MOOC for Microcontroller Design Course

A Design Project Report

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Master of Engineering (Electrical)

by

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Abstract

Master of Electrical Engineering Program

Cornell University

Design Project Report

Project Title：MOOC for microcontroller design course

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Abstract：

The design project is to develop a strategy for MOOC lab delivery and implement it for a online course which is like a web version of ECE 4760. MOOC means massive open online courses, and ECE 4760 is a lab-based microcontroller design course in Cornell University which uses hardware and software techniques to teach students a variety of design skills, culminating in a large design project. In order to let massive users take lectures and do labs and then grade others' works online, we hook up 123d.circuits.io, a free online platform for developing and debugging electronic projects, to the content management and homework grading system made by ourselves. The content management is realized with PHP, WordPress and Mysql, and the grading component is based on web-based peer review grading method. Our goal is to create a safe service with high scalability to let people around the world learn the basic knowledge of microcontroller and put theories of it into practice without buying microcontrollers and accessory parts and get feedbacks on their way of learning.

Report approved by

Project Advisor：_____Date:_____

Executive Summary

The MOOC is intended for covering a major subset of the basic of designing with circuits and microcontrollers and let users or students to learn and carry out labs online in one semester. To achieve the goal video lectures, lab instructions, and course policy are made to help users of the MOOC learn. There are four labs in this course, lab1 is for teaching users of the MOOC how to use the MOOC and the online simulation platform 123d.circuits.io as well as the knowledge about Arduino, LEDs, digital I/O, pushbuttons, etc. Lab2 is intended for teaching people ADC, PWM and how to use relative functions of them on the simulation platform. Lab3 are made to give instructions on 7 segments. Lab4 introduces how to build a pointer using servo and functions about this topic on 123d.circuits.io, the simulation platform our MOOC relies on. There are grading criteria for each lab to measure how well people learn and do their own lab. All the labs and grading criteria are introduced with more details in part 3 of the report.

To host all the material or links to materials needed for the course and to carry out functions of the MOOC like authentication, lab assignments and submissions, regrade requests, a data driven server side system is needed to be established to take up these tasks. Now we have already make the server side system for the MOOC based on PHP and WordPress along with Mysql run on the server of School of Electrical and Computer Engineering. The database design of the system is now completed for user data storage and retrieval. Basic Functions of the MOOC to needed like authentication, homework or lab assignment are all ready. Web-based peer review is an advanced function completed for the project to allow users of the MOOC to grade others' works and make comments on them to improve the comprehend of the knowledge of the course for both the graders and the people whose work is graded by others. Though all these functions work fine,

there are some issues should be addressed. Many people use MOOC because its availability and flexibility they can get access to it whenever and wherever with a connection to the Internet, It seems not perfect to keep the exact same course schedule for all of them just as what we did in the design, because we will loss users by doing so , thus every one having the same schedule but different offset should be a reasonable solution, but under this case there would be cases that the first user who accomplish a lab may need to wait several weeks or even longer for other users to finish the same lab and then grade her work.

1. Introduction

1.1 Background and motivation

MOOC represents massive open online courses, and there are already a lot of MOOCs out there on coursera or edX for different subjects and different people, mostly they provide video lectures of the course, make homework assignments and sometimes have some quiz but mostly with only multiple choice questions. Because of the lack of the ability to provide experience of doing experiments in labs along with lectures, it is worth noting that there are few online courses that traditionally require students to spend much time in laboratory and put theories into practice. For example, a course like ECE 4760, Designing with Microcontrollers, could hardly be as sufficient and efficient as usual without labs. Though, putting hardware experiments online is challenging , there are already some effort made about it, 123d.circuits.io is now leading in this aspect and providing free service to open designer, which makes it a perfect complement to a MOOC for courses like Designing with Microcontrollers. Hence in our MOOC, there are instructions to teach students how to use 123d.circuits.io to do experiments and labs with circuits and microcontrollers and how to submit their works done on 123d.circuits.io to the data center of our MOOC.

One effective way to stimulate people and make them do better on their job is grading, we also want to give users of our MOOC feedbacks of how well she comprehends the content of the course and how good her skills are when doing labs. Hence we decided to incorporate a grading subsystem into the MOOC. But since MOOC means massive open online course, it is a good assumption that there will be too many users and too many homework submissions that we can not find enough graders and teaching assistants to make these feedback on time, and because grading criteria for a lab is much more complex than multiple choice questions, it may not be possible to use machine grading for the MOOC. So with all these considerations, we choose peer review to take up the job of grading and commenting, which means except for doing their own homework and labs students also need to grade their peers' work and make comment on them based on the instructions and grading criteria provided with each lab.

1.2 The main content and goal of the project

Our MOOC itself consists of online lectures and instructions, homework and labs, and the server side system that hosts the materials or the links to the materials needed for the course and carries out services like user data storage, homework assignment and notification, web-based peer review grading , etc.

The MOOC is intended for one semester with four labs, each lab is associated with an instruction as well as several video lectures, all the labs and video lectures covers a major subset of basic of electronic knowledge and functions of microcontrollers like digital I/O, analog I/O, LED, pushbutton, PWM, timer, etc. All the videos of the MOOC are hosted on Youtube to alleviate the burden of our own server.

The server side system for our MOOC takes on the responsibility to build bridges among different functions of the MOOC and it also provide ways for users to interact with each other. The system is built on PHP and Mysql, the former is a popular server scripting language with a large number of developers using it and many good modules and frames that can speed up the process of server side development. In our design, PHP is used with WordPress, a full-fledged and well known content management frame based on PHP, for implementing all the logic behind the service we provided with our MOOC, the latter is one of the most widely used relational database management system, which works perfectly with PHP with thousands of successful web applications based on this combination as proof. We use it for data storage for public content, user data and super user data. Public data is accessible to all, like instructions and grading criteria of labs, user data consists of different kinds of data with varied level of privacy, some of them is only known to the user itself like password, while some is accessible to others but not all of them like users' submissions of code of a lab with very little of them is available to all like usernames. Super user data is much like user data, which means a lot to the safety of the MOOC, and is needed to handle with great precaution.

The grading subsystem is an indispensable component inside the whole system of the MOOC, it should be intelligent, convenient, effective and safe. The role of grading is important in the process of learning, it is a reflection of the quality of the process of learning. Hence we need the grades and comments of users' works to be precise and instructive, but peer review is a complex method with many things not under control of the grading system, extra rules and constraints needed to be enforced in order to prevent bad behaviors like degrading with intention，retaliation for a bad score, etc. the grading subsystem heavily relies on the database of the system, to grade on others' works, one need to get it from the database, and then need to put her comments and grading for others back into the place in the database. More details about how the database is

designed and how functions are implemented based the on the database is illustrated in part two of the report.

1.3 The structure of the report

In the following sections of the report a large number of details of the design of the MOOC in different categories are being introduced.

Part two illustrates in great detail how we build the server side system in for the MOOC including how we build the database system in order to store and retrieve user data, keep safety and privacy, and lay part of the foundation of the grading subsystem in the database design as well as how the data flow and logic is implemented for the whole system. This part is also divided into

In part three, the content of the MOOC is introduced. Course policy, instructions for labs, video lectures are all included. Course policy presents the rules of the course as well as the structure and the schedule of it. Content of each lab and the considerations on why to put it into the MOOC and how to teach for it are talked about.

In part four, we treat our design of the MOOC from the view of software engineering and introduce how we tested the system and services for safety and availability along with the bugs found on the way of testing.

A conclusion of the project is included in part 5, and part 6 serves to list reference.

2. System Design

2.1 Basic design of using what kind of technology

We decide to use PHP + MySQL to develop our websites and use wordpress as a basic software. Although we discard all the exist pages a basic wordpress provide and write our own page, wordpress's thousands of plugins and widgets, plus some exist functions it provided is useful for our project.

2.1.1 Why PHP+MySQL

- With PHP, we can connect to and manipulate databases and MySQL is the most popular database system used with PHP.
- PHP + MySQL is the most mature, stable and secure WEB develop technology. It is widely used in most popular websites.
- PHP combined with MySQL are cross-platform (you can develop in Mac or Windows and serve on a Unix platform)

From our group's view, This is our first time to develop a websites, PHP+MySQL has the most mature reference material to look at and when we encounter some problems or bugs we cannot figure out, we can easily find the solutions online.

2.1.2 Why Wordpress

WordPress is web software for people to create a beautiful website or blog. It is first used as just a blogging system but has evolved to be used to full content management system and has thousands of plugins and widgets which can help us to implement some great functions which we have not enough time to complete such as discussion forum part.

2.2 High-level Design

This system is designed for Cornell course ECE4760 MicroController Design on MOOC

platform. This system will be used by thousands of students who are interested in this course from everywhere around the world. Our target is to develop a platform for them to conveniently study this lab-based course online. The basic functions are as follows: view the basic information and material of this course, submit their work after they complete the labs, help them easier assessing others' work, give them a fair grade.

The basic information and material of this course is displayed on the course websites where students can easily access. The information includes the following: the syllabus, instruction of every lab, the lectures student may need to learn before they start each lab.

As this is a lab-based course and student have to some labs during the study to get experience of microcontroller. However, we may have massive users from everywhere around the world, we want them pay low price or nothing to study this course. We find a 123circuit website which can design the circuit on so that student do not need to buy any hardware for these labs.

After students did their work, they can submit their work on our websites. The work will contains report, code, a video link and a 123circuit website link. All four things make us easy to assess their work. A video is used to record some trivial things that student may cannot describe in words and need to show us something.

After their submission, they are assigned four peers' works to assess. They can simply complete a grading form to assess other's work.

After assessment phase, students get their grades. The grades are depended on how well they did the lab and how well they assess others' works. If they submitted their work and done all the assessment but still have no score to view, they can ask for regrade.

As for TA, we design a TA page for them to easily allocate whose will assess which four assessments and whose submission will be assessed by which four students. And when the assessment phase ends, TA can easily compute the final score for every student.
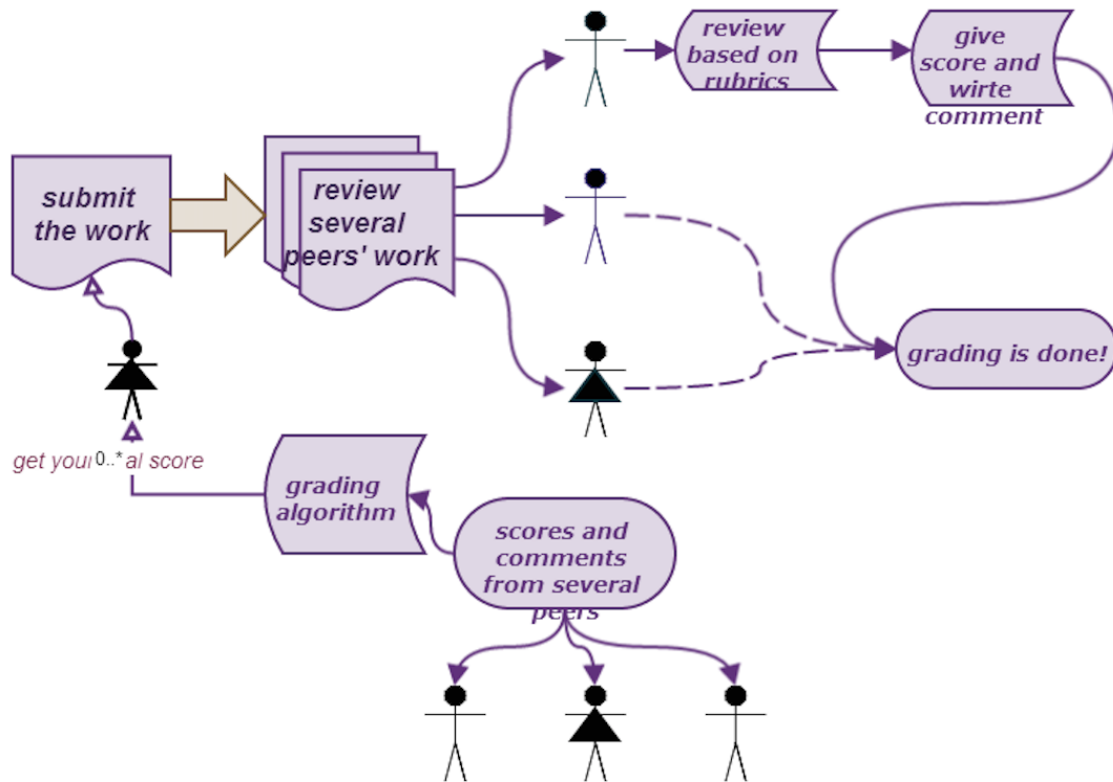
The basic procedure of one lab assignment

2.3 The Design Decisions

2.3.1 The design consideration

During the design stage of our projects, we have made a lot of decisions are suitable for this specific ECE4760 Micro-controller course. Here are the details ordered by the time of the whole procedure of one semester.

For the home page, students can see a introduction video to this course from Yuanyuan to

learn the basic structure of this course and a video from professor Bruce Land to explain the tools we will use in this course. This will give students an overall description and they can decide whether or not they would enroll.

For Syllabus page, student can get some basic information such as course description, objective, lecturer, the simulation website they will use, the prerequisites and suggested materials. They can also find a course's outline tells what are the specific lab and how the grading system works.

For the guidance page, you will get an understanding of how to use our website and things students need to pay attention to. We design this page to make users easier learn the basic functions of our websites. It is more like a user manual.

For the lab-table page, It display the basic information of all the labs you need to finish this semester and their instruction, start time and due time.

When we click on one of those labs, we can get to the assignment page. This page contains all the procedures one assignment should include and can be seen only when you are logged in. We design to divide one assignment into four phases. They are Start phase (which you can submit and resubmit your work), the assessment phase (which student can assess other's work), the grades phase (which students can see their grades) and re-grade phase (which students can request re-grade and if they do so, to see their re-grade score).

The first phase is start phase. In this phase you can see the instruction of this assignment and submit your work. Once submitted, you could resubmit your work and download your submission. We decided to only save only one copy of students' works because we

are graded on their final submission by the due time and it also save more space. If one student continue to upload their work again and again or a robot just try to fill up our space will just fail. In the submission part, we design to let student submit four things: the youtube video link (they will make a short video to describe what they did including some difficult part they cannot describe by words in their report), the 123Circuits link (which is used to test their code and check their circuit, the 123 Circuits has the detail explanation in part 3.3), their report (which contains the information our student's work and information for help grading) and the code (which contains the code students design).

The second phase is assessment phase. In this phase, you can assess other's work. Once you complete your work, by the deadline of this assignment, you will be assigned to assess four other submissions (if there are only 4 or less submission, you will be assigned less). By click on the link button, you can go assess their work. And there will also a hint for you describing which assessment you have done and which you have not. Also there is a link to instructions describe how you should assess other's work. This peer review design can help student learn more about the lab, they can see how other students did the same thing: where they did better or using a totally different method. We design this assessment phase to be anonymous which means students do not know whose work they are assessing. This decision will help protect students' privacy and prevent discrimination assessment. The detailed peer review decision will be discussed later in this part.

When click on one assessment you are assigned, you can go to the Grading page. In this page, you can download the code and report you need to assess and see the youtube link and 123circuits page. We design a form for users to complete which will be convenient for both users and us. We divided each assignment for several dimension, for each dimension, we set up a total score and give student a criteria for each dimension to judge how much this dimension should be scored. Students only need to give the dimension

score and write some comments explaining why you give this specific score.

The third part is grade phase. In this phase, you can see your grade. Students in following situations cannot see their grades. The grades are consisted of two parts, one is submission-grade and the other is assessment-grade. Submission grade shows how good your lab work is and assessment-grade shows how you assess others' work. The final grade is combined of two parts and the criteria of the assessment-grade will be discussed later in this part.

• They did not submit the complete documents for the certain lab. Students are supposed to submit all four things we discussed above, lack of each part can lead to failing to see the score.

• Less than two peers have reviewed student's work. We assign each student four submission to assess. And each user's work will assess by four other peers (four is assessment factor value we store in assignment table). And then we will use an algorithm to compute the score. However, if only two or less students have assess a work, this work will not be computed automatically, we will not display the score to this student and will let him do the re-grade procedure. In this case, you can see your assessment-grade if you have done all of your assessment work.

• Student did not complete all his assessments. We only allow students who done all their assessment to see their score. This will give student more motivation to assess others work. By this way, we can decrease the possibility of situation. In this case, you cannot see your assessment grade.

The last phase is regard phase. In this phase, students can request regrade their work. However, not all students are allowed to request. In the phase 3, only situation 2 can request students which means if you have not complete the assessment work or you have

not submit the complete document. And if students are not satisfied with their score, we do not allow them to request regrade. Since this is a MOOC (Massive Open Online Courses) course website, it is used for maybe thousands of students, if all students are not satisfied with their score, our TA will be stressed out. For this kind of reason, we are not allowed the formal situation regrade request in normal university course. We will give a hint that "you are not allowed to regrade" when you click on the regrade button and you are not qualified to regrade. Once your work has been regrade by the TA, you can see the regrade your regrade score.

As for peer review part we decide to let one student assess four other students' work for one lab. This module is suitable for MOOC because of the large amount of students. Contrary to the peer review university often uses, we develop more structured forms of assessment/grading. In our system, students not only create and submit their own work. They also participate on the assessment of others' submission, give them feedback and suggest a grade for them. A student's final grade is contains two parts, one part is how well a student does with their work. The other is how well a student assessed his peers. This kind of strategy gives the motivation for students to assess others' works during which they can have opportunity to see others' work and learn from them. Also students can see how his peers think about his assignment and learn from these comments.

As for how to compute the score of one student, we decide to use Rubric algorithm. We divided each work into several dimension, professor will provide criteria for every dimension about how to assess it. For all assessment dimensions, calculate the arithmetic mean and sample standard deviation. Because there are normally four assessments for one assignment, we are trying to find the "best" assessment. For our purposes, the best assessment is the one closest to the mean. For each assessment, the distance from the mean is calculated similarly as the variance. Standard deviations very close to zero are

too sensitive to a small change of data values. Therefore, data having standard deviation <= 0.05 are considered equal.

$variance = 0
for each assessment dimension
    if stdev > 0.05 then $variance += ((mean-grade) * wight/stdev) ^ 2;

If there are less than three assessments for this assignment, they all are considered "best".

The best assessment gets grading grade 100%. All other assessments are compared against the best one. If there are more best assessments, the one closest is used as a reference. The difference/distance from the best assessment is calculated as sum of weighted square differences.

$sumdiffs = 0;
$sumweights = 0l
for each assessment dimension
    $sumdiffs += ((bestgrade - peergrade) * dimensionweight / maxpossiblescore) ^ 2;
    $sumweights += dimensionweight;

In this strategy, the weight of every dimension is calculated as $w_i = max_i - min_i$.

And we use the following formula to compute the gradinggrade, which means how well student assess others' work.

gradinggrade = (1 – f * sumdiffs / sumweights) * 100 [%]

In our case, we choose f as 2.5, we can change the value of f to change the strategy of our

grading system. The possible values are "very strict: 5.00", "strict: 3.00", "fair: 2.50", "lax: 1.67", "very lax: 1.00". We can see an example following:

	Min grade	Max grade	Best	Peer	difference
Dimension#1	1	4	4	3	0,56
Dimension#2	1	4	3	4	0,56
Dimension#3	0	10	5	5	1
Dimension#4	0	10	6	6	1
Dimension#5	0	10	8	8	1
subGrad			68.42%	65.79%	
assessGrade			100.00%	71.35%	

form 1

As for user roles. We decided to design two roles, one is normal student and the other is TA. The student role is used for student to enroll the class, submit their work, assess others' work, see your grade and view regrade. The TA role is used to assign the assessment tasks including who will assess which four assignment and each assignment will be assessed by which four people. When the submission deadline is coming, a TA will click the assign button to do this procedure. Another button we design for TA is used for compute the scores. When the submission deadline is coming, a TA will click the compute button to do this procedure. In the future, another professor role will be perfect for this system. It will be used to modify some lab instructions, including grading details and something like that.

2.3.2 Security Concerns

There are several security concerns of our website. One is file permission security, and the other is database security.

As the website is running in the user of apache in redhat OS, the root directory and subdirectories should be readable and executable by apache but not other users. So the mod of file should be 755; For the wp-content directory, as it will be used to contain uploaded files, so it should be writable by User apache. The mod should be 775; The directories and files are all in the apache group.

As SQL Injection is a very common and serious security problem, our system use the robust prepare function provided by WordPress Database library to protect this. For every database query, we use the $wpdb->prepare function, which parameterizes the query, so that no harmful parameters will be executed. This is quite robust and proved to protect against most SQL injections.

2.4 Database Design

2.4.1 Database overall structure

From the figure above, we can see that our database contains 6 tables:

- Table User keeps the information for the user of our website;
- Table Assignment keeps the information about the assignment instances and their settings;
- Table Submission keeps the information about the submission, including the aggregation of the grade for submission, grade for assessment and final grade;
- Table Assessment keeps the information about the made assessment and automatically calculated grade for it;
- Table GradingPoint contains the information of how the reviewers filled-up the grading   forms, given (submission) grades and comments;
- Table Criteria contains the information of the evaluation elements definitions of Rubric grading strategy forms.
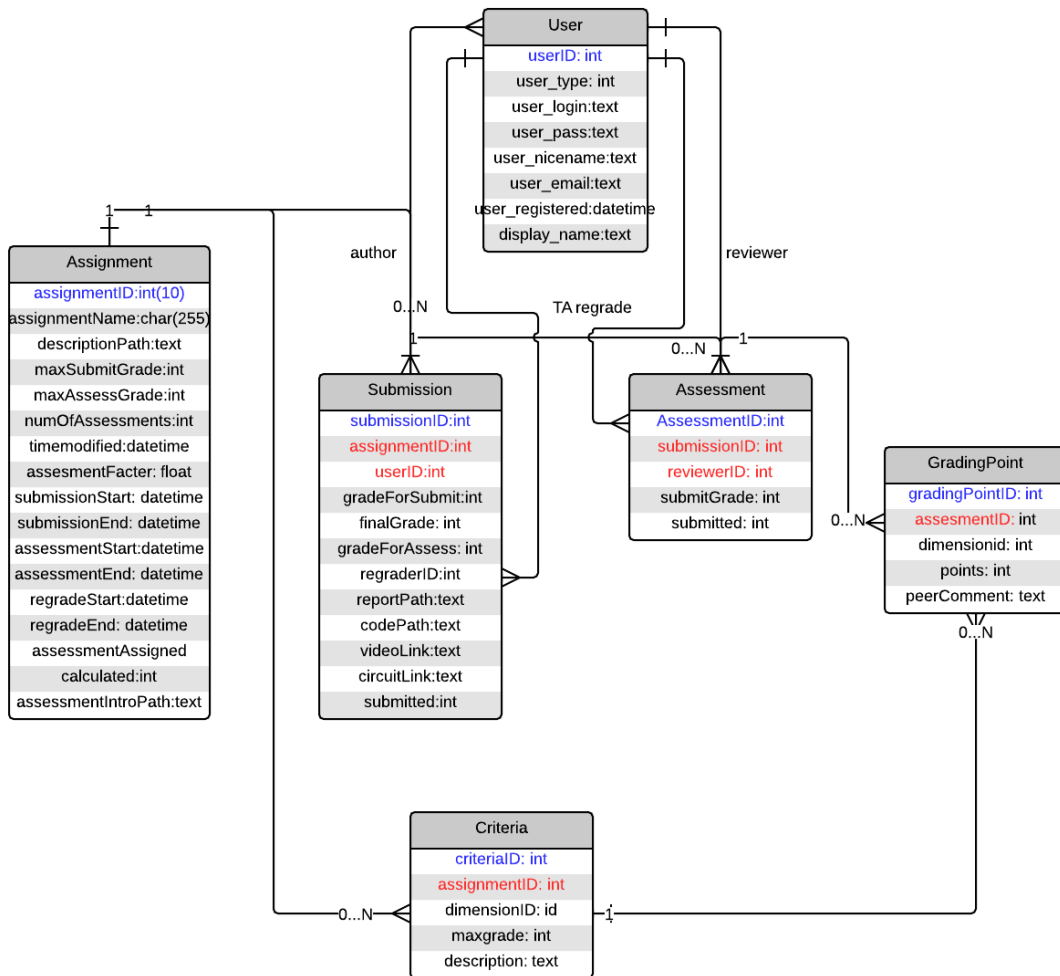
Entity-Relationship Diagram of Database

2.4.2 Detail description of database

Table User:

This table keeps the information of the user of our website.

Field	Type	Default	Info
userID	bigint(20)		auto-numbered(serial)
user_type	Text		Define the type of the user: contributor,administrator,subscribor
user_login	Text	NULL	the login account of the user
user_pass	Text	NULL	the encryted password of the user
user_nicename	Text	NULL	the nice name of the user
user_email	Text	NULL	the user's email address
user_registered	datetime	NULL	the time when user registered
display_name	text	NULL	the display name of the user

Table Assignment:

This table keeps the information about the assignment instances and their settings.

Field	Type	Default	Info
assignmentID	int (10)		auto-numbered(serial)
assignmentName	char (255)		the title of the project as it appears at the course outline
descriptionPath	text	NULL	the path of the description of the project stored in server
timemodified	datetime	0	the timestamp when the module was modified
maxSubmitGrade	int (5)	80	the percentage of grade for submission
maxAssessGrade	int (5)	20	the percentage of grade for assessment
numOfAssessments	int (3)	4	number of required assessments of other students' work
assessmentFactor	float (3)	2.5	Factor when evaluating assessment job = required level of assessment similarity (1.67 => lax, 2.5 => fair, 3 => strict, 5 => very strict)
submissionStart	datetime	0	0 = will be started manually, >0 the timestamp of the start of the submission phase(assignment start time)
submissionEnd	datetime	0	0 = will be closed manually, >0 the timestamp of the end of the submission phase
assessmentStart	datetime	0	0 = will be started manually, >0 the timestamp of the start of the assessment phase
assessmentEnd	datetime	0	0 = will be closed manually, >0 the timestamp of the end of the assessment phase
assessmentAssigned	tinyint(4)	0	0 = assessment has not been assigned, 1=assessment has been assigned
calculated	tinyint(4)	0	0 = grades has not been calculated, 1= grades has been calculated
regradeStart	datetime	0	0 = will be started manually, >0 the timestamp of the start of the regrade phase
regradeEnd	datetime	0	0 = will be closed manually, >0 the

			timestamp of the end of the regrade phase (assignment end time)
assessIntroPath	text	NULL	the path of the description of the project stored in server

Table Submission

This table keeps the information about the submission, including the aggregation of the grade for submission, grade for assessment and final grade. Both grade for submission and grade for TA can override assessment if student do not receive their grades when grading session ends. Final grade is always the sum of them. All grades are stored as of 0-100.

Field	Type	Default	Description
submissionID	int (10)		Auto-numbered (serial)
assignmentID	int (10)		he id of the assignment instance
userID	int (10)		The author of the submission
gradeForSubmit	Number (10,5)	NULL	Grade for the submission calculated as average of the peer-assessments. The grade is a number from interval 0..100. If NULL then the grade for submission has not been aggregated yet.
finalGrade	Number (10,5)	NULL	Final grade (subm&assess)
regraderID	int (10)	NULL	The id of the TA who has regraded the work
gradeForAssess	number (10,5)	NULL	Grade for the assessment. The grade is a number from interval 0..100. If NULL then the grade for assessment has not been aggregated yet.
reportPath	text	NULL	the path of report file (.pdf)stored in server
codePath	text	NULL	the path of code file(.zip) stored in server
videoLink	text	NULL	the link of youtube page which explain your work
circuitLink	text	NULL	the link of 123circuits page
submitted	tinyint(4)	0	0=the user did not submit complete work for the assignment;1=the user has submit the complete work for the assignment.

Table Assessment:

This table keeps the information about the made assessment and automatically calculated grade for it. TA can override it if student do not receive their grades when grading ends.

Field	Type	Default	Description
assessmentID	int (10)		auto-numbered(serial)
submissionID	int (10)		The id of the assessed submission
reviewerID	int (10)		The id of the reviewer who created this assessment
submitGrade	number (10,5)	NULL	The aggregated grade for submission suggested by the reviewer. The grade is computed from the values assigned to the assessment dimensions. If NULL then it has not been aggregated yet.
submitted	tinyint(4)		0=this assessment is not completed;1=this assessment is completed.

Table GradingPoint

This table contains the information of how the reviewers filled-up the grading forms, given (submission) grades and comments.

Field	Type	Default	Description
gradingPointID	int (10)		auto-numbered(serial)
assessmentID	int (10)		Part of which assessment this grade is of
dimensionID	int (10)		Foreign key. References dimension id in one of the grading strategy tables.
points	int (10)		Given grade in the referenced assessment dimension.
peerComment	text (medium)		Reviewer's comment to the grade value.

Table Criteria

This table contains the information of the evaluation elements definitions of Rubric grading strategy forms.

Field	Type	Default	Description
criteriaID	int (10)		auto-numbered(serial)
dimensionID	int (10)		dimension
maxPoints	int (10)		The max grade of this part
description	text (medium)		Simple description of the criteria
assignmentid	int (10)		Which assignment it belongs to

2.5 The data flow of System

2.5.1 The overall data flow of system

We have already stored the related information of the settings of our four assignments in table Assignment and Criteria. Table Assignment is used to generate the LabTable for students and TAs and define settings of each assignment, including the title of each assignment, the start and end time of each phase, the factors for grading algorithms, the number of assessments each students need to complete and so on. Table Criteria is used to generate grading forms for students to assess other peers' work, including the details of rubrics and max points of each rubric.

Once a user register in our website, all his or her related information will be stored in table User and a userID is generated automatically in serial for the user. UserID is vital since we using userID to recognize and extract the related records of one specific user. During the submission phase, students can see the instruction for the specific assignment and complete their work. Students must submit their solution before the submission deadline if they want to get their scores. After students submit their work on the upload page, we will create a record in table Submission for him or her.

After the submission phase, it is the assessment phase. After TA click the button to assign the assessment, we will create records in table Assessment. Each user will have several records in Assessment table which decide whose work they need to review and how many assessment they need to accomplish. According to the records in Assessment table,

students can view their assessment tasks in assessment page. Based on the rubrics stored in Criteria table, students can review other peers' solution and give scores and coments for each rubric, those information will stored in the GradingPoint Table.

After the assessment phase, it comes the grading phase. If students accomplish all their assessment tasks, system will calculate the grades for their submission and the grades for their assessment based on the records in Assessment Table and GradingPoint Table. After calculation, store their submission grades and assessment grades in the corresponding records in Submission table, thus students can view their scores. If students do not complete all their assessment tasks, they cannot view their grades as a punishment.

If a student's solution is reviewed by less than two peers but he or she complete all the assessment tasks assigned to him or her, they can only see their assessment grades since the system could not calculate their submission grades based on the information of two peer review records. This lead to the re-grading phase, students who only get their assessment grades can request for re-grading. And their request will be assigned to a TA by random and after TA review this student's work, system will calculated the grades and store it to corresponding record in Submission table, thus the student can view his or her complete score.

2.5.2 The detail description of the data flow of system
2.5.2.1 Description
This part mainly describe the detail of the data flow of our system based on each phase:

How the system work page to page;

What information to get from the database during each stages;

How the database will change during different stages by inserting an updating records.

2.5.2.1 Data flow when registration

When students registered to our website, a record that contains his or her information will inserted to table User and allow this user to use his or her login name and password to access our website again. The user ID in our database is crucial since it is used to identify the user and served as foreign key in other table. Students can view the instruction and go to the assignment page of each lab based on the lab table page.

2.5.2.3 Data flow in submission phase

At the beginning of the submission phase, students can use the lab table in our website to get access to the assignment page of each lab. If the time is not appropriate or the user is not login in, corresponding message will show up to remind users. In the assignment page, students can view the instruction and complete their work.

After completing the work, students need to submit their solution to the assignment before the submission deadline. For each lab, they need to upload their source code(zip file), report(pdf file), 123dcircuit link, youtube link in the upload page. After clicking submit, there are two things need to be done.

Firstly, the system will upload the two files to the server if they meet the requirements (no bigger than the maximum size). There is a folder named uploads in our server that store all the users' upload files. Each user will have a subfolder named with their encrypted userID and in this subfolder stores all the files uploaded. The path to those files will be recorded to put into the database later.

Secondly, a record of this submission will inserted to Submission table if this is the first time for the user to submit solution or updated to Submission table if the user has already submit solution before. This can allow users to resubmit their work. This record uses assignmentID and userID as foreign key and automatically generate a submissionID in

serial. The youtube video link and 123dcircuit link the user input will directly store into this record and the path to the report file and the source code file will stored to the record either.

Each time the user submit their work, the system will check if the record corresponding to the assignmentID and userID has the two path and the link to 123dcircuit written, which means the user has complete their work, it will set the submitted value of this record to 1. Only those who complete their work has can participated in the next phase, that is the assessment phase

2.5.2.4 Data flow in assessment phase

When submission deadline comes, it comes the assessment phase. Only the students who submit their work completely can take part in this phase. That means the records in Submission table whose submitted value is equal to 1 rather than 0. When assessment start time arrives, either of the TA can click the 'assign assessment' button to assign the assessment. Students need to complete all the assessment tasks assigned to them before the assessment deadline to get their scores.

Firstly, the system will extract the records in Submission table whose submitted value is equal to 1 and shuffle them. This is to ensure that the distribution of assessment will be randomly.

Next it will check the corresponding record in Assignment table using assignmentID to see if the assessment of this assignment is being assigned before to prevent double distribution (just see if the value of assessmentAssigned is 1). If the assignment has not been assigned before, for each shuffled records extracted from the Submission table, get its userID as reviewerID and the following n records of submissionID as submission ID, insert n new records based on the reviewerID and submissionID to the Assessment table.

Thus generate n assessment tasks for each user who submitted their complete work before.

The number n is the number of assessment get from Assignment Table. If the total number of the records extracted from the Submission table is smaller than n, just set n equals to n-1 in order to make sure everyone can be assessed by other peers rather than themselves. After doing this, set the value of assessmentAssigned in corresponding record Assignment table to indicate that this assignment has been assigned. This is the data flow for assign the assessment for each user.

After assign the assessments, students can view their assessment tasks in assessment page, by clicking each assessment button generated from the records in assessment table whose reviewerID is equal to the userID, they will go to the grading form page to complete the assessment using the assessmentID from the records mentioned before. The system will first check the userID with the reviewerID in the assessment table to make sure the user is qualified to review this assessment. In order to review this assessment, reviewer need to get access to the links and files (report and code) submitted before, the system will use the submissionID get from the records in the Assessment table to find the corresponding records in Submission table and thus get the paths to the files and links to the 123dcircuits and youtube video. Reviewer can follow the link to review the work and fill the grading form with score and comment based on each rubric. The grading form is generated using the information stored in Criteria Table.

After user pick one assessment task, complete the grading form and submit his or her review work, several records will be inserted or updated in table Gradingpoint. If the reviewer has never submit this assessment before, then the system will inserted several records into table Gradingpoint, each with specific assessmentID, dimensionID, the

points reviewer entered and the comments reviewer gave. Each record will generated will generated with an automatically serial gradingPointID. If the reviewer has reviewed the assessment and submitted it before, which means the reviewer is resubmit the assessment this time. The system will find the corresponding records in table Gradingpoints with the assessmentID and dimensionID and overwrite the specific part that reviewer resubmit this time.

After updating the Gradingpoint table, the system also check whether this assessment is completed, by checking the total number of records in Gradingpoint table with specific assessmentID and the total number of the records in Criteria table with specific assignmentID. If those two are equal, it indicates that the reviewer has accomplished all the dimension in this assessment. Set the value of submitted to 1 in table Assessment with corresponding assessmentID. Also set the value of submGrades to the total cumulative grades of each dimension of this assignment in table Assessment with corresponding assessmentID.

2.5.2.5 Data flow in grading phase

When assessment deadline comes, it comes the grading phase. Only the students who accomplish all the assessments assigned to them can get their grades caculated. That means the records in Assessment table whose submitted value is equal to 1 rather than 0. When grading start time arrives, either of the TA can click the 'calculate the grade' button to assign the assessment. System will calculate the submission grades first and then the assessment grades and updated them in table Submission. After this, students can go the view grade page to see their scores, as well as details and comments of peer review.

Just like what system do in assessment phase, first it will check whether the grades of this assignment has been calculated or not based on the value of calculated in the Assignment

Table with specific assignmentID. If the value is 0 rather than 1, that means the grades of this assignment has not being calculated. The system will do the calculation of submission grades based on the grades other reviewer gives. Then do the calculation of assessmentID based on the grades this user gives to other peers and the corresponding submission grades other peers get.

In order to calculate each user'sf submission grades, first we get the records from Submission table with corresponding assignmentID and with submitted value equal to 1. Then for each of the submissionID, get the assessment records that they have. That means get the records from Assessment table with that submissionID and submitted value equal to 1. If the number of the records is larger than 2, that means more than two peers has accomplished the assessment of this submission. Then use the submGrades from those records to get the value of the submission grades of this submission based on the algorithm introduced before. Update the submGrade in table Submission with corresponding submissionID to the calculated value. If the number of the records get form Assessment table is smaller than 2, then system cannot calculated the submission grades, just set the submGrade in table Submission with corresponding submissionID to 0.

Based on the submission grades, the system will then do the work with assessment grades. First system will get the submGrades and submissionID from both Assessment table and Submission Table, where the reviewerID of the Assessment table is equal to the userID and the submissionID of two tables are equal, and the submitted value in Assessment table is equal to 0 with corresponding assignmentID. This is to get the information of each assessment this user has accomplished(including the total grades he or she gives and the corresponding submissionID of this assessment). Based on each submissionID we get, get the final submission grades the system just calculated from the Submission Table. By

calculating the variance between those two submGrades and considering the assessment factor stored in Assignment table, the system can calculate the assessment grades for the user and update it to the corresponding records in Submission table.

After all the calculation, set the value calculated to 1 in Assignment table with corresponding assignmentID.

When students view their grades, system will first get the records from the Submission table with specific assignmentID and userID. If records of this user has the assessGrade equal to 0 and has the submGrade larger than 0, that means he or she did not complete all their assessment tasks, thus both the assessment grade and submission grade are not available to this user. If records of this user has the submGrade equal to 0 and has the assessGrade larger than 0, that means he or she complete all their assessment tasks but fewer then 2 peers has reviewed his or her work, thus this user can see his or her assessment grade, but submission grade is not available to this user. This is the only situation when user can request for re-grading. If both the value of assessGrade and submGrade of this record is larger than 0, this is the normal situation, the user can view his or her assessment grade and submission grade.

2.5.2.6 Data flow in re-grading phase

After system automatically calculated the grades for each qualified user, then is one situation when user is allowed to request for re-grading. If records of this user has the submGrade equal to 0 and has the assessGrade larger than 0, that means he or she complete all their assessment tasks but fewer then 2 peers has reviewed his or her work, thus this user is qualified to request for re-grading.

The system will check if the user is qualified for re-grading. If the user is qualified and has not requested before (by checking the value of regradeID of specific records in table

Submission), system will randomly choose a TA and put that TA's userID into regradeID of the records in Submission Table. At the same time insert a new record in table Assessment with the submissionID and regraderID, just like what system do when assign the table during assessment phase of peer review. Basically, system will do the exact same thing with the database like the former peer review procedure, first TA can view the assessment assigned to them for each assignment, then they give the scores and comments based on rubrics of grading form. The only difference is that after TA submits the assessment and system update the submGrade value in the Assessment table, also update the submGrade in Submission table with the value of submGrade in Assessment table. The score that TA gives is the submission grade of this student. Thus the students who request for re-grade can view his or her submission grade and assessment grade together.

2.6 Theme Design

The theme is used to change the appearance of the websites. For our website, we develop our theme based on the "coller" theme. A theme is consists of a lot of php files including index.php, archive.php, page.php, single.php, comments.php, content-page.php, content-single.php, footer.php, fuctions.php, header.php, index.php and style.css.

The following describe the details of making the themes step by step.

Header.php is used to display the title of our website and our menu bar. In every pages we use <?php get_header()> to get the content in header.php. In our header.php, it includes the simple title of our website and the menu bar which includes Home, Lab-table, Discussion Forum, Guidence and the Log in and Sign up.

Footer.php is used to display the end of every page. We also use <?php get_footer() ?> to

include the content in footer.php. In our footer.php, we design to include the theme information and the link to the ECE4760 course website.

Sidebar.php is used to display the side of each page. However, we do not need to use this sidebar, we still need to write the sidebar.php for further develop of our website. Sidebar is consists of log in function, a search menu, and some other basic functions. When later if some page need a sidebar, we can just use <?php get_sidebar();?> to get the sidebar we have written.

Comments.php is used to display the comments user can provide, we did not change much from the coller theme for this part.

Page.php is used to develop the basic templates of simple html page. All our page is divided into two parts: one is pages written in the folder page-template, where we use php to control the whole structure. The other are pages that only contains the html elements, we just use the default page template and some html+css to design them, for example, our home page and syllabus.

404.php is used to display error page when users try to access a link that not exist. In our 404.php, we design to tell the users this is not a valid page and lead them to the websites they might really want to access.

We also develop the page-full-width.php and single.php are used to display two different kinds of pages. The first one is used to pages that not own sidebar and the second is pages with sidebar.

And the most important part we design is our style.css. All of our pages and other php

file use this style.css file. Because our website is a MOOC course website, we design not to display too many gaudy features. For these kind of websites, simple and easy to use is often at first priority so we decide to use simple gray and green combination. We first defined some basic features like how links looks like and how h1 or h2 look like. Then we use class and id to define definite demand of certain elements.

3. Course Content Design

3.1 Lab Design

3.1.1 Design Goals

This MOOC course is to familiarize users who interested in electronics with the basic electronic knowledge and functions of microcontroller, without buying any hardware. After taking the course, students are expected to be able to design their own projects with Arduino fulfilling their interesting and fancy ideas. On the other hand, since the website: 123d.circuit.io is still under development, there is limitation of its online compiler and electronic components library. Under this circumstance, my job is to make full use of its compiler and components to design interesting labs, through doing which students can learn the use of Arduino as much as possible. The first two Labs aim to let students know the basic stuff of Arduino, and the topics include digital I/O, analog I/O, LED, pushbutton, etc. The last two labs are more difficult requiring students to combine what they learned from first two labs, which aims to give students an interesting experience of designing.

3.1.2 Design Process

ECE 4760 is a lab-based microcontroller design course, which uses hardware and software techniques to teach students a variety of design skills and experience of handling large projects. The key to delivering such a course on MOOC is to build a virtual lab, so students can do labs on their own computers without buying any hardware. At first, we came up with three ideas. The first one is to find an existing cheap or free software which can provide an integrated simulation environment for both CPU of ATmega1284, which used in ECE4760, and peripheral circuits connected to microcontroller. Our second idea is to hook up the Atmel Studio, which is a free platform for debugging and compiling Atmel AVR microcontrollers, to LTspice, which is a free circuit simulator. We also planned to design several peripheral simulators for keypad,

LED and LCD, which often used in microcontroller projects, and connect them to Atmel Studio or LTspice for complete simulation. The third idea to let users buy their own hardware, and we give the lectures and instructions. After they finished the labs, they have to make a video recording what they do and upload to our website for demo and evaluation. That was our last option, because buying hardware is against our original purpose of delivering a lab-based course on MOOC.

It turned out that we did not find an existing software can provide integrated simulation platform for both CPU of microcontroller and peripheral circuits. So we had to give up the first idea. Since the third one was our last choice, we planned to start with the second idea, which is hooking up Atmel Studio to LTspice. We have to say that was a huge plan. In order to connect them, IO ports of the microcontroller are the key part, since it is the connection of the microcontroller and circuits. At first we worked on the Atmel Studio part. We tried to write stimuli files for the CPU simulator. In the stimuli files, any I/O register can be assigned a value as input to be simulated, and the result, the output of I/O register can also be logged into a file. We planned to use the output file to control the circuits in LTspice. However we had some difficulty in writing the stimuli file. Timing problems often happened and simulation stopped suddenly. We tried a lot but still could not figure it out.

When we were struggling with the stimuli files, Prof. Bruce Land told us he found a website support integrated online simulation for Arduino, which was really good news for us. The website is 123d.circuits.io. I did some research about this website, and I found it only supported very basic functions of Arduino and the components in its library were also limited. Then I contacted the team working for 123d.circuits.io. They said, the website was still under development and more features would be released in the future. After discussion Prof. Bruce Land, we settled on our final plan, which is to design

Arduino labs on 123d.circuits.io and include its link on our website.

Since the microcontroller used in ECE 4760 is Atmega 1284, while the Arduino Uno used in 123d.circuits.io is based on Atmega 328, we have to modify the lab assignments given by ECE 4760 to fit into our MOOC. Considering the limitation of 123d.circuits.io, we designed four labs aiming to teach students certain functions of Arduino, which are commonly used in Arduino projects. At the same time, we have been always following the latest development of the 123d.circuits.io, so that we can make full use of features that can be supported by this website. By the end of February of 2014, we have completed the lab content design. The first lab is chasing LEDs with button control; the second lab is blinking LEDs with potentiometer control; the third lab is building a timer using 7-segment; the fourth lab is building a pointer with servo. They covered the topics including digital I/O, LED, pushbutton, voltage divider, ADC, PWM, 7-segment display, serial communication, millis (), servo and keypad. More details about each lab will be introduced in the next section 'Design Content'.

In March, we got down to writing lab instruction, which is guidance for students to complete each assignment. In order to write clear and useful instructions, we carefully studied the course webpage for ECE 4760:
http://people.ece.cornell.edu/land/courses/ece4760/ at first. Then we searched a variety of materials about the topics we covered in labs. Based on those, we finished lab instructions for four labs. Instructions contain three parts: introduction telling users what they should do in each lab; procedure telling them how to finish the task; assignment & grading criteria letting them know the specific points they can get.

Another important part of MOOC is the lectures. We decided to make mini-lectures to briefly talk about topics in each lab, and each mini-lecture is about 5-7 minutes. This job also started in March, more details about making mini-lectures are in the section 3.3.

Lab1

The first lab assignment is to build seven chasing LEDs with a button controlling direction on the virtual breadboard. When the button is pushed, LEDs start blinking from right to left. When pushed again, the chasing direction changes. This is a basic lab which aims to guide students learn the use of virtual Arduino and breadboard on the website 123d.circuit.io and know basic functions of Arduino.
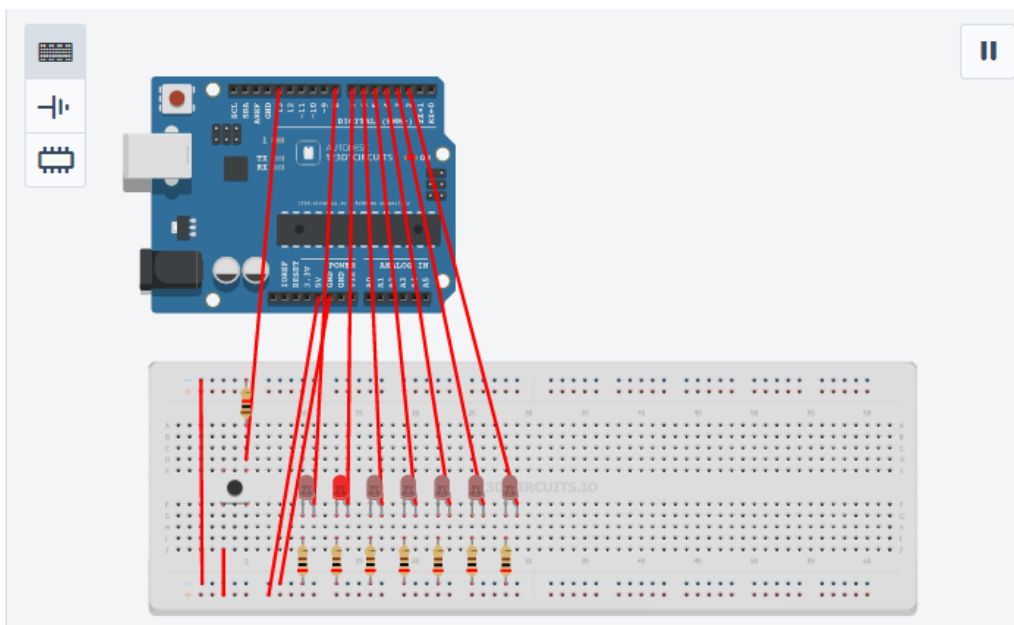
To help students get started, we found two video tutorials on 123d.circuit.io, which clearly introduce how to build circuits on virtual breadboard, how to compile the Arduino code and run the simulation. We also provide basic information about Arduino Uno and programming language syntax.

Schematic for this lab is shown in the following. We want students to learn the concepts of digital I/O, LED, and pushbutton in first lab. Digital pins on the Arduino can be configured as either inputs or outputs. Lab1 lets students experience the function of the pins in both modes. LEDs are widely used in microcontroller projects, which are very useful for debugging and many other purposes. LED cannot be directly added on a circuit

without something to limit the current. Thus we give a mini-lecture about working principle of LED and its current limiting resistor. We also provide a mini-lecture talking about pushbutton and its pull-up and pull-down resistor. Besides those mini-lectures, some other reference and reading material also be provided to help student finish their first lab. We also give a simple example, which is using button to control one LED. Based on this example, we made a mini-lecture talking about its Arduino code line by line, which is a detailed beginner's guide.
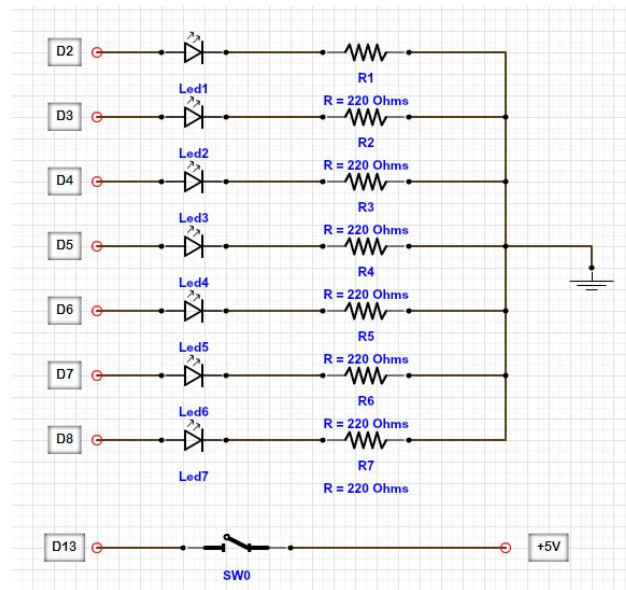
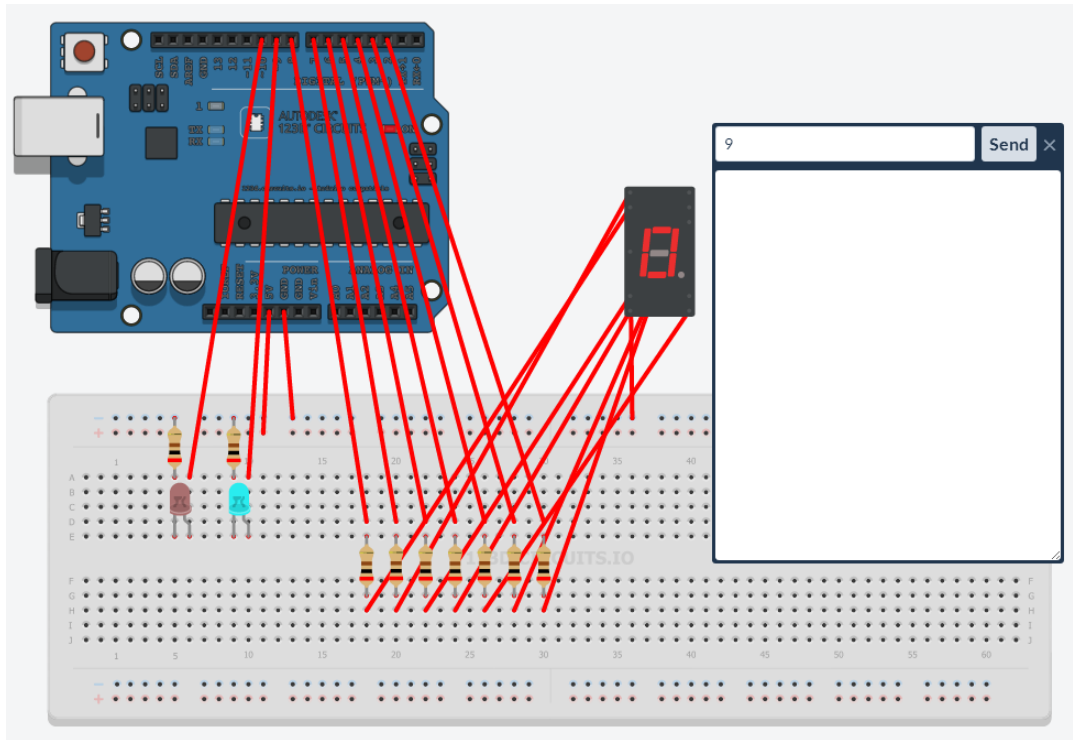

Schematic of Lab1

Lab1 accounts for 20 percentage in final grade. Total points for lab1 are 100 points. Students can get 15 points if they can light up seven LEDs, get 25 points if they can let LEDs chase each other and each one blinks about 200ms, get 30 points if they can use button to control the chasing direction. Since the job will be evaluated by other users, we want to make sure the code is readable. So a heavily commented listing of code will get 10 points. Besides, a short and clear report explaining how you get the lab done will get you 20 points. We also set a bonus 25 points for video report, since we really appreciate different types of report making this course more interesting and interactive.

Lab2

The second lab assignment is to build ten LEDs with a potentiometer controlling the lighting numbers and brightness. A button or slide-switch is used to set up two modes. In one mode, when you tune the potentiometer, the number of lighting LEDs will change. In other mode, when you turn the potentiometer, the brightness of ten LEDs will change. This lab is designed to let users learn the ADC and PWM function in Arduino and the use of potentiometer.
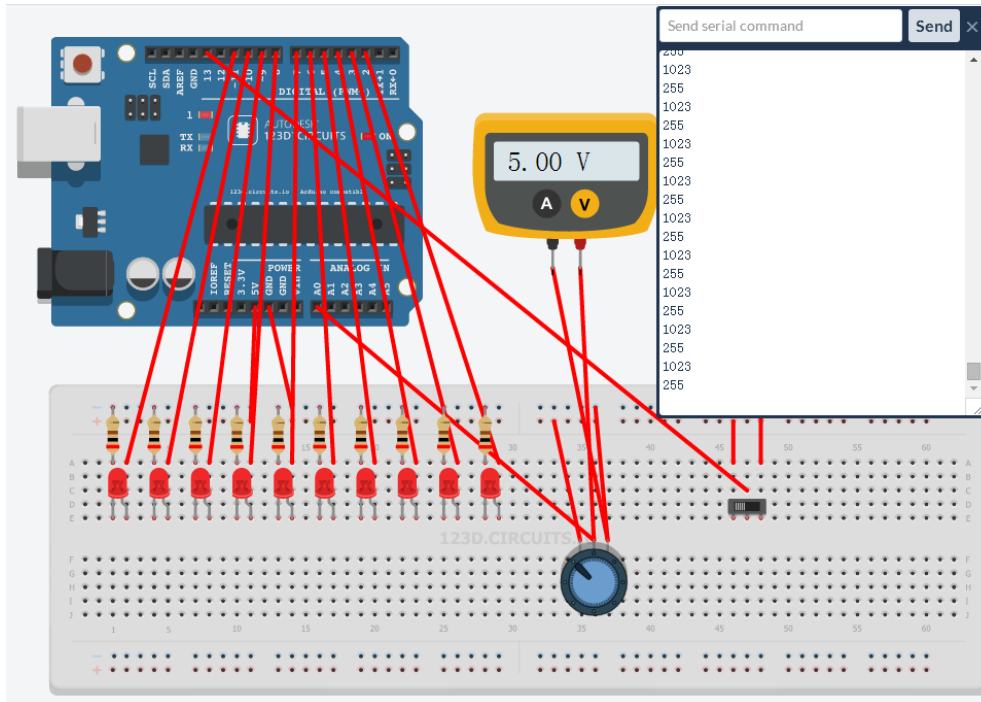
Schematic of this lab is shown below. We provide schematic on lab instruction to help students build the circuit. Students are expected to know the ADC and PWM functions in Arduino and use of potentiometer after this lab. We first give a mini-lecture about analog and digital signals and difference between them, which is basic concepts we need to clarify for beginners. Then we talk about ADC, which is analog to digital converter. The main function of ADC is to read analog inputs into our system and convert them to digital numbers, so the microcontroller can process them. Another important concept PWM, or Pulse Width Modulation, which is a technique to get analog results with digital method, is explained by guest professor Bruce Land. And he also talks about how to implement it in Arduino system. Potentiometer is widely used to get any voltage between supply

voltage and ground. Students should know how to use it very well when finishing lab2. We also give an example, which is using potentiometer to control the brightness of one LED. In example, users will see connection of potentiometer in virtual breadboard, and the syntax when using ADC and PWM in Arduino. After watching all those mini-lectures and example, students should be fully prepared to work on lab2.
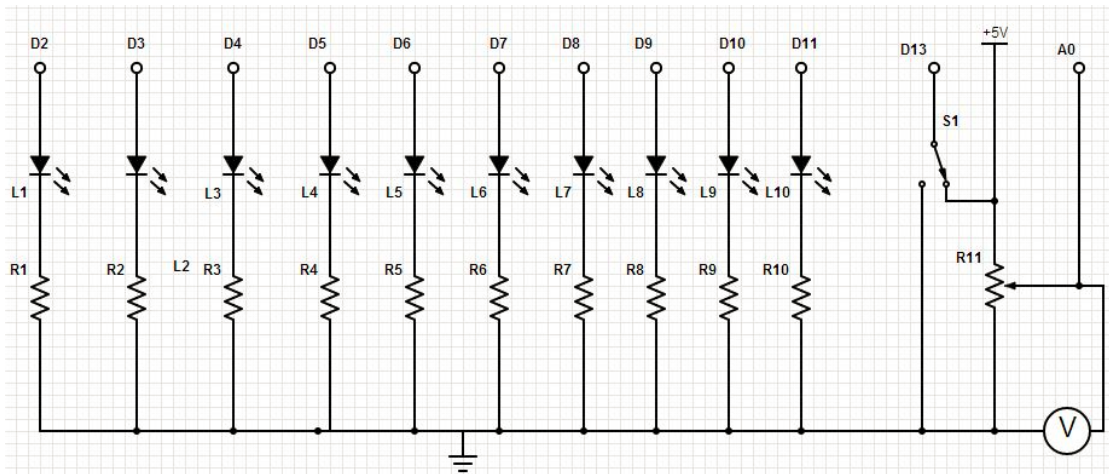

Schematic of Lab2

Lab2 accounts for 20 percentage in final grade. Total points for lab2 are 100 points. Students can get 35 points if they accomplish one mode, either controlling the brightness or controlling the lighting numbers. They can get another 35 points if both two modes are accomplished and can be switched smoothly. Same as the first lab, a heavily commented listing of code will get you 10 points and a complete report also accounts for 20 points. We provide those grading criteria in the instruction, so the students can predict their grade when they submit their job.


Lab3

The third assignment is to build a countdown timer using a 7-segment. The 7-segment is controlled by serial communication. When opening the Serial Monitor and inputting a number between 0 and 9 in the command window, the segment will display the number you input and then countdown. When it countdowns to 0, two LEDs start blinking. This lab aims to let students learn how segments work, how to do with serial communication

and how to use millis () function avoiding delay ().

Schematic of this lab is shown below. We provide schematic on lab instruction to help students build the circuit. We want students to learn the use of segments, serial communication and millis () in this lab, which are very useful when they come to large project design. The 7-segment consists of seven LEDs (a, b, c, d, e, f, g) arranged in a rectangular form, looking like number '8'. Lighting up a particular set of LEDs can display a certain number. We provide detailed reading material to help students fully understand the working principle of segments. Serial is used for communicating between microcontroller and computer or other devices. In this lab, we use the serial to send a command to Arduino board controlling the display of segment.   Another important thing students need to know is, using millis () function is better than delay (), since delay () stops the CPU for a certain number of millisecond, nothing in code can run during the delay time. We also provide three simple examples about serial communication and segment display to help student know the syntax and logic.
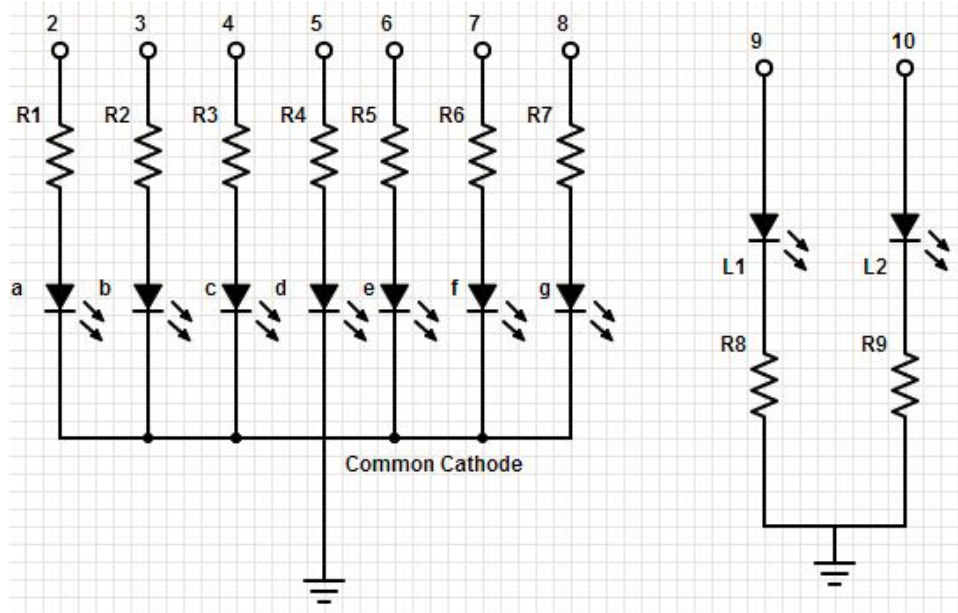
Schematic of Lab3

Lab3 accounts for 30 percentage in final grade. Total points for lab3 are 100 points. Students can get 35 points if they can display a number on segment controlling by the serial communication. They can get another 25 points if the segment countdown as a timer, and 15 points if two LEDs start blinking when timer countdowns to 0. A heavily commented listing of code will get you 10 points and a complete report also accounts for 15 points.

Lab4

The last lab assignment is to build a pointer using servo. The servo is controlled by a self-made keypad. In lab4, students have to build 3*3 keypad using pushbuttons. When key 1 is pushed, the servo begins rotating until it points to the first LED, and the first LED turns on. When key 2 pushed, servo turns to the second LED and lights it up. Similar when you push key 3, 4, 5, 6. Key 7 is used to reset the servo and LEDs. When key 8 is pressed, the servo starts sweeping from 0 degree to 180 degree, and as it passing a LED, the LED will be lighted up. When key 9 pressed, the servo sweeps back from 180 degree to 0 degree. This lab is designed to let users learn the principle of keypad and how to control servo in the Arduino. To do this lab, students need to combine what they

learned from lab1-3 and carefully deal with the timing issues.
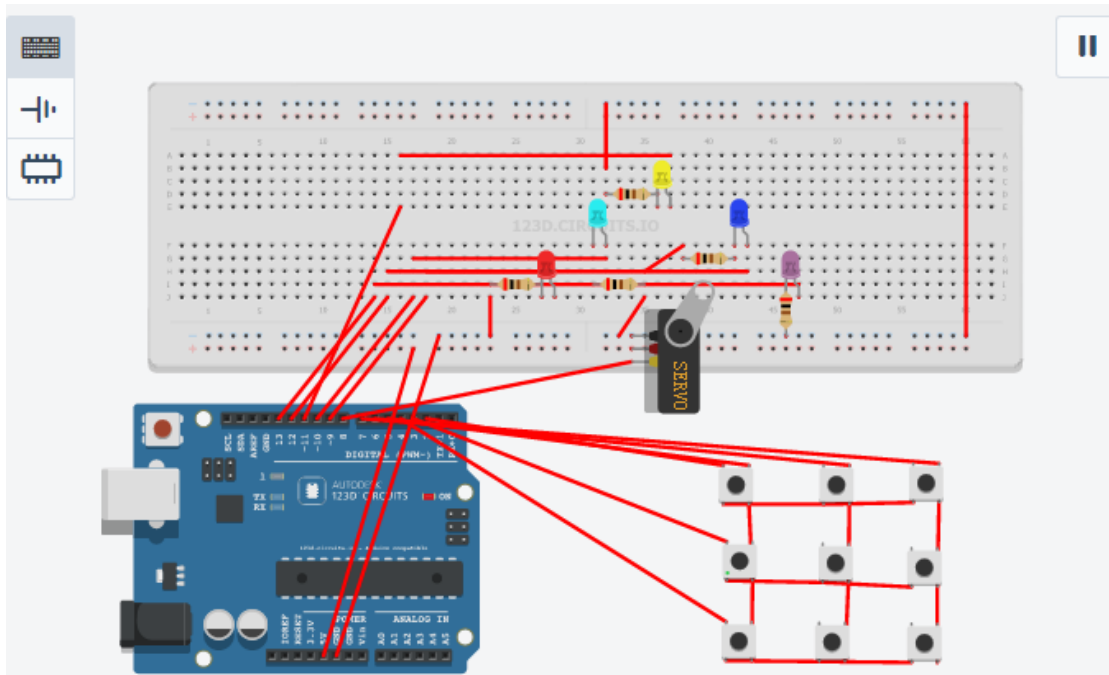
Students are expected to know the principle of keypad and servo after this lab. The keypad is basically made up of 9 pushbuttons and 6 wires. Reading the value on each line in a proper way can detect which key has been pressed. The library of 123d.circuits.io does not include the keypad, so users have to build it by themselves. But that actually is good way for users to fully understand the structure of keypad. Servo motors are widely used in microcontroller projects, which have gears and a shaft that can be precisely positioned at various angles. We provide two example circuits to show how to control servos using Arduino servo library. And an example about building and detecting keypad is provided. After carefully studied those examples, students should be full prepared to work on lab4. Schematic of this lab is shown below. We provide schematic on lab instruction to help students build the circuit.
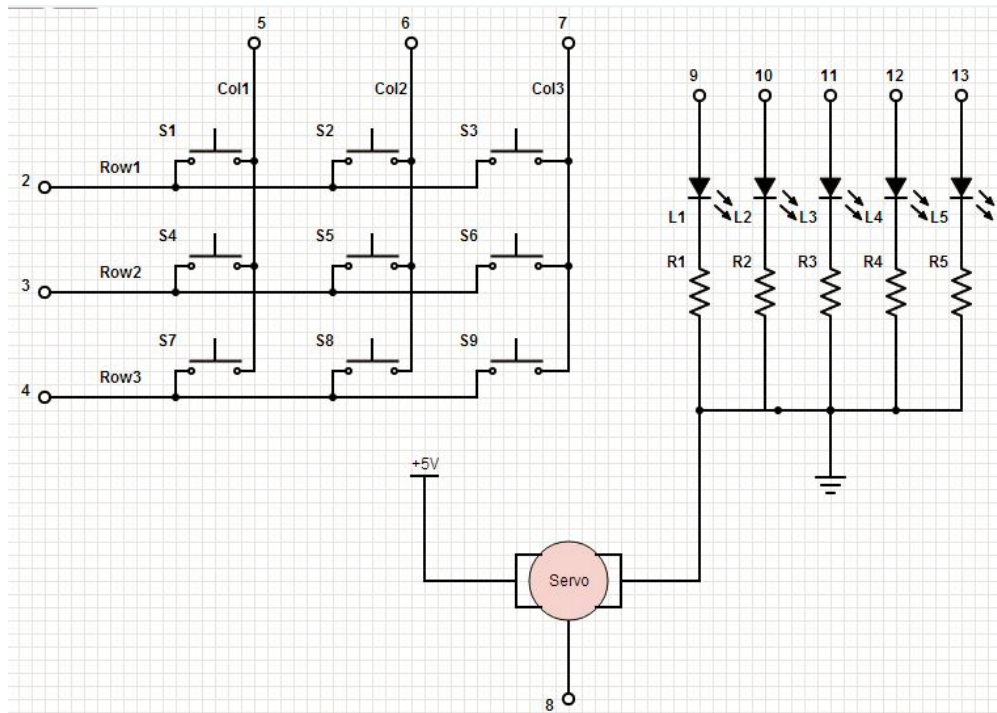
Schematic of Lab4

Lab4 accounts for 30 percentage in final grade. Total points for lab4 are 100 points. Students can get 35 points if they successfully build a 3*3 keypad and work well, get 25 points if the keypad can control the servo properly, get 15 points if they can accomplish the function of key 1-6, and get 15 points if they achieve the reset and sweep function with key7-9. Code and report account for 20 points as always. We also set a bonus 25 points for those who add new function to the pointer. We are expected to see students show their creativity in this lab.

3.2 Making Mini-lectures

Lectures are traditional parts of MOOC. In our MOOC course, we provided 19 video lectures in total. Four lectures are given by our guest lecturer, Prof. Bruce Land, and others are given by Yuanyuan Gong. Those videos contains of demo for each lab, introduction of knowledge that needed for each lab and explanation for some examples. There are 4 videos for lab1and 5 videos for lab2, and each mini-lecture lasts about 5

minutes.

Here we have to thank Jessica Stephenson for lending the video camera to us so that we can make the mini-lectures. After taping the video, we used Corel video studio to edit it, then Prof. Bruce Land uploaded it to his channel on YouTube. Here is the link: https://www.youtube.com/playlist?list=PLKcjQ_UFkrd4lWDmLnA5lftKtHVek0qk2 . We embedded those videos in our website so students can watch them when they read the instruction for each lab.

Due to limited time, we only provided two videos for lab3 and lab4. To make up for that, we gave more example circuits for lab3 and lab4 to help users understand the key points. We also made a Chinese version for those videos, since Chinese students are really large populations. Unfortunately YouTube is blocked in China, so we decided to put the Chinese version on Youku, the most popular video website in China, and advertise it in Weibo and Renren, like twitter and Facebook in US. In this way, more and more students in the world will benefit from our MOOC course.

4. Test and Debug

4.1 Method

4.1.1 Static test

We first test our website statically, we just build the whole structure of our websites including all pages we needed to implement our basic functions (which is discussed in the part 2.2). We basically test and mediate the front-end code to make every page looks simple, easy and beautiful.

Then test every page to make sure their functions works well. In this step, we did not build a relationship between each page. We just insert to the database some data which is required to access from the database and then test if we can get the expected data we want. And insert the information to the database, and then use manager identity to see if the database has the data we have inserted in.

4.1.2 Dynamic test

In this step, we build the relationship between each page and do this in the order of the whole procedure of one assignment. We first insert into the database the basic lab information, and then from the procedure we have discussed before, test them pages by pages to find the bugs.

4.2 Details of test each stage

Here we will mainly discuss the dynamic test we have mentioned in the above part. As the data flow we have discussed before, we have to the test step by step so that the database will complete page by page. And this is also the way to simulate what will really happen when a lab is assigned to students.

Because we design to assign each student four submissions to assess, we create 5 student role to test this. And we also need TA to assign the assessment, calculate the score and regrade, so we also create two TA accounts. Finally we create 7 users to test the whole system, they are as following:

yunhao—administrator

yun --subscriber

hao---subscriber

goodluck--subscriber

haoyun--subscriber

TA1--contributor

TA2—contributor

First, we test the static pages which don't need to interact with database:

Home Page:
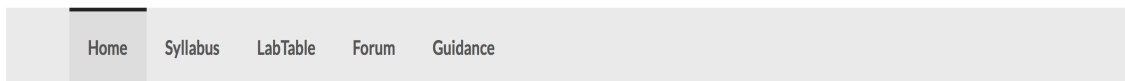
Syllabus Page:

Syllabus

Microcontroller Design Course on the MOOC

Course description:
In this course, we are going to use Arduino to do four projects on the internet, through which you will learn how to use microcontroller. Arduino is awesome open-source platform microcontroller, which is widely used for doing electronic projects. In this MOOC course, you don't have to buy any hardware. You can totally finish the four projects on the internet, thanks to this amazing website: 123d.circuit.io, which provides free simulation environment for you. For each lab, there are several mini-lectures to introduce the related knowledge you need, and we also provide detailed instructions in our website. If whether you are the beginner who never used electronics before, or you are a veteran who has been working with other microcontrollers, this is a great course for you.

Course Objectives:
This MOOC course is to familiarize users who interested in electronics with the basic electronic knowledge and functions of microcontroller. By doing the labs, students will learn the design procedure of a microcontroller project. After taking this class, students are expected to be able to design their own projects with Arduino fulfilling their interesting and fancy ideas.

Lecturer:
Yuanyuan Gong   Contact: yg325@cornell.edu

Distinguished Lecturer:
Prof. Bruce Land is our guest lecturer for few exciting sessions

Course Outline:
Lab1: Chasing LEDs with Button Control

Forum Page:

Forum

This category contains 5 topics and 2 replies, and was last updated by yunhao 5 hours, 58 minutes ago.

Forum	Topics	Posts	Freshness
Lab1	1	1	6 hours, 1 minute ago yunhao
Lab2	1	1	6 hours ago yunhao
Lab3	1	3	5 hours, 59 minutes ago yunhao
Lab4	1	1	5 hours, 59 minutes ago yunhao
Suggestions	1	1	5 hours, 58 minutes ago yunhao

Guidance Page:

We then test the student role (subscriber) , we test every pages following the lab table page we have written according to this order:

lab table→upload→assessment→grading→re-grade

We insert the basic information of four labs into database and then begin our test procedure. For the lab table, students can see all four labs, the instructions of labs and the start and due time. They can click on start to begin their lab tour. We checked all the information are same to what we exist to the database.

LabTable Page:

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Title	Description	Assignment	Start Time	End Time
Chasing LEDs with Button Control	Instruction	Start	2014-05-12	2014-06-30
Blinking LEDs with Potentiometer Control	Instruction	Start	2014-05-12	2014-06-30
Timer	Instruction	Start	2014-05-12	2014-06-30
Pointer	Instruction	Start	2014-05-12	2014-06-30

MOOC Theme by ece4760   Welcome to Join us!

Clicking the instruction link for each lab will go to the specific instruction page, here shows the instruction page for Lab 1:

Read the description for Lab 1: Chasing LEDs with Button Control
Chasing LEDs with Button Control
Introduction
You will build seven chasing LEDs with a button controlling direction on the virtual breadboard. When the button is pushed, LEDs start blinking from right to left. When pushed again, the chasing direction changes. First you need to know how to use the virtual Arduino and breadboard on the website:
http://123d.circuits.io/.
Procedure
1. Learn how to use 123D Circuits
http://www.instructables.com/id/Zero-to-Breadboard-Simulation/?ALLSTEPS
http://www.instructables.com/id/EZGYWF1HKJTCHMZ/
2. Learn the basic of Arduino

Clicking the start link for each lab will go to the specific assignment page, here shows the assignment page for Lab 1:

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Let's start Lab 1: Chasing LEDs with Button Control

Lab 1 Chasing LEDs with Button Control

Start	Instruction	Upload Files
Assessment	Assess Other's Work	
Grades	View Grades	
Regrades	Request Regrade	Regrade Result

In the upload part, we tested if we can upload four things and if the data in database is correct. We also tried some corner case to test if we can upload invalid things and if we continue upload several times, which version will be saved finally.

Submit your work here!

Please submit your work before deadline!

Youtube Video Link :   https://www.youtube.com/wa

123Circuits Link :   http://123d.circuits.io

Upload your report(.pdf):   Choose File   📄 report5.pdf

Upload your code(.zip):   Choose File   📄 source.zip

Submit

You can view your uploads using the links below!
You have already submitted all the required file. Your submission is completed!
click here to view your code!
click here to view your report!
Your Youtube Video Page
Your 123Circuits Page

Get the information below:

Upload: 19a1de167122a18af369c749f4e40a48report.pdf
Type: application/pdf
Size: 53.7861328125 kB
19a1de167122a18af369c749f4e40a48report.pdfhas been uploaded again.
click here to view your code!
Your Youtube Page
Your 123Circuits Page

We also tried to upload the file doesn't meet the qualification in the submission phase (including the file type and the file size). We have defined the file size is no more than 200KB. The report file should be in .pdf and the source code file should in .zip.

Submit your work here!

Please submit your work before deadline!

Youtube Video Link : [   ]
123Circuits Link : [   ]
Upload your report(.pdf): [Choose File] 📄 source.zip
Upload your code(.zip): [Choose File] no file selected

[Submit]

Get information below:

We only accept .pdf file for your report!
You did not select the .zip file for your code!
Empty Input for Youtube Link!
Empty Input for Youtube Link!

Similarly we tried to submit the invalid website links (which are not start with "http://"):

Submit your work here!

Please submit your work before deadline!

Youtube Video Link :	https://www.youtube.com/wa
123Circuits Link :	www.google.com
Upload your report(.pdf):	Choose File report5.pdf
Upload your code(.zip):	Choose File source.zip
Submit	

Get information like below:

Upload: 19a1de167122a18af369c749f4e40a48report.pdf
Type: application/pdf
Size: 53.7861328125 kB
19a1de167122a18af369c749f4e40a48report.pdfhas been uploaded again.
click here to view your code!
Your Youtube Page
Invalid URL for 123Circuits Link!

When the submission deadline passed, we log in with the TA role and assign the assessment to every student who has submitted their work completely. We check the database to see if one student are assigned four different submissions to review, if the one who didn't submit his work are assigned and so many corner cases like that. We modify our code by checking all these situations and finding errors.

Then we test the assessment part, each student are assigned with four assessment tasks, click them we can see the grading form to complete, We try to fill the form in different way and see what the database has received when submit different things. And also we test if we can suggest a score that is bigger than the max score, or if we can fill one form during two different times.

The assessment page:

Assessment Page

There are four assessments assigned to you. Your work will be reviewed by other four peers too. Please view the assessment instruction first and complete the four assesments before the assessment deadline!

Assessment Instruction

Assessment1   Assessment2   Assessment3   Assessment4

You have already complete this assessment1!
You have already complete this assessment2!
You have already complete this assessment3!
You have already complete this assessment4!

The grading form page for assessment1:

Start to review the assessment now!

click here to view the code!
click here to view the report!
Youtube Video Page
123Circuits Page

1:Light up the seven LEDs

Score: 15   /15

Comment:

Good!

2:Let LED chase each other, each one blinks about 200ms

Score: 25   /25

Comment:

Great!

3: Use the button to control the chasing direction

Score: 25   /30

Comment:

Good!

4:A heavily commented listing of your code (readable: 5pt; short & clear: 3pt; creativity: 2pt)

Score: 5   /10

Comment:

good

5:A short and clear report explains how you get this done. Repot should include how to light up the seven LEDs (6pt), how to let LED chase each other (7pt), and how to use the button to control the chasing direction (7pt).
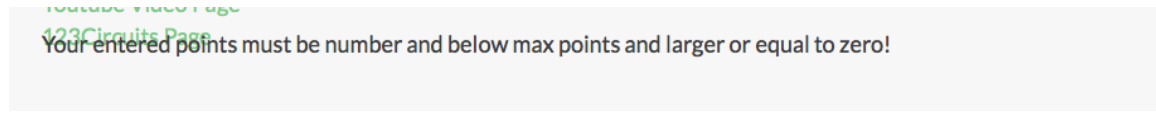
Score: 15   /20

Comment:

well done

Submit

If the score we put in is bigger than the maximum value of each dimension or is not a number:

Youtube Video Page
123Circuits Page
Your entered points must be number and below max points and larger or equal to zero!

When students done the assessment, and the assessment deadline is coming then comes the grading phase.   TA will go the lab table of TA and click the button to calculate the grades.

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Home	Syllabus	LabTableForTA	Forum	Guidance

Title	Description	Detail	Start Time	End Time
Chasing LEDs with Button Control	Instruction	Detail	2014-05-12	2014-06-30
Blinking LEDs with Potentiometer Control	Instruction	Detail	2014-05-12	2014-06-30
Timer	Instruction	Detail	2014-05-12	2014-06-30
Pointer	Instruction	Detail	2014-05-12	2014-06-30

The Detail Page for assignment1:

TA Detail Page

Assign the assessment!   Caculate the grades!
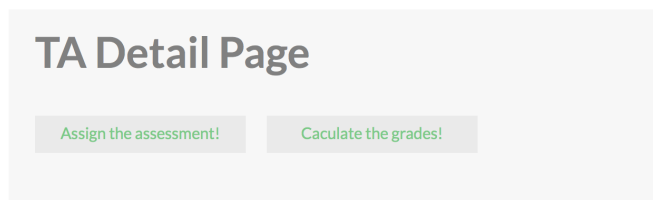
If the grades has been calculated before, those button will not work and give you the information like below:

This assignment's grades are already been calculated!

We check the view score part, we tried different situation we discussed above to see if situations in design decision happens, whether or not the student can see their score.

After checking all the situations we may meet with in score part, we came to the regrade part. In this part, we mainly check whether student is qualified to request regrade. For those who are not qualified, our system will give them corresponding hint.

In the test part, we decided to test all the corner cases we have mentioned in the design decision. Here are the situations we have tried.

We will simply say five student users as A, B, C, D, E. We first test the situation that A and B do not assess C's work and C complete all four submissions he is assigned. In this case, A and B cannot see their submission grade because they didn't complete all four assessments and they cannot request regrade. C can only see his assessment grade but cannot see the submission grade because only two people D and E assess his work. He is qualified to request regrade, and when he request, system will find a TA to assess his work and give a email address of this TA for him to contact. Now we use this TA's account, then we can see the assessment, after TA have done the assessment, student C can see his re-grade score, comments and detail.

We did the same thing in the assessment phase, when assess others' works, student have to suggest a score of each dimension, we defined that the score given must no bigger than the max point and can only be numbers. When we tried these error behaviors, we got the corresponding hint information.

In our system, there are two parts that students must submit something. The first is to submit their work and second one is to submit the assessment form. We defined to keep only one copy of these and when new submissions are made, we delete the old copies. As test part, we submitted several times and it only keeps the newest copy. As for the

assessment part, students can complete some part of one assessment, and once submit, the database will only record the part they filled and other parts of this assessment will remain the old version.

D's view score page (normal situation):

The detail of peer review page:

A and B's view score page:

Your Score!

You did not complete all your assessments, your grades are not available!

Submission Grade	Assessment Grade	Final Grade
notavailable	notavailable	notavailable

If your score is not available, then it is because you did not submitted your complete work or you did not complete all the assessments assigned to you. In this case, you are not allowed to apply regrading.

If you can see your assessment grade but can't see your submission grade or any peer review details, unfortunately,your failed to get your grades at this time. You can go to Assignment Page and request for regrades, then your work will be reviewed by TA.

C's view score page:

Your Score!

You did not get your submission grade since less than two peers have reviewed your work!
You can go to Assignment Page and request for regrades, then your work will be reviewed by TA.

Submission Grade	Assessment Grade	Final Grade
not available	18.00	not available

If your score is not available, then it is because you did not submitted your complete work or you did not complete all the assessments assigned to you. In this case, you are not allowed to apply regrading.

If you can see your assessment grade but can't see your submission grade or any peer review details, unfortunately,your failed to get your grades at this time. You can go to Assignment Page and request for regrades, then your work will be reviewed by TA.

C request for re-grade:

You have already request before.
You can contact TA by email: TA1@gmail.com

Unqualified user to request for re-grade:

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| Home | Syllabus | LabTable | Forum | Guidance |

Sorry! You are not allowed to request for regrading.

After C request for re-grade, TA1's detail page:

| Home | Syllabus | LabTableForTA | Forum | Guidance |

TA Detail Page

Assign the assessment!   Caculate the grades!

Below is the regrading tasks assigned to you for assignment 1!
Assessment1

C's view regrade score page:

Your Score!

Submission Grade From TA	Assessment Grade	Final Grade
61	18.00	79

Details and
Comments

You submission is assigned to a TA, you can contact the TA by email: TA1@gmail.com

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As we discussed above, our system is in a strict order that users are not allowed to do things in the reverse order, if this happens, the system will give users the hint and inhibit these actions. For example, you cannot upload your file before you log in to the system, you cannot assess others' works before you submit your own work.

4.3 The result of test

We find some bugs during the test and finally correct them and make our website works well. Here are some important bugs we have find.

Bug1：

In the assessment.php, we want to get data to display in the page using such command:

```
$query=$wpdb->prepare("SELECT
                Assessment.assessmentID,Assessment.submitted
                FROM Assessment,Submission
                 WHERE
                Assessment.submissionID =
Submission.submissionID          AND Submission.assignmentID = %d AND
Assessment.reviewerID =%d",$assignmentID,$userID);
```

In the beginning, we forget the Submission table and only check the data from Assessment Table. In such situation we cannot decide which assignment this assessment is belong to, then we get more than four assessments for one student (including all assessments he need to assess in four labs, which is sixteen in this case.)

Bug 2:

When we test the submission work phase, we need to save the report and code files under folder "upload", the limit of authority stop us to do such action. Then we should set the limit of folder "upload" to "775".

Bug 3:

To enable use pretty look permalinks, we should install the mod_rewrite module in apache server, and also alter the AllowOverride from "none" to "all", and also change the permission of   .htaccess file in root folder to mod 775 so that WordPress will be able to change it.

Bug 4:

When we migrate our system from localhost to server, we found that although it works fine in localhost, there are many bugs when it is running on server. When modify the wp-config.php file,
make ("WP_DEBUG", false) to ("WP_DEBUG", true). And add one line @ini_set('display_errors', 1) after the above line,   So that any error logs will be displayed. This is debug mod, we should change it back after deploying system.

Bug 5:

By using the DEBUG mod, we find that it is because the version of PHP is a little old, so that some syntax are not supported. We modified our code to adapt to the PHP of server.

5. Conclusion

Things done:

- The design of labs and videotaping of lectures for the labs are done, and the videos are now hosted on YouTube.

- We have complete the foundations and basic functions of the server side system for the MOOC, and the system has already been put on a server of ECE. The design and implementation of data base of the MOOC is finished for user data storage and retrieval. The system behaves in accordance with the course schedule made by administrator like making assignment release at the dates specified by the schedule.

- We also made some tests on the services we provide to see if they are available to users and if the strategies used in these services to protect user' privacy are working.

Things need to do:

- The instructions of lab3 and lab4 need to be polished, and they are not translated to Chinese yet.

- To test the scalability of the system the responding speed of the system with different burdens to see if the current set ups of the system are suitable for massive users and how to improve the performance of the system.

- To make trade-off between fixed course schedule for all or flexible course schedule for everyone, or find a way to make a better course scheduling strategy by combining the two choices above.

6. Reference

[1] Lourdes Guàrdia, Marcelo Maina, Albert Sangrà(2013) *MOOC Design Principles. A Pedagogical Approach from the Learner's Perspective*, eLearning Papers; 05/2013; 33:1-6.

[2] Michael Rowe, Vivienne Bozalek, Jose Frantz(2013) *Using Google Drive to facilitate a blended approach to authentic learning.* British Journal of Educational Technology. 06/2013.

[3] Lyubomir Serafimov (2012) *HTML5 Support in Mobile Learning Tools*. In proceeding of: International Scientific Conference eLearning and Software for Education, At Bucharest, Romania, Volume: 2.

[4] Kamil Kopecký(2014) *New Trends in the Development of Mlearning with Focus on Tables and Other Mobile Devices.* The 10th International Scientific Conference eLearning and software for Education. 04/2014.

Appendix A: User Manual

Dear visitor and student, this is a user manual to our website. As a student, you should first have a look at Syllabus to get an overall understanding of this course. After having a basic view of this course, if you decide to take this course, you could go to the lab table page.

In the lab table page, you can click the instruction link, and see the detailed description of the lab, corresponding materials, resources, and video lectures from Professor Bruce R Land, Yuanyuan Gong.

From the lab table, you can also see the start time and deadline of each lab, so you can decide which lab session it is now so that you will be able to engage in the assignment. You must submit your solution to the assignment before the submission deadline if you want to get scores. For each lab, you should upload at least the source code, 123dcircuit link, report. You have the option to upload the link to a YouTube video that describe your solution so that others can better understand it.

As our grading system is based on peer review, you will also need to assess other 4 guys homework to get your homework graded. You need to finish all the assessments before the assessment deadline. You should click the assessment button after submission deadline and download the grading criteria, read it carefully. Then choose one work of others to assess. Give credits to every part according to the criteria, and write down any comments you want. You can save the assessment anytime by submitting it. Next time when you go to this assessment, you will see all the information that has been saved. In this way, you can change your assessment anytime before the assessment deadline. After the assessment deadline, all the assessments will be analyzed, then, you can see your score.

As there is possibility that some people drop course half way or forget to assess others' work, if less than two people assess your work, you won't get a score. If you don't see your score, you can request to have it re-graded by the Teaching Assistant before the re-grading deadline. You can also discuss any problems you encounter during lab with other students in your discussion forum. Each lab has a discussing section. You can also give your precious suggestions in the suggestion section to help us improve website.

Address of the MOOC: en-ec-ece4760mooc.ece.cornell.edu

Appendix B: PHP codes

Please go to the zip file phpcodes.zip in the source code package provided with the report.

Appendix C: The SQL we use in the system

Please go to the zip file dbSQL.zip in the source code package provided with the report.