used to create devices that can help save lives instead of putting them at risk.

Within the company, my responsibilities are in the Crystal Growth Department. The crystals grown here are used for scintillation, which is the matter in which images are captured for the SPECT machines. The crystals are grown from Sodium Iodide doped with Thallium (NaI(Ti)) in large furnaces consisting of thick metal and hundreds of outdated analog electronics which are used for the control. The main issues which I have seen arise have to do with the environment and its effects on the control systems. The salt gets in the air and eventually oxidizes most metals within the department. This includes many of the custom-built analog components which work together with digital process controllers to control the growth process. Based on past work performed, I believe that implementing digital IO devices (i.e. National Instruments) in lieu of the analog electronics would greatly improve the control process and omit many of the problems that are currently present. A single IO device for each furnace would greatly reduce the amount of components on that respective furnace. Adding a weather-proof casing on the device would keep the harsh environment away from its contacts, IC's, and anything else that can oxidize or rust. Finally, the implementation of custom software would allow us to control everything in a more efficient manner. Because the furnaces rely heavily on sensors in order to tell operators what's going on internally, custom written software would allow us to more effectively work with individual sensors in order to acquire the information that we need. Implementing some form of artificial intelligence would also greatly aid in diffusing emergency situations (power outages, power spikes, device failures, etc.) since it would allow the software to automatically know what to do next instead of relying on a panicking individual to make the right decisions. Developing such a system would certainly call for a research-based approach due to the fact that every aspect of control would need to be dissected and broken into its individual parts before anything was physically developed. Many hours of testing would need to be implemented in order to verify that the new system works properly and efficiently. Although there would be much work involved, I believe that the advantages would far outweigh the disadvantages as a newly developed autonomous system would surely improve many aspects of the manufacturing process.