# 2014 CRADLE Internship Technical Report

Project title: Building an LED automated lighting system

Project mentor: Mr Wendell

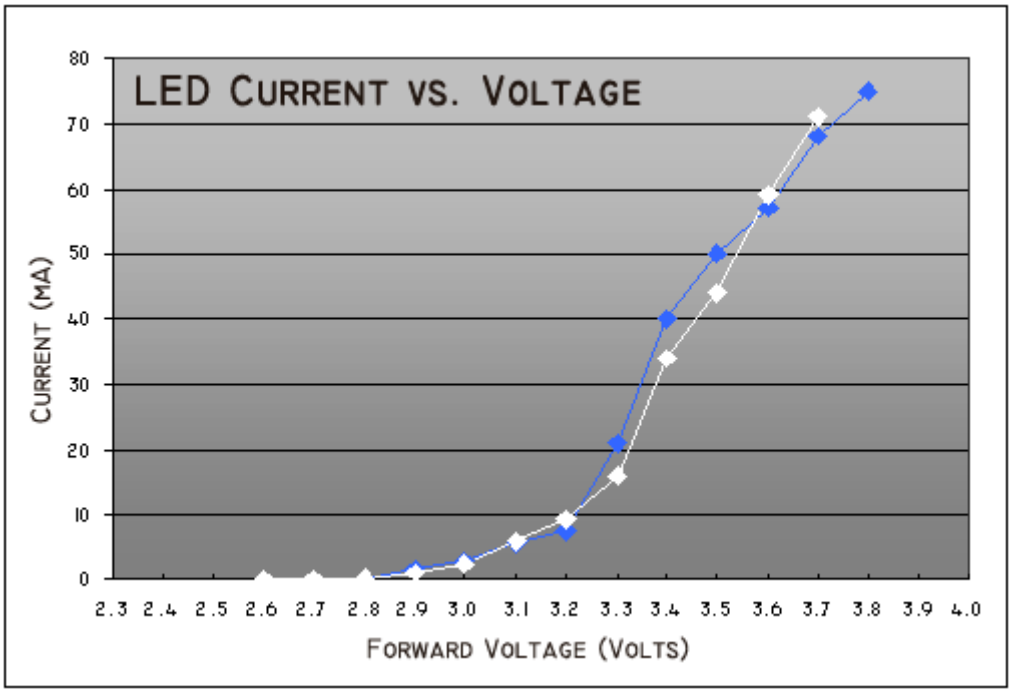
## 1. Component:

LEDs, PIR sensor, transistors, voltage regulator, crystal oscillator, resistance, capacitor, battery, chip.

## 2. Circuit Diagrams:

Part One: LED current regulation circuit:

Initially, I came up with the idea of using a voltage regulator to generate stable voltage. However, it did not work out well. After consulting and doing research, I found out that since the current-voltage graph shows an exponential relationship, small changes in voltage will led to significant fluctuation in current. Thus, I decided on a current regulation circuit. I used two transistors to achieve this.



No.

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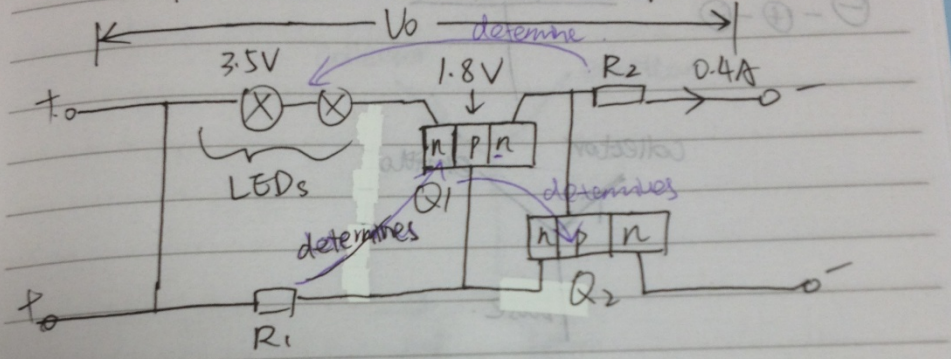
Calculations for this circuit:

$V_L = V_S - 1.8$.

# of LEDs $= V_L / V_F = (V_S - 1.8) / V_F$.




3.5V & 0.4A come from LED datasheet.

Determine $R_2$:

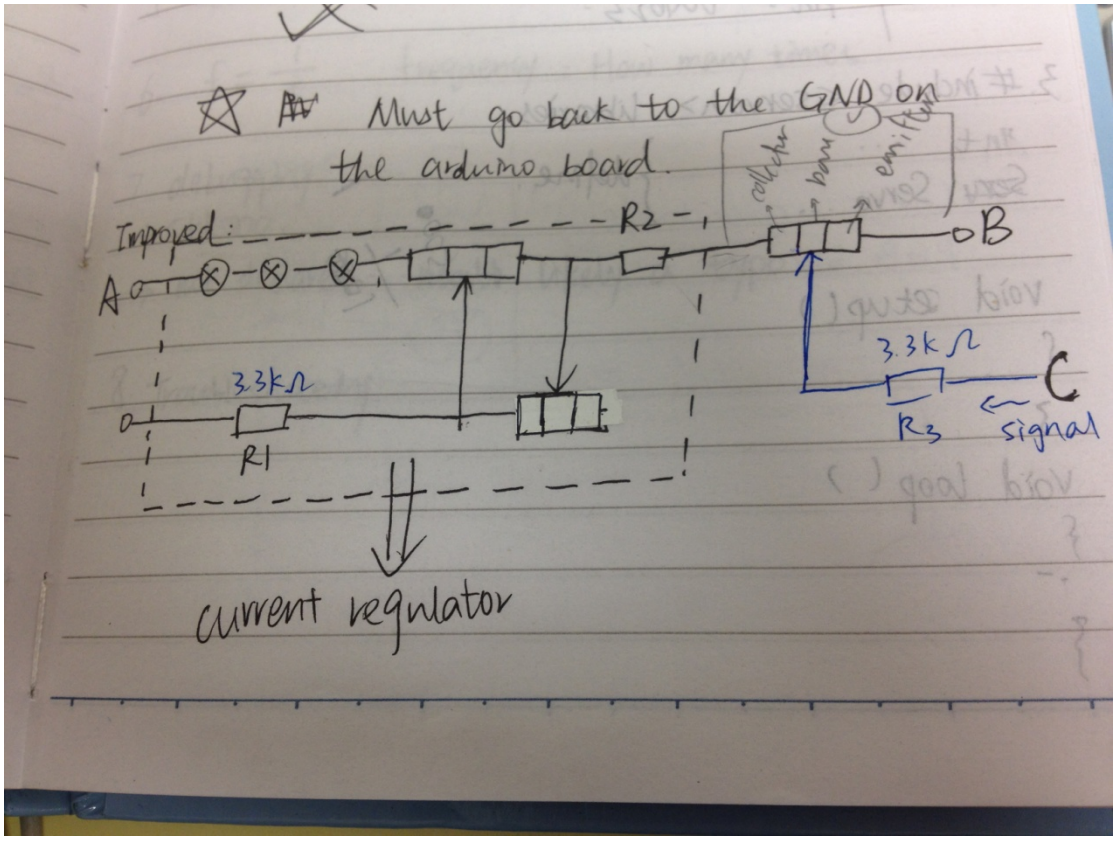
$3.5V \times 2 + 1.8V + 0.4R_2 = V_o$

△

minimum voltage between ground and collector of $Q_1$.

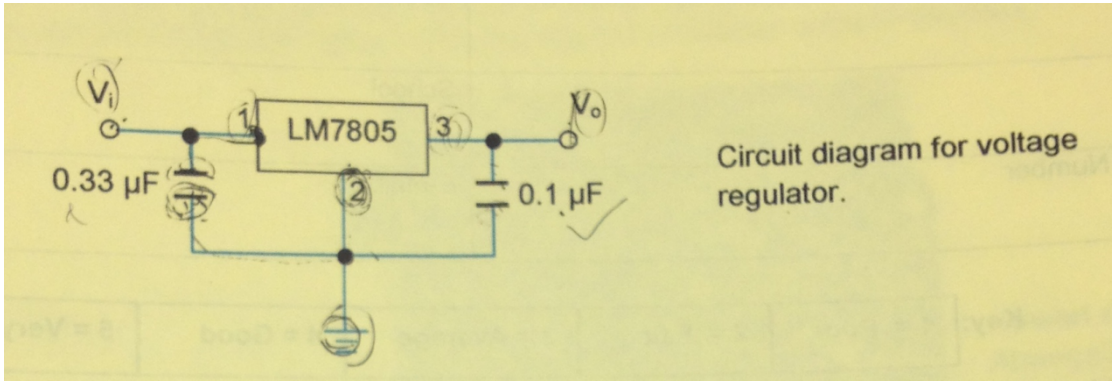
## Part Two: On/Off control circuit

Arduino board has a maximum voltage of 5V. In order to generate more voltage to light up three LEDs at the same time, I tried a lot of ways to make improvement to the circuit. Finally, I used a transistor as a switch. A is connected to cathode of the battery, B is connected to the anode, C is connected to the PIR sensor. The LEDs will not light up because of the open circuit, until the motion is sensed and a signal activate the transistor. Therefore, I can have as much voltage as I want. The 5V on Arduino board is only responsible for the chip and the PIR sensor.



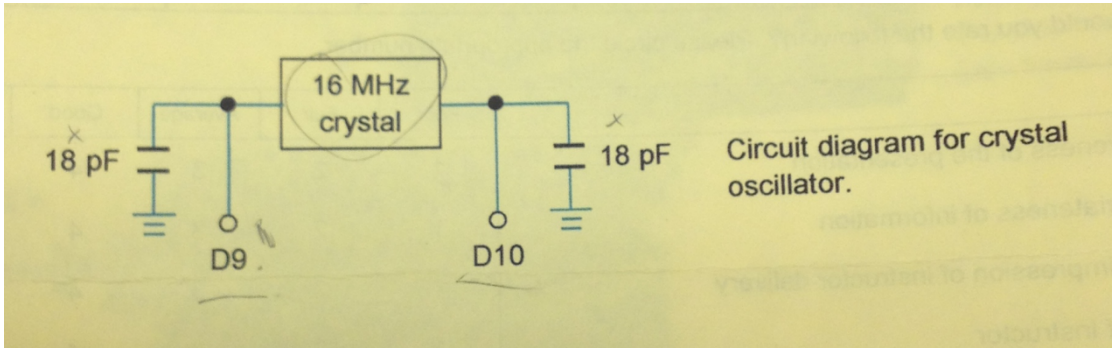

## Part Three: Chip voltage regulation circuit:

This is used to stabilize the voltage from the chip at a constant voltage of 5V.

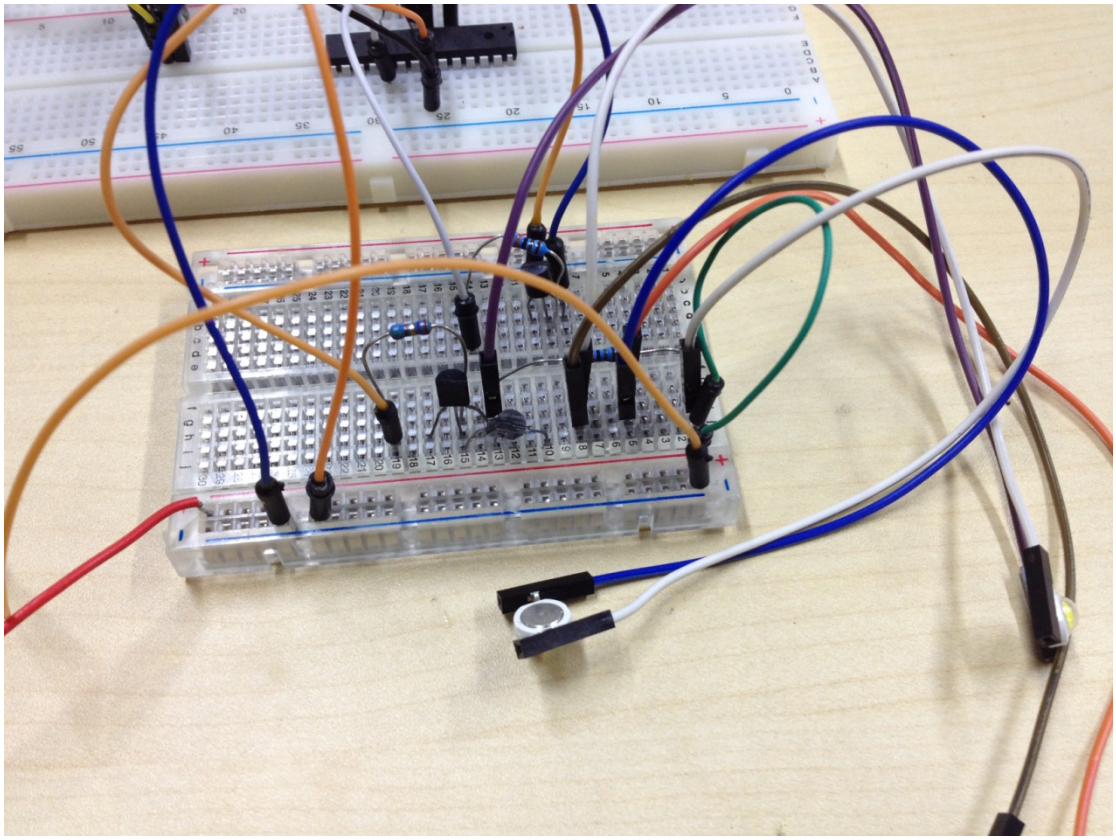


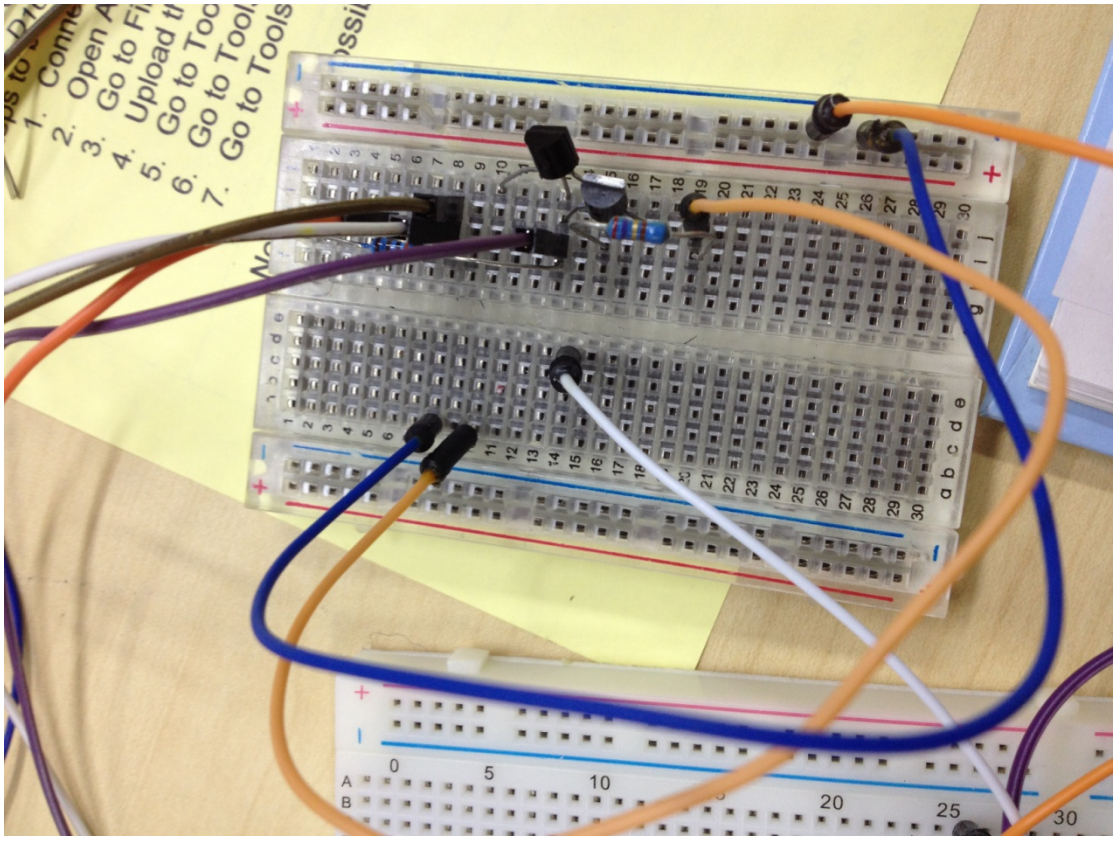
Part Four: Crystal oscillator circuit:

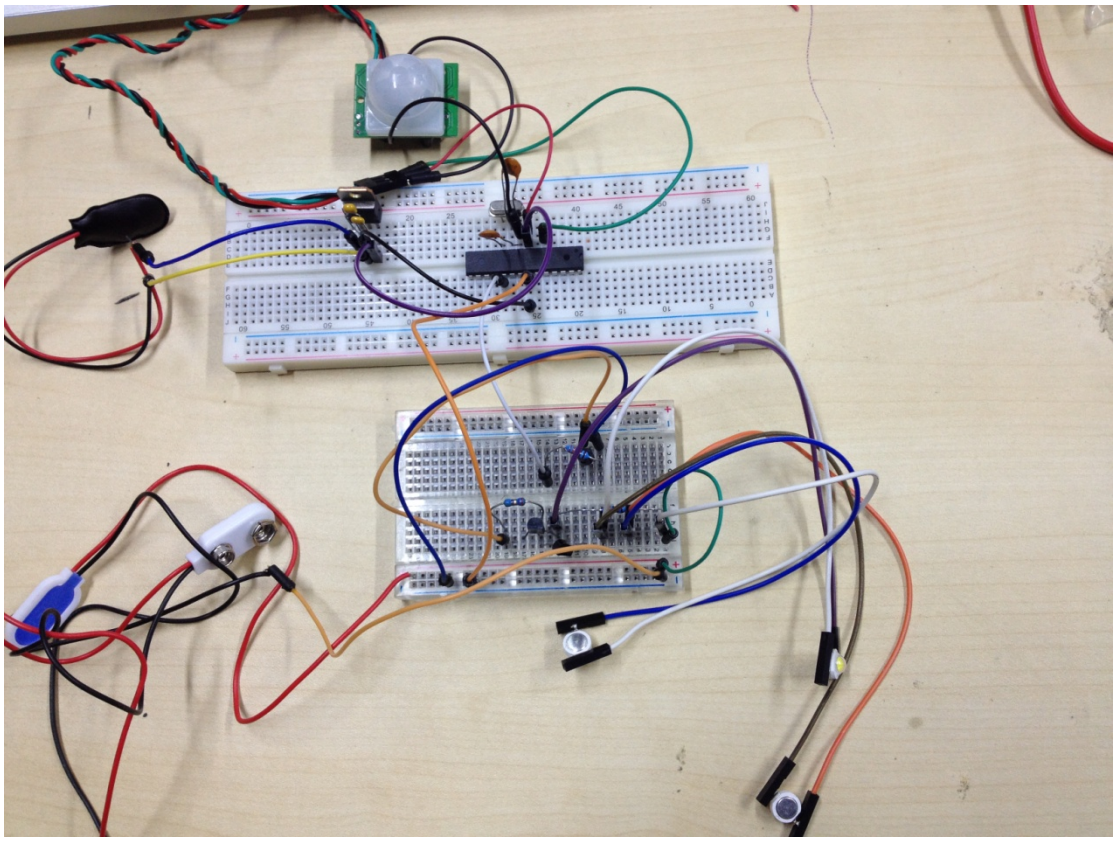
This is used to speed up the operations of the chip.



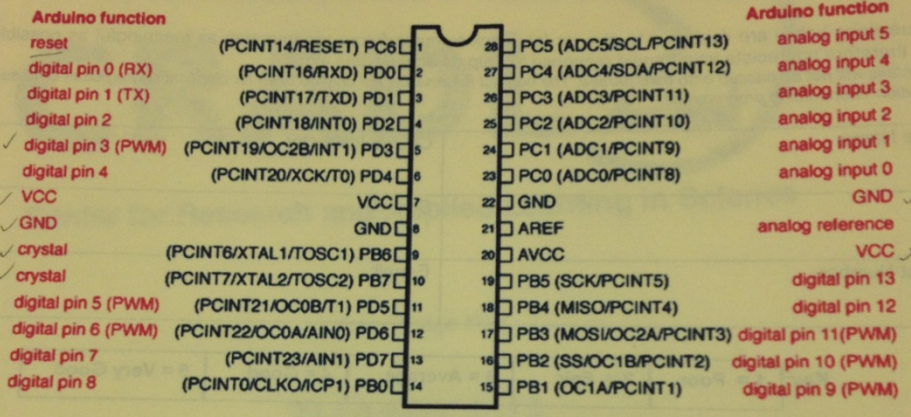

## 3. Prototype pictures (after boot-loading):





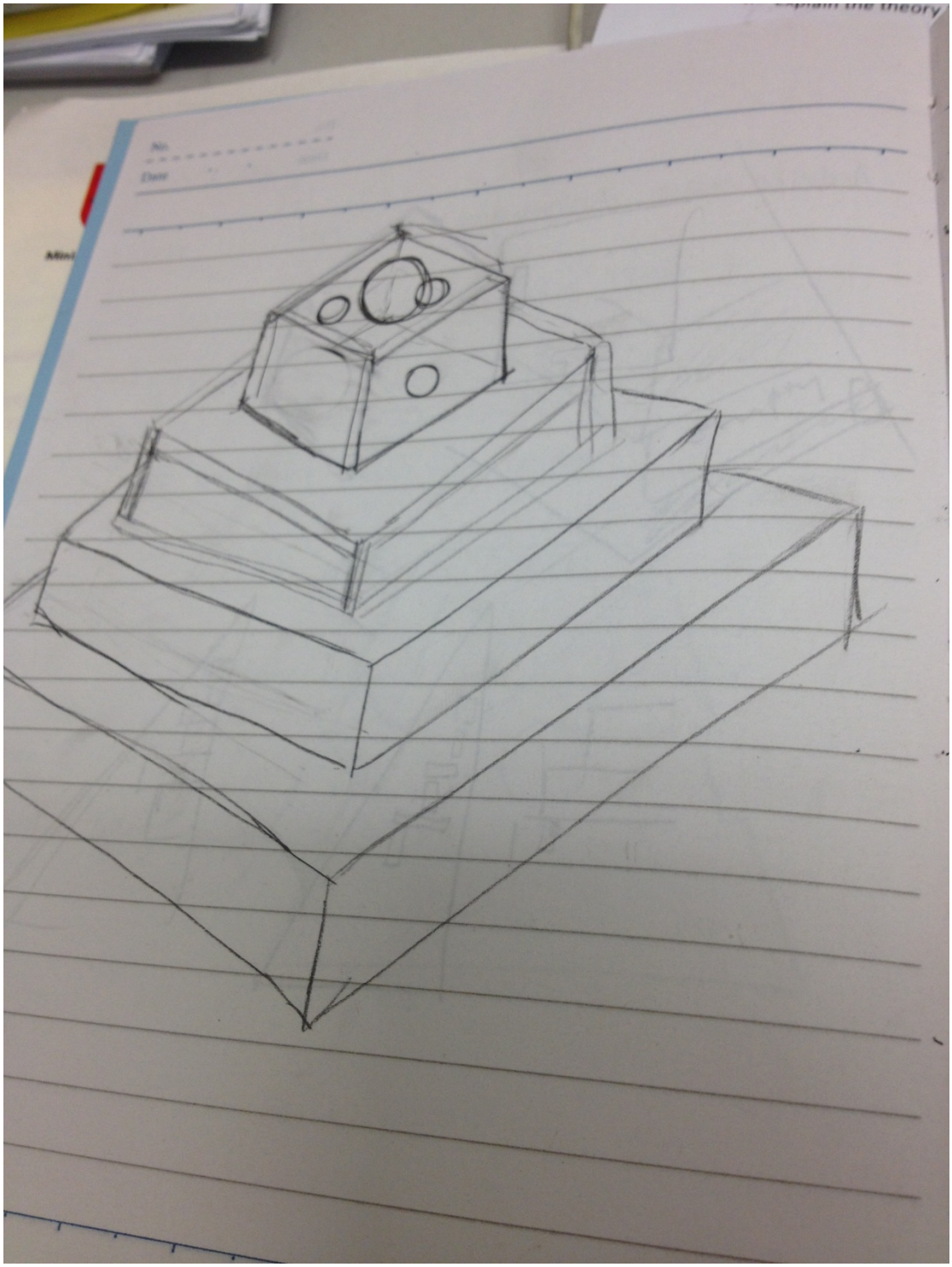


## ATMEGA328P-PU Chip to Arduino Pin Mapping



## 4. Designing case:

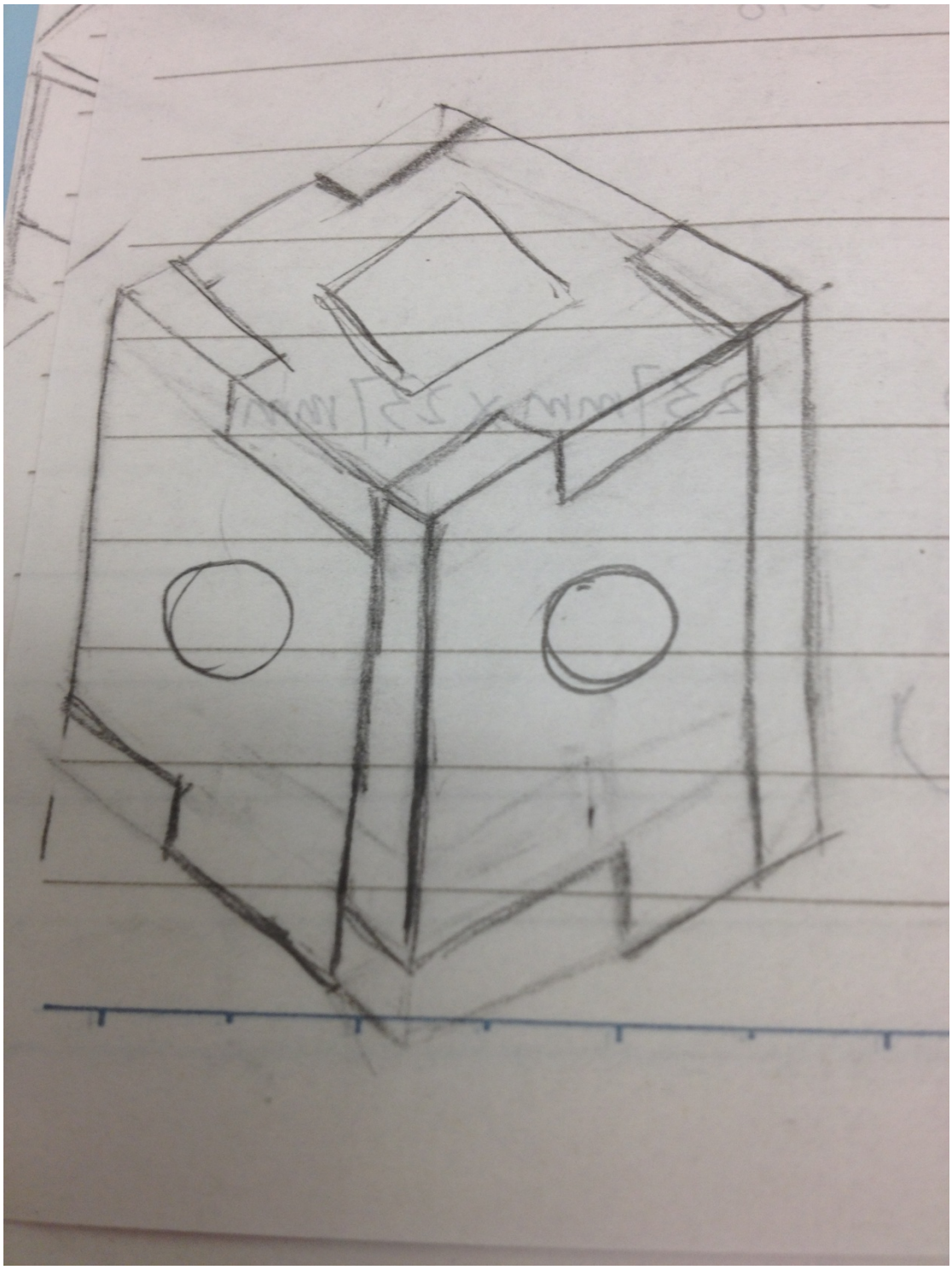
My idea is to design a pyramid, the problem is that there will always be gaps between two slanted boards. I solved the problem by stack boards of different sizes together which will eventually give us a Maya Pyramid.



(In real application, it will be upside down)

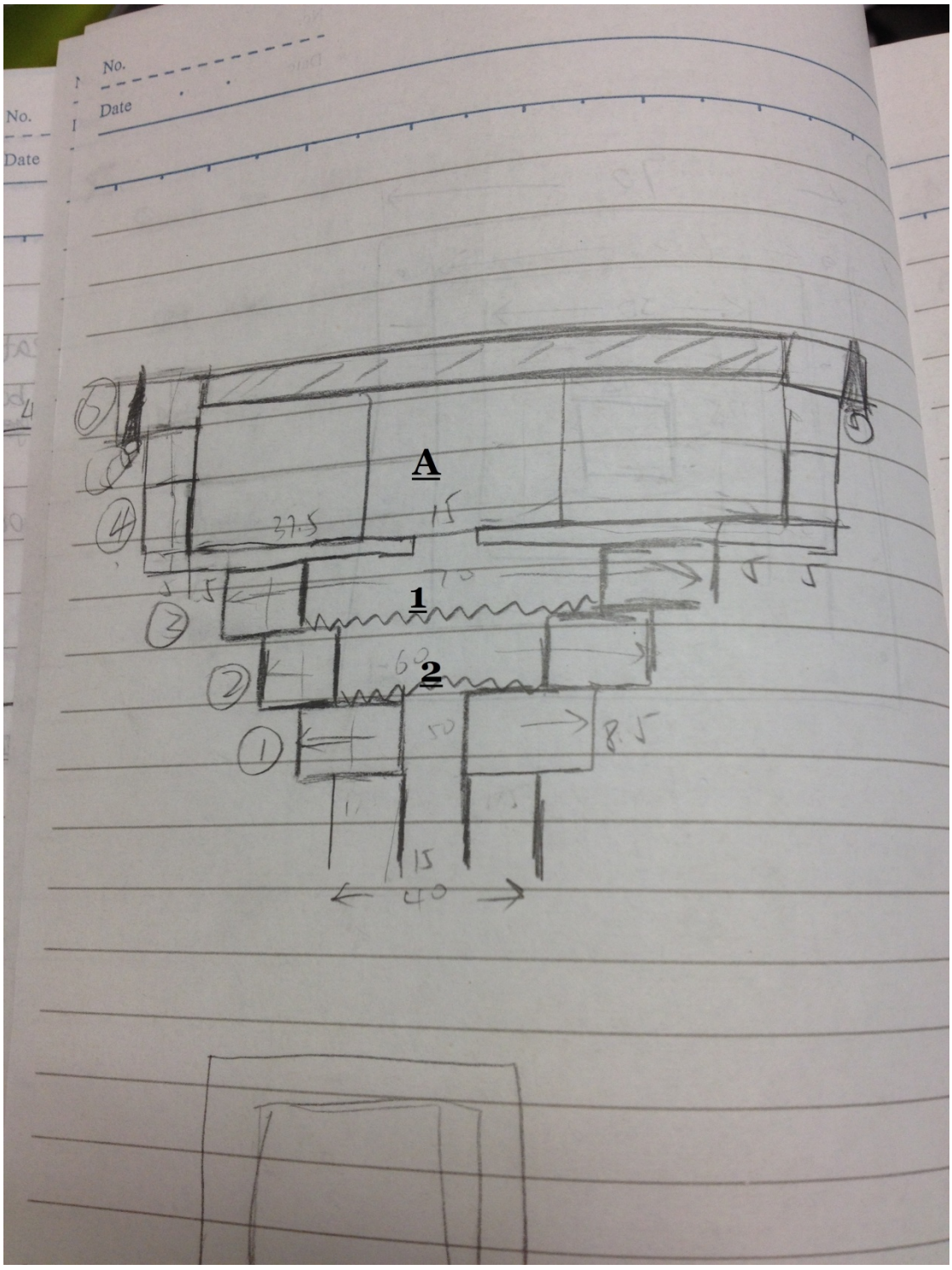
## Part One: Cube box:

I put the sensor through the hole on top, and three LEDs through three holes on the side of the box. "Puzzle Method" can build this cube box. I use the software "Autodesk CAD" to do the drawing (*which can be found in the attached documents) and the laser cutter to cut.



## Part Two: Pyramid:

I stacked six 8.5mm board together as the diagram shows. Zone A is an empty space to place the battery. Due to the limited space, I must solder everything onto two boards, one connected the battery, chip etc. at position 1, the other connected sensor, LEDs etc. on position 2. Besides all these, I attach the pyramid to a ceiling, using screws.



## 5. Application in real life

At night, it is always a trouble for people to board or alight the bus. Though there was light inside the bus, the bus stop is still very dark, thus the stairs are not clearly seen. This will be a potential threat to the safety of the passengers, especially for the elderly and the handicapped. Therefore, the product can be fixed on the ceiling near the bus door. When people board or alight, the PIR sensor will sense their motion and the three LEDs will light up at the same time. Similarly, this function can also adapt in a building(doorway), a cab (when the driver gives changes).



End of the Technical Report