

Self-publish textbook for Embedded System Education using an MSP432 microcontroller

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Abstract

In some engineering fields, the pace of the development has been accelerated. One of the fields is a computer engineering. Specifically, a few microcontroller and microprocessor courses can be considered as relevant. There is a good chance that the course materials in these courses can be easily outdated in a couple of years after published. This may not be desirable for educating college level students because the engineering instructors are expected to deliver the up-to-date information to their students. In this reason, there would be essential needs of frequently updating lecture contents and materials due to the technological changes. The author has been teaching a microcontroller related courses including embedded system courses and found that this embedded system course is one of the examples of the cases with the need of frequent updates as it was described earlier. Author has been trying several new methods to tackle this problem. In this paper, one of the methods is introduced, which is about self-publishing a textbook for the course. Moreover, in this paper, the transitional effort and the relevant impact to the course due to the Covid-19 in Spring 2020 have been presented.

Introduction

In an engineering field such as Computer Engineering, the technological changes have been accelerated. There is a chance of the case where some of the knowledge and information that were used to be considered as valuable, accurate, and relevant could have become less valuable, inaccurate, or less relevant today. Some of the reasons may include the rapid pace of the development and newly introduced technologies. For engineering educators at a higher education institution, they are expected to deliver the up-to-date lecture contents to their college level students. However, because of the accelerated development of technologies, their course materials may need frequent updates and may need to include some of the new contents periodically. The author has been teaching microcontroller application courses and found that there are the needs of updating lecture contents periodically. These relevant courses are microcontroller application courses including an embedded system course. I have tried several efforts to tackle this problem. In this paper, one of the efforts is introduced, which is to self-publish a textbook for the course.

A traditional textbook approach is to work with a publishing company¹. This is typically processed by the agents. This is a good choice, and there are many benefits in this method. However, typically, it tends to expect to sell a decent number of the copies of the book. Therefore, this process may tend to take a significant amount of time to be published. In addition, this approach may not be a suitable

for the materials that may need frequent updates or a short revision cycle. If educators are expecting the high volume of their textbook sales, this would be a good approach. However, in some cases, college textbooks are not written for a general audience. Therefore, the number of copies of the textbook may not be high. Therefore, it may result in a high cost per copy of the textbook.

There is an open Educational Resource approach^{2,3}. In this case, educators release their textbook under an open copyright license and make it available freely. This is also a good choice for educators. Typically, their work can have a good record of access and recognition, but there is no direct financial benefit in this approach. However, there can be a case where a university library or a government department provides a scholarship or a grant to support faculty members to write an open access textbook.

There is a self-publishing approach^{4,5,6,7}. This is a flexible method that leaves many choices to the authors. If it is managed properly, it may be able to offer the copy of the textbook at an affordable price. Educators can have a freedom to write new next revision of the textbook, as it becomes necessary. For students' side, they could receive education using structured and up-to-date course materials. For authors, they can receive book royalties. However, the royalties may be processed and treated differently by the institutions and departments. It is an important process for instructors to consult with their supervisor and business office to be compliant to the system policy. There are several companies that support self-publishing a book. In this paper, the process via Amazon kindle direct publishing (KDP) is introduced. Also, it includes the brief introduction to the method of publishing in Barnes & Noble Press as well as IngramSpark. A self-publishing platform supports both paperback and electronic book (eBook) versions. Due to the Covid-19, a digital format of the content has become more important. This digital format eBook is a good alternative choice for students in this new mode of remote and hybrid college class operations.

In short, I have been teaching a microcontroller application courses including embedded system course, and I found that there was a need of updating lecture materials frequently. In addition, I found that there was a need of finding a suitable textbook that matches with my own course curriculum. In this reason, a textbook has been written and self-published. In this paper, the on-going process and the journey of self-publishing a textbook for Embedded System Education using an MSP432 microcontroller has been presented.

Background and Motivation

Microcontrollers are commonly used in an electronic system. These microcontroller applications gain more popularity as they have an internet access, and they become IoT (Internet of Things) devices. An embedded system is a specialized and typically small sized computing system. Microcontroller can be used in an embedded system.

There are several microcontroller models that were taught and used in my embedded system courses since 2016. These microcontroller models include TI (Texas Instrument) MSP430F5438A, MSP430G2553, MSP430F5529, and Tiva TM4C123G. For an embedded system course, it has been offered every Fall and Spring semester. There have been several revisions of lectures that used a different set of microcontrollers.

In the early lecture set in this course, I have taught about TI MSP430F5438A applications. Also, students had learned about MSP430G2553 to expand their horizon. Next lecture set was about teaching MSP430F5529 as well as MSP430G2553 applications. Next, I have taught about Tiva TM4C123G and MSP432F5529 applications. The recent version of my course is based on single microcontroller and the choice was an MSP432 microcontroller (MCU). While the course topics were kept mostly unchanged. However, the detailed contents of the course had been updated throughout these lecture revisions over several semesters. These changes are not uncommon, but they are essential due to several reasons. For instance, regarding the recent change to the MSP432 MCU from Tiva TM4C123G, both of the microcontrollers are based on ARM Cortex M4F. However, the company had introduced a concept of SimpleLink family. In order to educate students to be aligned with the industry trend change, this course had to choose one of the MCUs in the SimpleLink family and made the relevant changes. In my course, the choice was an MSP432 MCU⁸. Given these changes and the reasons, this embedded system course has been presented as one of the examples that may need frequent updates to deliver up-to-date lecture contents to the students.

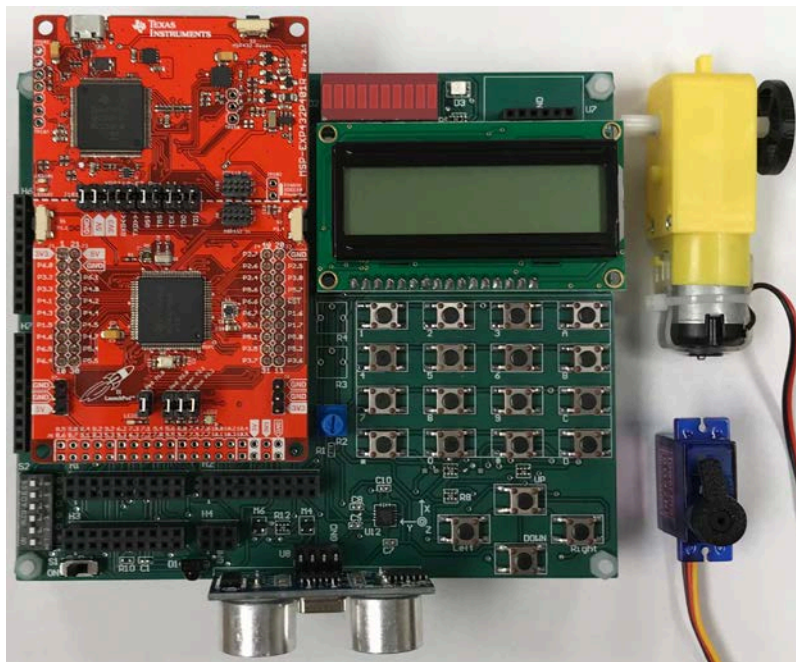


Figure 1. BH EDU board kit (Version 2.1.x).

This recent choice of the MSP432 MCU seems a solution that may be viable for several more semesters. This version has been used from Fall semester of 2019. Figure 1 shows a custom laboratory kit that has been used in this course. This show a recent version of the laboratory kit, and its name is BH EDU board kit⁹. Students can mount their MSP432 launchpad boards on the BH EDU boards. Students will learn about various aspects of the MSP432 applications using this BH EDU board kit. After the completion of the Fall semester of 2019, to provide better education for the students for the following semester, the author decided to compile the lecture contents and to publish a book regarding this MSP432 application course. The detailed process of this textbook project has introduced in the next section.

Process and Method

The first edition of this MSP432 textbook was published through Amazon Kindle Direct Publishing (KDP) in January 2020. The strategy for this textbook project was to split the book into two volumes. This method of splitting volumes was effective and helpful in getting it started early. The second volume was completed and published during the semester. During the summer of 2020, two volumes were merged, and the contents were revised^{10,11}. The second edition of the MSP432 book was published through Amazon KDP in August 2020¹². The first edition was used in Spring 2020, and the second edition has been used in Fall 2020 and Spring 2021. The publication of this customized textbooks has made this course more systematic and organized, and it made lecture materials the best match with my course schedule and course topics. There are several self-publishing companies that are relevant to this book project, and they are introduced in the following sub-sections.

Kindle Direct Publishing (KDP)

Amazon provides a large number of eBooks through its proprietary Amazon kindle. Amazon has a kindle direct publishing (KDP) service that supports paperbacks and eBooks. KDP authors can easily learn about the publication process through the resources including webinars and videos, and articles. These resources can be found in the one of the web pages that was named as KDP University. Moreover, authors can get help directly from KDP, or they can get their questions answered through KDP community. Self-publishing a book could be an intimidating and complicated task for beginners, however, KDP made it relatively easy. This is very good. At the same time, this could be misleading, if someone is not careful. A self-published book author is supposed to understand and manage many aspects of publisher's responsibilities and tasks. It is good to publish the book without the need of understanding details of the book industry during the publication process. However, it is important and highly recommended for the self-published book authors to continue to learn and study about the publisher's roles and tasks. If an author does not want to be involved in activities of studying and understating publisher's roles and tasks, a self-publishing method may not be a good choice. In this case, it would be a reasonable and better choice to consult with a traditional book publishing companies to publish your book.

For instance, a paperback needs an ISBN that is International Standard Book Number. KDP allows to use an ISBN that is given freely by KDP. This is helpful. At the same time, it may be not, depending on the purpose of the author. If an author uses a free ISBN given by KDP, the author cannot choose the imprint. This means the publisher will be shown as "Independently published." Also, a free ISBN given by KDP may not qualify to receive a LCCN that is Library of Congress Classification¹³. Using an ISBN given by KDP does not mean your book is only available on Amazon. KDP offers an option called Expanded Distribution to allow the distribution to bookstores, libraries, and academic institutions.

For authors who are considering this self-publication approach more seriously, they can purchase their own ISBN through bowker. If you have your own ISBN, you can obtain your LCCN and you can choose your imprint. That means the publisher's name can be shown as an author's name. An imprint is a trade name like a brand name. Your data will be recorded properly in the book industry database. So, the question to the authors is whether you would want to use free ISBN or to buy their

own. Moreover, one of the aspects to consider is the system policy of your organization. For self-published book authors, it is important to check with your supervisor and the business office regarding the royalties, if you have chosen your own book as a textbook. The policy varies by the schools. There can be resolutions such as a donation process. It is worth of mentioning that the focus of self-publishing a textbook is about providing a good quality education for students.

In order to reach more readers as well as to make the book available in more distributors, there is an option that is an Expanded Distribution as it was mentioned. However, the assigned percentage of the royalties from this expanded source is lower than the normal percentage in KDP. Instead of the dependence on the KDP Expanded Distribution, authors can expand the availability through directly publishing their book on self-publishing companies like Barnes & Noble Press and IngramSpark.

Barns & Noble Press

Using Barnes & Noble (B&N) Press, authors can publish their paperbacks and eBooks. The process of the publication is also straightforward, particularly, if you already have an experience in publishing a book in KDP. If your book cover was designed by a professional, you can ask your book cover for B&N Press. However, if you have designed your own book cover using book cover template in KDP, you may need to put some efforts in creating a separate book cover for B&N press.

For the paperback, B&N press also offer a free ISBN. This means that the ISBN of the book for B&N Press may be different than the one in KDP. For eBooks, an ISBN is not required for either B&M or KDP. Some of the benefits of direct publishing through B&N are related to royalties and the access of the sale report tool directly from B&N press.

IngramSpark

For authors who choose to have their own ISBN, there are several self-publishing companies that may be appealing to them to reach more readers. One of them is IngramSprk. It has a large distribution channel including Amazon and Barnes & Noble. However, this is a paid service. Fees may be required per uploading a book. If an author selects an option of the Expanded Distribution in KDP, the distributors may include IngramSpark. However, authors can choose another publisher like IngramSpark as a main source of the distribution. After having own ISBN purchased from bowker, authors can publish their book via IngramSpark first, and they can make it available through many other distribution channels including Amazon and Barnes & Noble.

For the book described in this paper, the second edition of the book has been published via KDP and B&N press. A third edition of the book is in progress, and it is scheduled to be publish in this Spring or Summer. It has been considered to publish the third edition through IngramSprk as well.

Transition and Impact regarding Covid-19

There was a major mode transition of operation due to the lock-down for the Covid-19 crisis in the middle of Spring 2020. Instructors were requested to shift their classes to an online format given a short preparation time. In my institution, students were not supposed to come to the campus in that

period. In-person lecture meetings and laboratories were not possible back then. For faculty, it was requested to teach their courses remotely. Students had their own MSP432 Launchpad boards. However, they could not access the BH EDU kit (as shown in Figure 1) in Spring 2020. It varies by sections; however, there are up to 16 to 18 students in one laboratory section. In Spring 2020, we offered seven laboratory sections. The total number of students in Spring 2020 was about 99. There were enough BH EDU kits for one laboratory section and extra BH EDU kits that are available for students to borrow. However, the total number of the BH EDU kits are less than the total enrolled students. So, the situation was not simple because it was not possible for students to access these kits. Even if we had sent all available kits to the students, it would not cover all the students.

In order to tackle the problem and continue the classes and laboratories without the physical BH EDU kit, a virtual BH EDU board kit was created as shown in Figure 2. This BH EDU board simulator software was used for Laboratory 7. This virtual BH EDU board kit is an executable program generated by LabVIEW. A stand-alone application can be created using LabVIEW Application Builder Module¹⁴. An MSP432 Launchpad can work with this simulator via serial communications. The connection can be made by the connect button in the serial port connection window as shown on the right side. It includes a virtual accelerometer, and it shown on the left side. The levels of X, Y, and Z can be manipulated by a user. The level data can be sent to the MSP432 MCU over the serial port.

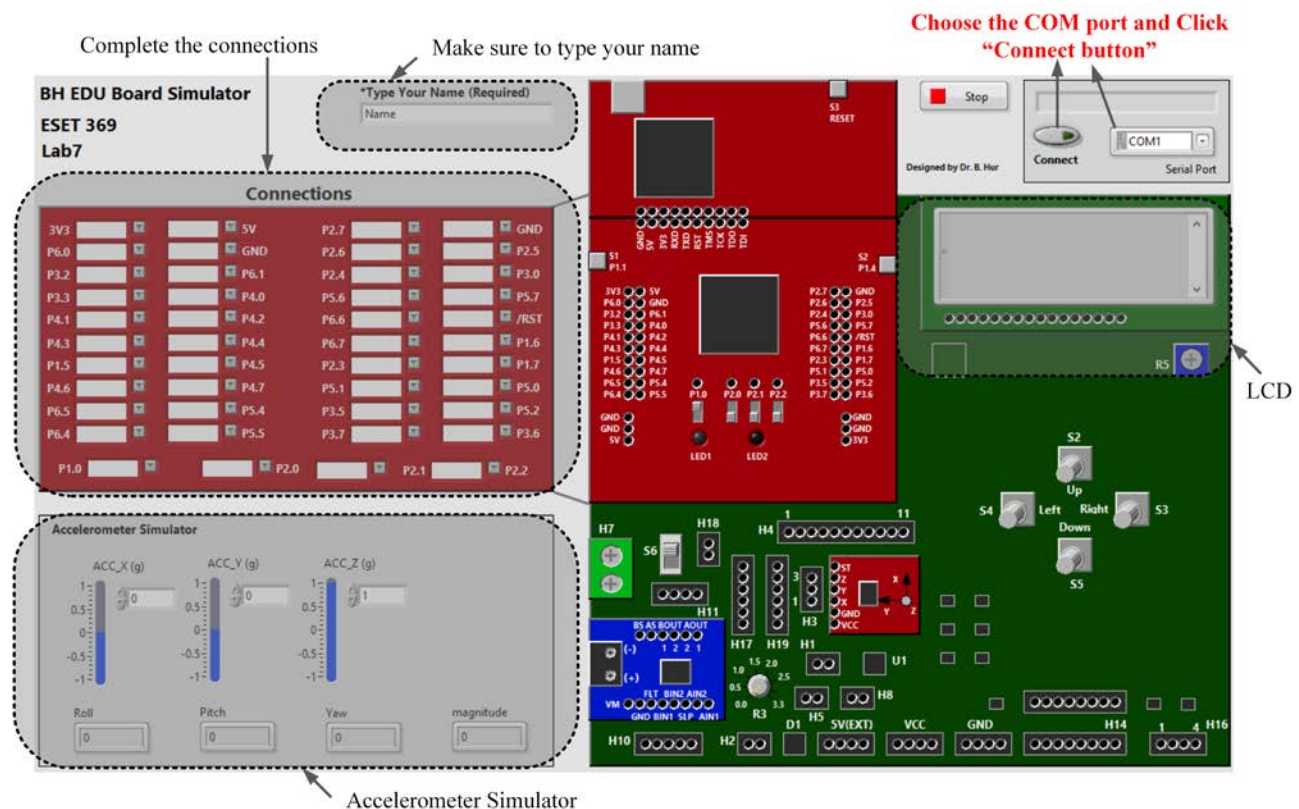


Figure 2. Virtual BH EDU board kit for Laboratory 7.

In the previous semester of Fall 2019, some of the students were needed to build MSP432 robots for the given robot challenge as their term project. In this mode of limited operation due to the Covid-19, it was not feasible to assign an assignment to build an MSP432 robot as it had done before. Instead, a virtual MSP432 robot assignment was given, and students were asked to program to implement the functions that were requested. The virtual MSP432 robot that was used for the term project is shown in Figure 3. On the right side, it shows the controller for the gripper. On the left side, it shows virtual accelerometer, speed gauge, temperature sensor graph, and the picture of the robot.

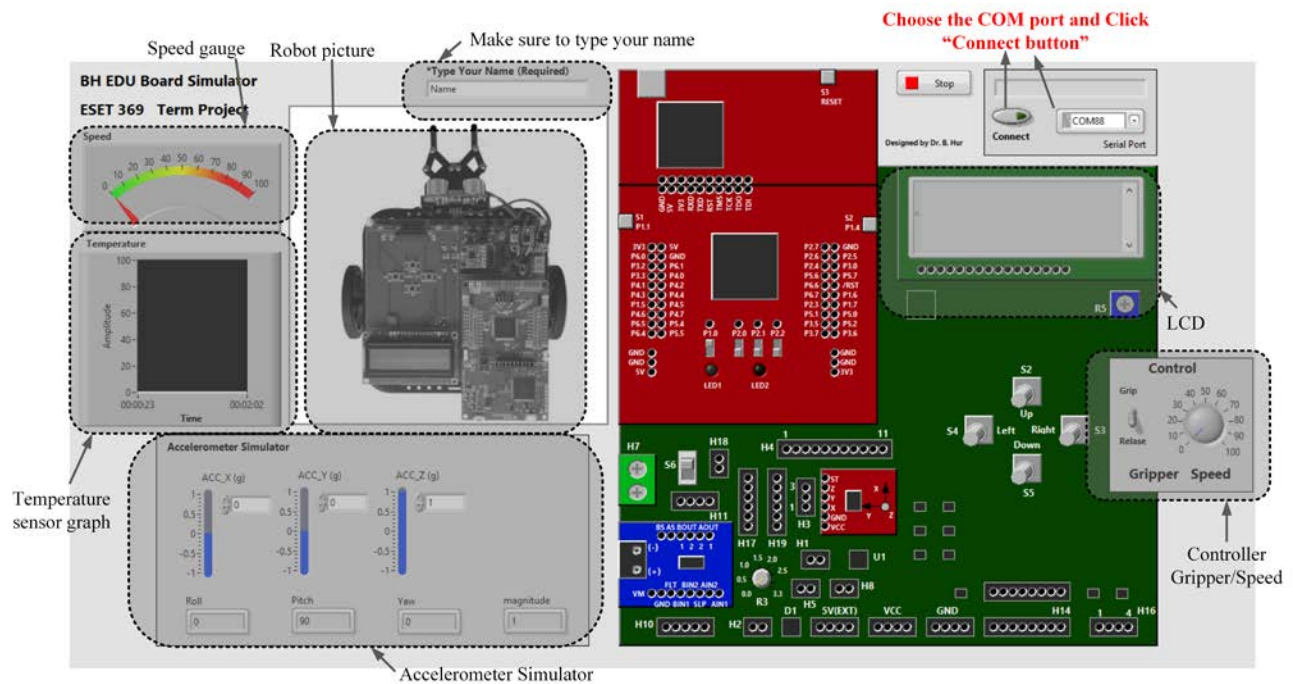


Figure 3. Virtual BH EDU board kit for Term Project.

Evaluation and Feedback

It may be considered as a good achievement for an instructor to create good teaching materials. And, it may be expected to have positive course evaluations from students. However, based on my personal teaching experience, students tend to provide subjective evaluations at some level. Therefore, the impact to the course evaluation might not be as satisfactorily good as it is supposed to be. However, in my case, there have been some positive evaluations from students. While there have been appreciations from students about teaching effort that I had put in writing this textbook, there are also some students with strong opinions regarding the management style of the course and my lecture style according to the course feedback. I have received this criticism before. I do not claim that my course is a very good class example. However, I would rather to want to mention that my course is a work-in process that needs a continuous improvement. At the end of the semester, students were given to provide their course feedback. Regardless of some negative comments toward my course and teaching styles, most of comments regarding the textbook were positive. Some excerpts of the feedback regarding the textbook from the students who took the course in Spring 2020 include “*textbook the most helpful...*”.

Some excerpts from the feedback from Fall 2020 regarding the textbook include “*I commend Dr. Hur for all that he has done for the class: writing the textbook...*”

Moreover, it is interesting to observe that the general readers for the MSP432 book can leave their public comments and feedback on Amazon. Some excerpts from the feedback include “*I purchased this while taking a course that used an MSP432 Launch pad. It was a great supplemental.*” This is interesting to hear from the audiences who are possibly taking a similar course using an MSP432 MCU. Authors may need to pay attention to the comments and feedback posted on the vendor websites.

As mentioned, there had been a major mode transition due to the Covid-19 in Spring 2020. Some of comments related to Covid-19 include “*Dr. Hur adapted to the covid-19 situation the best out of all my professors...*”. From the instructor’s point of view, I think that it was feasible to adapt teaching this course remotely because students could access the class materials that were tested and proven in the previous semester, and students could access them via a textbook platform. Moreover, the development and the use of a virtual BH EDU kit had helped students leverage the gap.

Conclusions and Future work

In this paper, the comparison between methods of traditional publishing and self-publishing as well as the self-publishing process using Amazon KDP was introduced, and the method of the expansion to other self-publishing company including Barnes & Noble Press and IngramSpark was introduced. The process of self-publishing a textbook that is based on the use of an MSP432 MCU in an embedded system course has been covered. The impact and the transition due to the Covid-19 has been introduced. The brief discussion related to students’ feedback was also included. A next revision of the third edition is scheduled to be published by Spring or Summer of 2021. This short revision cycle of the textbook is possible because of the choice of the method of a self-publishing platform. The author plans to continue to improve the quality of the teaching materials and provide more books and relevant materials for the embedded system education.

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