# BOARD # 247: Improving Undergraduate STEM Education (IUSE) By Engaging Students Using IoT – Addressing AI and Cybersecurity

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# Improving Undergraduate STEM Education (IUSE) By Engaging Students Using IoT – Addressing AI and Cybersecurity


## Abstract

While Internet of Things (IoT) has become more common in everyday applications and products, many of these same IoT-based applications do not consider cybersecurity issues and associated concerns. In addition, with more access to cloud computing resources and more readily available graphics processing units (GPUs) being utilized for artificial intelligence (AI), AI-based processing continues to disrupt multiple technical fields and associated products. As a result, AI and cybersecurity were identified as areas that need to be introduced or included for the students participating in IoT-based projects.

In this project a team at two Hispanic Serving Institutions (HSIs), Texas A&M University-Kingsville and Texas A&M University-Corpus Christi, has developed new materials addressing the use of AI and taking into account cybersecurity. Using Python and appropriate Python libraries, pre-trained AI algorithms are added to Python coding which will allow more advanced features such as image recognition to be included in the student projects. Information on cybersecurity standards have been added to student project-related materials to introduce the student to an ongoing design and operational concern for IoT-enhanced products and projects. An exercise using AI has been added to the IoT tutorial materials previously developed as part of the work supported by this grant.


## Introduction

Student experience related to working with and designing Internet of Things (IoT) as well as AI capable products and applications continues to be relevant to those studying and graduating in engineering related fields. Many commercial systems have added IoT and/or AI functionality in the last few years as the cost of processors, sensors, memory and cloud-based analytics and storage services continue to be relatively affordable. In this project, lab exercise materials were developed at two HSIs, Texas A&M University-Kingsville and Texas A&M University-Corpus Christi, to introduce students to IoT concepts utilizing a Raspberry Pi [1]. with sensors and a motor as well as exercises using a BeagleBone Green microcontroller-based kit; the materials are based on work supported by a National Science Foundation IUSE grant no. 2044255. More details about the exercises can be found in [2]-[7]. In this project the team has developed new materials to facilitate student awareness of the use of AI and taking into account cybersecurity.

## Background

With readily available affordable options for adding processors and microcontrollers, sensors, actuators, memory, as well as cloud-based storage, many commercial applications have incorporated IoT capabilities. With this in mind, there is much work in the literature related to remote learning and/or IoT based courses and associated materials [2]-[9]. Cybersecurity issues have become more prevalent as more systems include IoT-related control, communications and

functionality; IoT-based projects, course materials and exercises should introduce or make students or end-users aware of potential cybersecurity issues, threats and concerns [10]-[14]. Recent advances in AI have led to more readily available open-source machine learning frameworks and APIs, such as Gemini Developer API [15] or PyTorch [16], as well as many tools such as ChatGPT [17].

**Artificial Intelligence and Cybersecurity**

Senior capstone course design projects should address cybersecurity issues and threats [18]. As part of the electrical engineering capstone course at Texas A&M University-Kingsville during the Fall 2024 semester, students were tasked to perform a whole system mapping for sustainable design which also took into account cybersecurity issues with their proposed project. Device accessibility, vulnerabilities and threats, as well as data protection are areas of concern for the IoT-based product designer [19]. NIST IR 8259 details areas of risk that might be mitigated as well as activities for the manufacturer/designer to perform as part of the design process to address cybersecurity-related issues or concerns [19].

Examples of past senior capstone IoT-related projects at Texas A&M University-Kingsville included a Database Website for Pressure Readings [20] and a Digital Pressure Recorder [21] as shown in Figure 1 while example projects at Texas A&M University-Corpus Christi included an IoT Enabled Unmanned Traffic Management (UTM) System [22] and ADDRAR-II [23] that was utilized for debris removal, as shown in Figure 2. In each of these example projects more attention to cybersecurity should have been addressed.

Figure 1 Digital Pressure Recorder [21]

Figure 2 Robotic Vehicle for Removing Debris [23]

The whole system mapping performed by the students in Fall 2024 ensured students were aware of cybersecurity issues related to their senior capstone design projects that will be completed Spring 2025.

Many commercial systems have also started to include AI functionality and features. An exercise using a Raspberry Pi IoT kit, a camera, Python, and Gemini API [15] to add AI-based image recognition functionality has been added to the IoT tutorial materials previously developed as part of the work supported by this grant. More details about the exercise are found in [24].

## Conclusions

Many IoT-based applications do not consider cybersecurity issues and associated concerns. AI-based processing continues to disrupt multiple technical fields and associated products. Device accessibility, vulnerabilities and threats, as well as data protection are areas of concern for the IoT-based product designer [19]. Students developed a whole system mapping for sustainable design for their proposed senior design project which also took into account cybersecurity issues. An exercise using a camera and AI for image recognition has been added to the IoT tutorial materials previously developed as part of the work supported by this grant [24].

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