What is Computer Engineering?

Computer engineering is the branch of engineering that comprises electronic engineering and also computer sciences. Computer engineers design and develop software and hardware computer components, computer systems and other technological devices. Computer Engineers specializes in analyzing and solving computer-oriented problems. They understand computers inside and out, that is why they evaluate computer related problems exquisitely. The knowledge of both the "body" and the "mind" of a computer helps computer engineers work at the microscopic level and on a large, system-wide scale.

History of Computer Engineering

Appreciate the advanced technological world today because of John Vincent Atanasoff, also known as “The Father of Computers”. He was born in Hamilton, New York on the 4th of October in the year 1903. At 9 years old, he was fixing broken electricity wires in his home, he then started to study trigonometric function and logarithms. With the help of his mother, he was reading books for college students and started to understand differential equations and other fairly difficult mathematical concepts. His mother introduced the young boy to the number systems based on a different number than 10. This is how he first learned about the base-two number system. In 1919, their family moved to Old Chicora, Florida, where he entered to Mulberry High School. He completed the entire school course within 2 years, with straight A’s. In 1921, he was accepted in University of Florida in Gainesville. However, the university did not offer a specific program in theoretic physics, which the is field he wanted to study, therefore, he signed for electrical Engineering Degree, where he graduated in 1925 with again, straight A’s, with bachelor of science in electrical engineering. Although, offered various scholarships from some of the best schools in the country, including Harvard University, the 22 years than old John Vincent Atanasoff, decided to accept the offer from the Iowa State College, which was famous with its engineering and science programs. This was where, later he invented the first digital computer in the world. During his master's in the university, John had a very busy schedule. He was working towards his degree and in the same time he was teaching two undergraduate courses in mathematics. However, he found time to meet with Lura Meeks, who soon after his graduation became his wife. In June 1926 John graduated from the Iowa State College with Masters of Science in mathematics. He accepted an offer from the university to teach mathematics. At first, his wife was teaching in a school in Montana, but soon she quit her job and moved back to Ames. So in 1929 their first child was born, a daughter called Elsie. Later, they had 2 more children, a boy and a girl. After Elsie was born, they moved to Madison, Wisconsin where John was taking his doctorate in theoretical physics. During his work on his final thesis, "The Dielectric Constant of Helium" Atanasoff had his first experience with serious computing. He was working with Monroe calculator, which was one of the best calculators at that time, but still it gave him a really hard time and he had to spend hours performing various calculations. It was this experience that made Atanasoff to think strongly in the course of developing a better computing machine. So after he received his Ph.D. in 1930, he accepted an offer from the Iowa State College as an assistant professor in mathematics and physics, and the family moved back to Ames. In the university, Atanasoff started to make various experiments with vacuum tubes and radio signals as well as various electronic devices and was really determined to develop an advanced computing machine. Meanwhile, he was promoted to an associate-professor in physics and mathematics. In the following years Atanasoff continued to examine various mathematical devices and he classified them into two groups: analog and digital devices. The main problem that the inventor found was that the analog devices were slow and their accuracy was dependent upon the performance of all the parts in them. Around year 1937 John was still obsessed with the computer problem he was trying to solve. As the story in various sources tells including the Iowa State Collage archives:

"...in the winter months of 1937. One night, frustrated after many discouraging events, he got into his car and started driving without destination. Two hundred miles later, he pulled onto a roadhouse in the state of Illinois. Here, he had a drink of bourbon and continued thinking about the creation of the machine. No longer nervous and tense, he realized that his thoughts were coming together clearly. He began generating ideas on how to build this computer! After receiving a grant of $650 from Iowa State College in March 1939, Atanasoff was ready to embark in this exciting adventure. To help him accomplish his goal, he hired a particularly bright electrical engineering student, Clifford E. Berry. From 1939 until 1941 they worked at developing and improving the ABC, Atanasoff-Berry Computer, as it was later named."

The ABC computer was the first electronic digital computing device. It was designed with a specific purpose, to solve systems of simultaneous up to 29 linear equations. The machine exact operation was to accept two linear equations at a time with up to 29 variables and a constant, using this data it could eliminate one of the variables. Following this way, the machine could continue by eliminating each time one variable, until the entire system of equations was solved.

Although, as one can see above, the ABC was not a general-purpose computer (its function was fixed), meaning that it did not implemented the stored program architecture (Von Neumann architecture). It still was the first to implement 3 of the most important ideas used in computers now-days. The first and probably most important was using binary digits (1's and 0's) to represent all the numbers in a given data. The second was to perform all the calculations using electronics instead of mechanical switches and wheels. And the third was using the principle from the Von Neumann architecture where the memory and the computations were separate. The ABC also implemented another important idea using a regenerative capacitor memory that is still used now-days in Dynamic Random-Access Memory. This means that since the capacitors are losing their charge pretty quickly, they need to be given a new electronic charge every few milliseconds. The system weighed more than seven hundred pounds (320 kg). It contained approximately 1 mile (1.6 km) of wire, 280 dual-triode vacuum tubes, 31 thyratrons, and was about the size of a desk.

The memory of the Atanasoff-Berry Computer was a pair of drums, each containing 1600 capacitors that rotated on a common shaft once per second. The capacitors on each drum were organized into 32 "bands" of 50 (30 active bands and 2 spares in case a capacitor failed), giving the machine a speed of 30 additions/subtractions per second. Data was represented as 50-bit binary fixed-point numbers. The electronics of the memory and arithmetic units could store and operate on 60 such numbers at a time (3000 bits). The AC power line frequency of 60 Hz was the primary clock rate for the lowest level operations. The logic functions were fully electronic, implemented with vacuum tubes. The family of logic gates ranged from inverters to two and three input gates. The input and output levels and operating voltages were compatible between the different gates. Each gate consisted of one inverting vacuum tube amplifier, preceded by a resistor divider input network that defined the logical function.

There were two forms of input and output. Primary user input and output and an intermediate results output and input. The intermediate results storage allowed operation on problems too large to be handled entirely within the electronic memory. (The largest problem that could be solved without the use of the intermediate output and input was two simultaneous equations, a trivial problem.) Intermediate results were written onto paper sheets by electrostatically modifying the resistance at 1500 locations to represent 30 of the 50-bit numbers (one equation). Each sheet could be written or read in one second. The reliability of the system was limited to about 1 error in 100,000 calculations by these units, primarily attributed to lack of control of the sheets' material characteristics. In retrospect a solution could have been to add a parity bit to each number as written. This problem was not solved by the time Atanasoff left the university for war-related work. Primary user input was via standard punched cards and output via a front panel display."

By 1945 the Navy, too, had decided to build a large scale computer, on the advice of John von Neumann. Atanasoff was put in charge of the project, and he asked Mauchly to help with job descriptions for the necessary staff. However, Atanasoff was also given the responsibility for designing acoustic systems for monitoring atomic bomb tests. That job was made the priority, and by the time he returned from the testing at Bikini Atoll in July of 1946, the NOL computer project was shut down due to lack of progress, again on the advice of von Neumann. Mauchly and Eckert applied for a patent on a "General-Purpose Electronic Computer" in 1947, which was finally granted in 1964. The rights to the patent had been sold in 1951 to Remington Rand (to become Sperry Rand); that company started demanding royalty payments from other computer manufacturers in the late 1960's.

The dispute over patent royalties eventually resulted in a lawsuit filed on May 26, 1967 by Honeywell Inc. against Sperry Rand in U.S. District Court in Minneapolis, Minnesota challenging the validity of the ENIAC patent. The trial, one of the longest and most expensive in the federal courts to that time, began on June 1, 1971, lasted until March 13, 1972, had 77 witnesses, plus 80 depositions and 30,000 exhibits. Atanasoff's machine was introduced as prior art. The case was legally resolved on Friday, October 19, 1973, when U.S. District Judge Earl R. Larson held the patent invalid, ruling that the ENIAC derived many basic ideas from the Atanasoff-Berry Computer. Judge Larson explicitly stated, "Eckert and Mauchly did not themselves first invent the automatic electronic digital computer, but instead derived that subject matter from one Dr. John Vincent Atanasoff". The decision in Honeywell Inc. v. Sperry Rand Corp. et al., was so well supported that Sperry declined to appeal. The decision received little publicity at the time, perhaps because it was overshadowed by the Watergate Era "Saturday Night Massacre" firing of special prosecutor Archibald Cox by President Richard Nixon the next day. While legally vindicated, Atanasoff's victory was incomplete as the ENIAC, rather than the ABC, continued to be widely regarded as the first computer until after his death."

After a long sickness Atanasoff died on June 15 1995, in his home in Maryland. In 1997 a project to develop a fully functional replica of the ABC, with a $350,000 budget, was completed in the Ames Laboratory, located in the Iowa State Collage. Right now, it can be seen on display on the first floor of the lobby of the Durham Center for Computation at Iowa State University. This is also where, most of the archives related to the development of the Atanasoff-Berry Computer, are held. There are many pictures, videos and a lot of information as well as a full documentation of the court trial led to the final decision that indeed it was the ABC - the first computer in the world.

Computer Engineering Education Across the World

As of 2015, there were 250 ABET-accredited computer engineering programs in the U.S. In Europe, accreditation of computer engineering schools is done by a variety of agencies part of the EQANIE network. Due to increasing job requirements for engineers who can concurrently design hardware, software, firmware, and manage all forms of computer systems used in industry, some tertiary institutions around the world offer a bachelor's degree generally called computer engineering. Both computer engineering and electronic engineering programs include analog and digital circuit design in their curriculum. As with most engineering disciplines, having a sound knowledge of mathematics and science is necessary for computer engineers.

Future of Computer Engineering

While there are many different jobs within the field of computer engineering, there are several commonalities among them that make it an excellent choice for the right person. The benefits of computer engineering as a career include great pa

y, job security and an environment of change and innovation. According to BLS or Bureau of Labor Statistics, the employment of Computer Hardware Engineers are to increase in employment form 2012 to 2022, however its increase is lower that of the average of other occupations. Only a modicum number of engineers shall be needed because more of the technology innovation takes place with software rather than software. Software developers are predicted to grow 22 percent from 2012 to 2022 which is a higher average for all other jobs. However, with the flexibility of the knowledge of Computer Engineers, this shouldn’t be a problem.

Sources:

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