

Integrating the Internet of Things (IoT) in Today's Technical Curriculum

Professor James Mallory

Department of Information and Computing Studies

National Technical Institute for the Deaf

Rochester Institute of Technology

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Abstract

Two of the hottest trends in the technical world today are Cyber Security and The Internet of Things, (IoT). Educators need to pay attention to these trends if they are to properly prepare their students for the technical workplace. Cyber security does not apply to some of the Engineering Technology curricula but IoT does as explained in this article. IoT is accelerating at an alarming rate in every aspect of our lives and should rapidly be seeping into a program's technical curriculum regardless of what level or sector the college is teaching. Simply put, " IoT is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction."¹ IoT impacts most areas in Engineering Technologies ins some way - including Electrical, Mechanical, Computer, Civil, Construction, Automotive, Cyber, etc. IoT is used in manufacturing, agriculture, automobile and transportation, home automation, health care, and energy sectors to name just a few.

Keywords: Internet of Things, IoT, Electrical, Mechanical, Computer, Automotive, Technology, Analog, Digital, Devices, Industry, Student Learning, Technical Education

Integrating IoT in Today's Technical Curriculum

Why IoT is Rapidly Growing

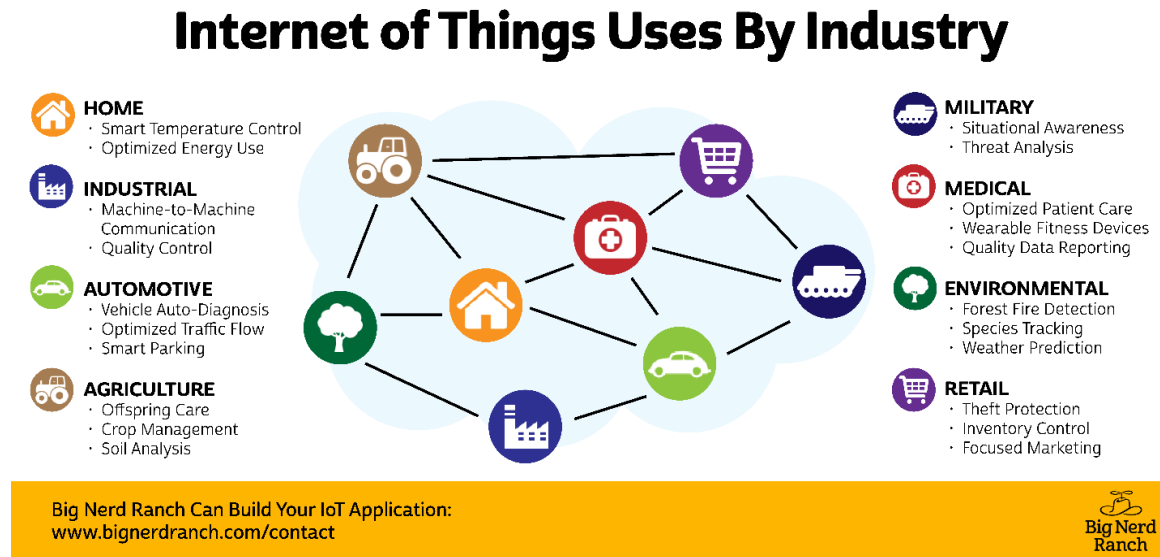
Businesses are motivated by IoT technology and the possibility of increasing revenue, reducing operating costs, and improving efficiencies. Businesses also are driven by a need for regulatory compliance. Regardless of the reasons, IoT device deployments provide the data and insights necessary to streamline workflows, visualize usage patterns, automate processes, meet compliance requirements, and compete more effectively in a changing business environment.

Internet of Things Used by Industry

IoT is evident in most of the technical sectors both at home and in industry. Examples of IoT devices include smart refrigerators, smartwatches, smart fire alarms, smart door locks, smart vacuums, and lawnmowers, smart bicycles, smart wheelchairs, medical sensors, fitness trackers, smart security systems, GPS-guided tractors, smart cars or trucks, self-driving cars, moisture sensing and watering devices for crops, in-flight services on planes, online shopping, drone surveying, drone delivery of products, etc. "A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an IP address and is able to transfer data over a network." (Canopy, 2021)

Figure 1

Internet of Things Used by Industry



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Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business. There is an increasingly huge demand for technical skills that include these areas. These skills can begin in the educational technical arena.

Integrating IoT into Technical Programs

Regardless of the content, a technical program may have, it is wise to include some aspect of IoT into the program. IoT means that devices are “smart”. The devices themselves, however, are devices that are currently being used in many technical curriculums - devices such as limit switches, mechanical activators, biometric devices, analog or digital sensing devices, GPS trackers, etc., Some small but comprehensive projects can be incorporated into most technical curriculums which can enhance what faculty are already teaching and help prepare students for the modern technical workplace.

Examples of IoT Projects

The author implemented several IoT projects as Capstone projects for technical students who are completing their two-year Associate of Applied Science (AAS) degree in Applied Computer Technology (ACT) at Rochester Institute of Technology's National Technical Institute of the Deaf. RIT has a rowing team which includes some deaf and hard of hearing (d/hh) rowers. These athletes and coaches became willing guinea pigs for our students to test their technical skills and help them improve their performance in their sport. The author hopes that sharing these ideas may inspire others at technical colleges to implement technical IoT projects and share their results also. If one is creative it is often easy to incorporate an IoT project into what is already being taught.

Some of the projects included water sports monitoring/measuring which included rowers, kayakers or stand-up paddlers using biometric straps, smartwatches to record heart rate, speed and GPS data, stroke counting devices such as Vaaka via Bluetooth or ANT+ communication, GoPro cameras, etc. All of the data recorded from these devices communicating with each other was synched and integrated into a video so the athlete's technique, speed, and biometric data can be easily analyzed. This included the use of smartphone apps and using data that was stored on the cloud. Below is one student's project using a variety of IoT devices with a rowing customer.

Figure 1

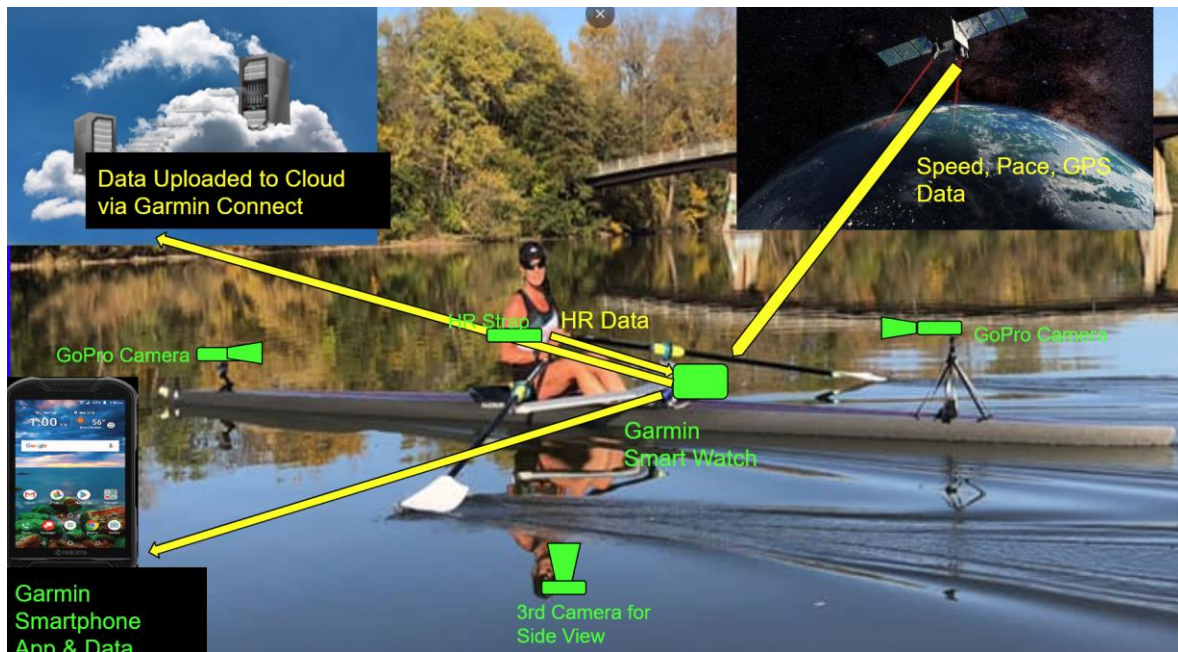
Rowing Shell and Customer used in IoT Class Technical Activity



In this activity students had to gather heart rate data from a chest strap which synchronizes and then sends either a Bluetooth or an ANT+ data signal to the Garmin Forerunner smart watch. The smart watch also records speed and pace via a satellite and stores this data via a smart phone app. This app then uploads the data to the cloud where it can be analyzed. The coordination of these devices is shown below in Figure 2.

Figure 2

Rowing Shell and Customer with IoT Devices Attached



The students then have to export the data into the proper format into a specialized editing program. They are allowed to use either a Mac or Windows PC. For a Mac they often choose iMovie and for Windows they often choose VIRB software for editing. A screen capture showing the editing software used is shown below in Figure 3.

Figure 3

Software Used to Edit IoT Project



A Youtube movie of students' completed project can be viewed at:

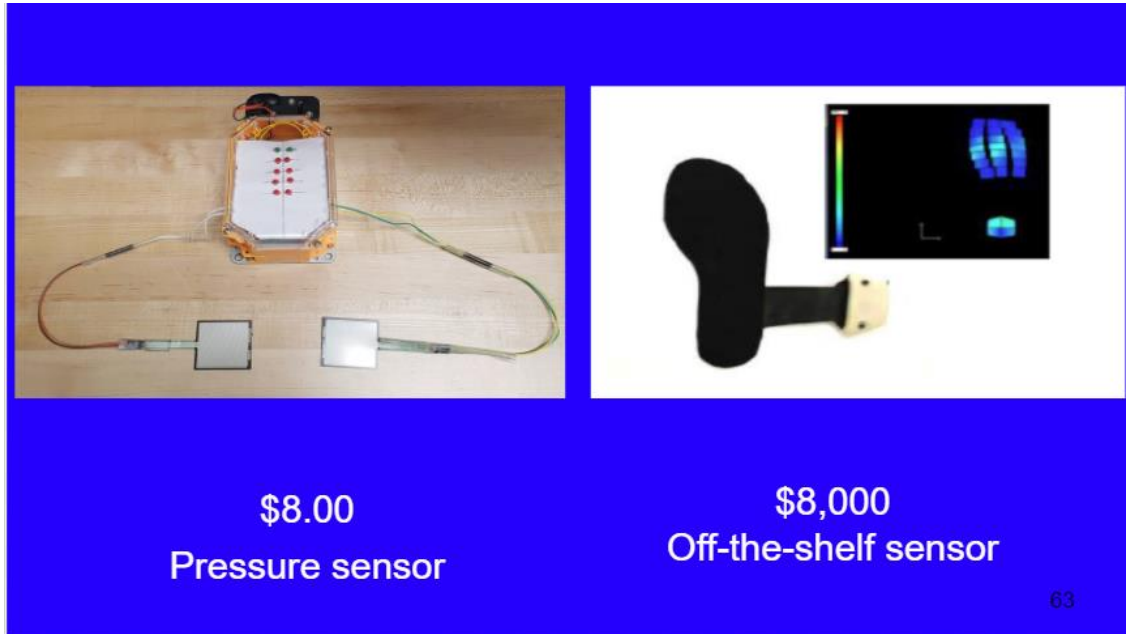
<https://youtu.be/DQfc9ae2M5M>. Students are required to present their projects to a large audience consisting of their peers, department faculty, staff, and customers. The students enjoyed the challenge of this activity as well as getting out of the classroom and implementing their IoT devices in the field.

Foot Pressure Monitor Project for Rowers

One other example of a project included implementing pressure sensors so that the athlete can tell if he/she is pressing equally on both feet when rowing. This included the use of pressure sensors and an Arduino programming coordinated with LED lights. Students were given a fixed budget and asked to implement a solution for the customer. They found off the shelf foot sensor used mostly for diabetic patients which cost \$8,000. Through their research and creativity students created a roughly equivalent measuring device with \$8.00 sensors and integrated this into their system. This system is shown below via a screen capture from the student's final presentation.

Figure 4

Foot Pressure Gauges Used in Student IoT Project



The students implemented one sensor for each foot and found the results were not accurate enough. This was due to the fact that some customers pushed more with the ball of their foot and some pushed more with their heel. The students solved the problem by adding two sensors so that inputs were received from two places on each foot. Two pictures of this can be seen in Figures 5 and 6 below which were extracted from the student's final presentation.

Figure 5

Prototype of Foot Pressure Device Using Four Sensors

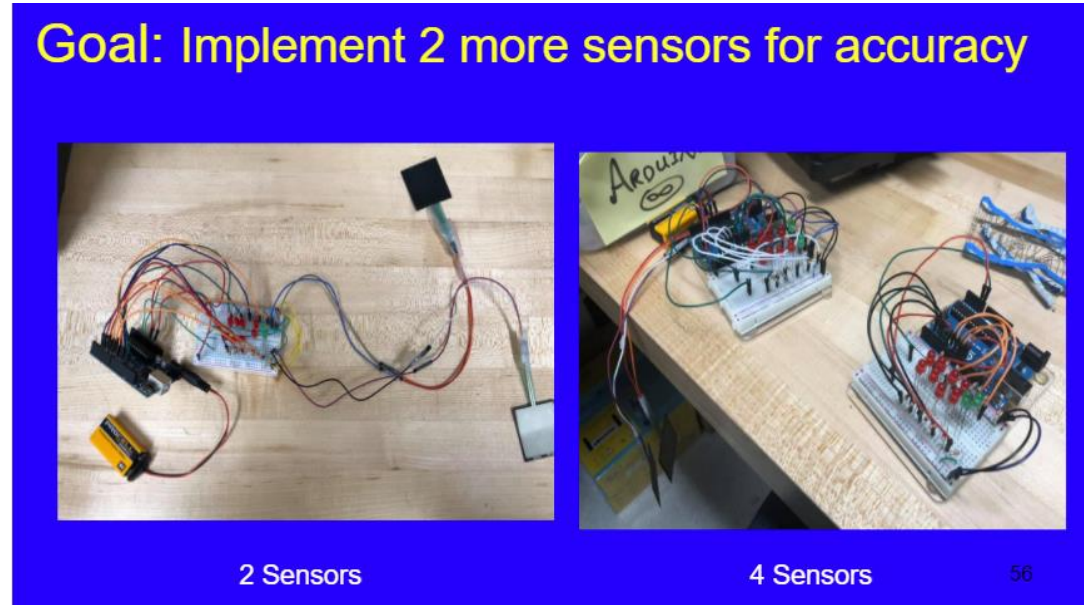
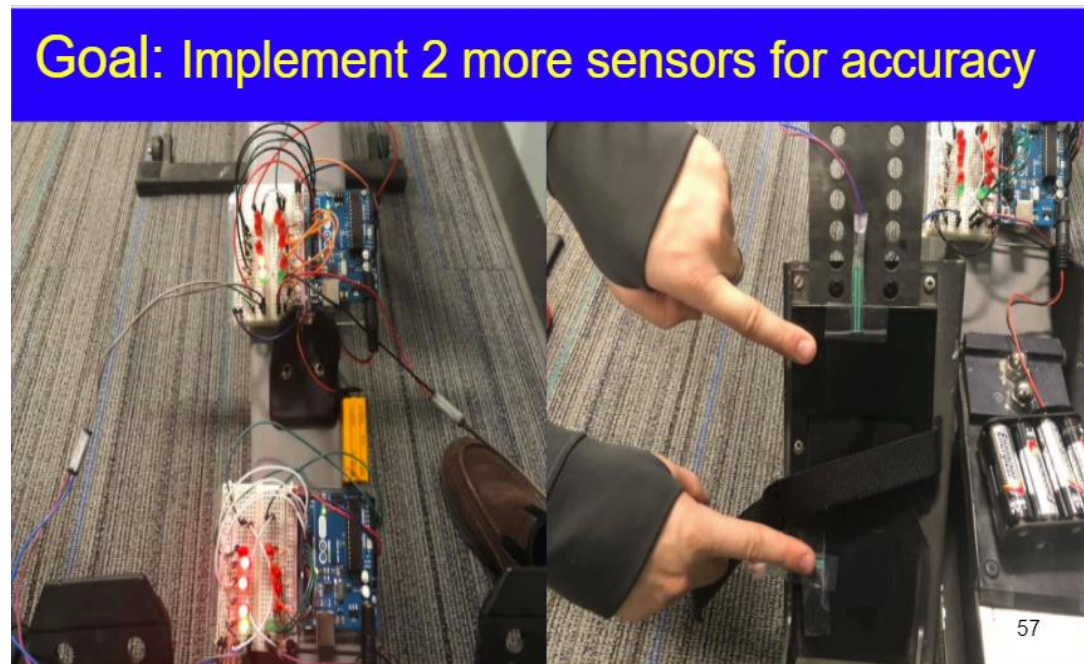


Figure 6

Implementation of Foot Pressure Device Using Four Sensors



Integrating IoT in Today's Technical Curriculum

This was a valuable project which helped the students develop several important skills needed in the technical workplace. Students had to learn Arduino programming and input/output connection and interfacing on their own to be able to accomplish this project. Following is a Youtube movie of the student's completed project: <https://youtu.be/4KSB9AyH-7A> .

Some of the goals and learning outcomes from this project are listed below. These were extracted from the instructor's course shell for the project description.

Goals, Learning Outcome(s):

1. learn about IoT devices and technology including biometric devices, accelerometers, GPS and blue tooth devices, Arduino controls, input/output devices and cloud computing
2. learn about mobile app phone interfaces with the items mentioned in 1. above
3. learn new application software
4. perform both independent and team research for technical solutions to a problem
5. work with hearing and deaf customers
6. work on a team, leveraging each other's time and efforts (instead of being redundant or wasteful with their time)
7. manage timelines and tasks
8. document and report findings
9. present and articulate results to an audience

Conclusion

This paper illustrates the growing field of IoT and the need to incorporate IoT in the technical curriculum. Two examples of student projects are described by the author. With a minimum amount of research and effort, any technical educator can find and customize an IoT activity and incorporate it into the curriculum. It adds value to the students' education and the variety makes it enjoyable for them.

References

1. Tools, Canopy (2021). *What is IoT?*. <https://canopytools.com/what-is-iot/>
2. Simon, Zack (2021). *What the Internet of Things Means for Your Business*.
<https://bignerdranch.com/blog/what-the-internet-of-things-means-for-your-business/>