Interactive Periodic Table

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1. Abstract

This paper emphasizes the advantage of how tangible interaction makes education more creative and fun. The Interactive periodic table is a blank periodic table, where the student can identify the element and its position by placing a marker over it. Using the tangible periodic table, student can learn about the element and its position with a fun game rather than reading from a book. Additionally this system gives students a challenge to identify the elements and its position in the periodic table, thereby helping them evaluate their periodic table knowledge. The entire system is developed using LabVIEW.

Keywords: Augmented Reality, Tangible interaction, Periodic table, Chemistry, Usability testing

2. Introduction

One of the major challenges of chemistry students is memorizing an elements name and its atomic number (i.e. position of element in the periodic table). It's not an easy task to remember around 117 elements and their position. My project provides a solution to this problem.

The use of technology in education enables learning process to be more effective, intuitive, simulating and meaningful to the student. My main aim with this project was to help students learn about periodic table in the form of a game. It makes teaching students about periodic table a fun experience. My approach has the potential to help students learn and interact with periodic table in a better and intuitive way. Its simplicity and ease of use makes it suitable for students of all ages.

The goal of Interactive periodic table is to help the student locate and identify position of an element on a blank periodic table. This system evaluates a students' knowledge of periodic table by asking questions about periodic table. Student can answer questions simply by placing a green marker over an element's position. Also this system will show an indicator whether the answer is correct or not. At the end of the quiz, the system also grades the student's performance.

2.1 Design and Development

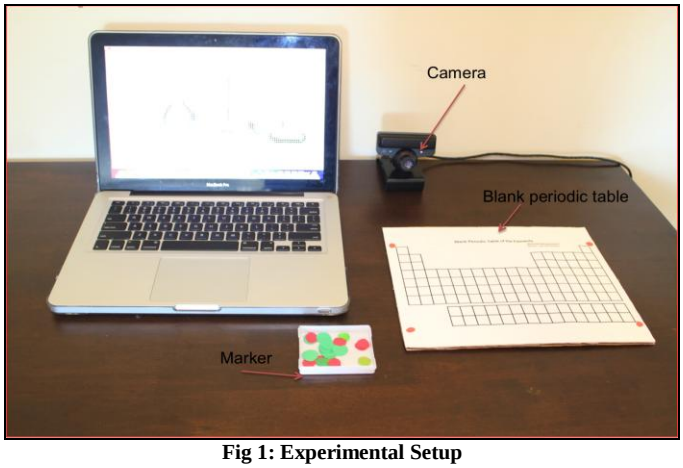

Fig 1: Experimental Setup

The basic purpose of this project is to help students learn more about periodic table and its elements through entertainment. With the help of advanced image processing technology information about the surrounding real world becomes tangible and digitally tractable.

For the purpose of input, a blank period table is used which will help the user to effectively select the elements using the green markers. The user has to place the marker on blank periodic table in order to identify an element. The position of the green marker is detected making use of the image processing library in LabVIEW.

3. Implementation Process

The following section describes the various phases involved in developing this system. Section 3.1 covers the periodic table tracking; section 3.2 involves element identification and section 3.3 involves creating user interface for the element position identification quiz.

3.1 Periodic table tracking

This is the very first step in building an Interactive periodic table. As part of this I used a blank periodic table and placed four red markers along the four corners of the periodic table. For tracking the table I used the Image processing toolkit library which allows marker identification, position determination and orientation calculation. After the identification of markers I created a bounding box through the markers to give an effect of the paper being tracked.

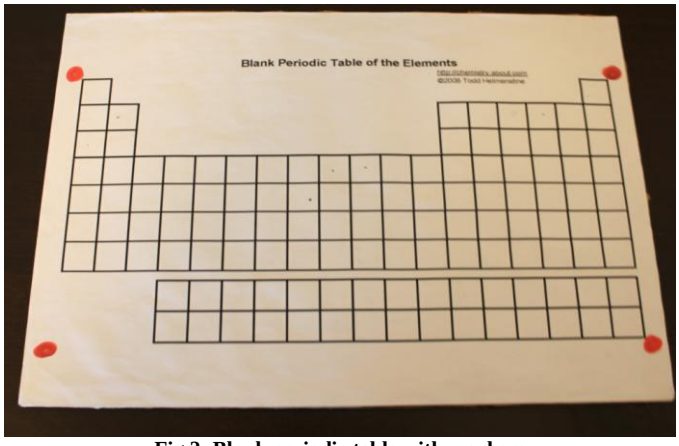

Fig 2: Blank periodic table with markers

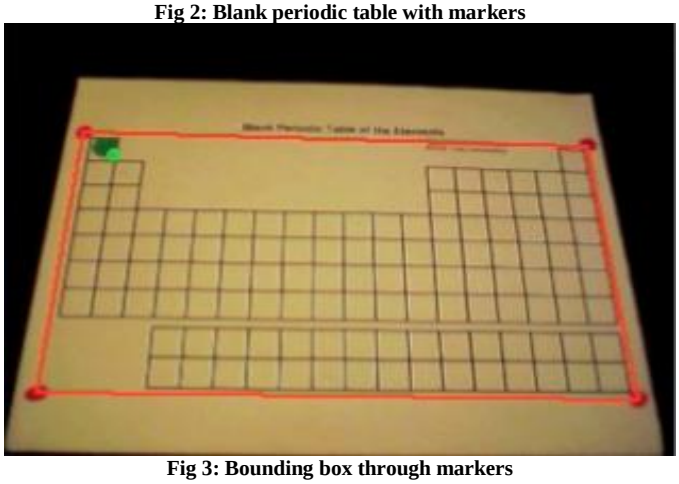

Fig 3: Bounding box through markers

3.2 Element identification:

After tracking the periodic table the next challenge was to identify an element and its position on the periodic table. Below is the algorithm I used to implement this:

3.2.1 Detecting green marker position

a. Identify the green marker on the periodic table using Image processing toolkit library.
b. Estimate the position (x,y coordinates) of green marker using the BigestBlob.vi provided as a part of LabVIEW Image processing library.

3.2.2 Calculating the distance of green marker relative to each corner

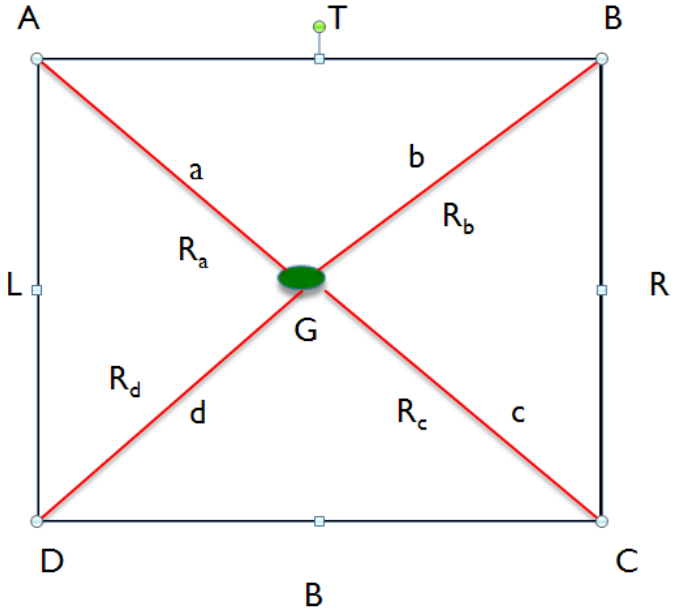

Fig 4: Element position calculation

G: Green marker point
A,B,C,D: Four corners
T,B,L,R: Four side
a,b,c,d: distance from corners
R_a,R_b,R_c,R_d: Relative distance from point to corners compared to two closest sides

a. Calculate the distance between corner-to-corner points (A to B, B to, C to D, D to A). Using the distance formula:

$$D=\sqrt{(x2-x1)^2+(y2-y1)^2}$$

b. Calculate the distance from green marker to each corner (G to A, G to B, G to C, and G to D). Using the same formula as above.
c. Calculate the Relative distance from point to corner compared to two closest sides. (G to A compared to T and L, G to B compared to T and R, G to C compared to R and B, G to D compared to B and L).

Relative distance formula: $R = D1/(S1+S2)$

Where D1 is the distance from point to corner, S1 and S2 are the two closest sides.

3.2.3 Creating Look-Up table and store elements name and its position

a. Create a csv file with field's element name and position. Element name is the name of 117 elements in the periodic table. Element position is the actual position of the element in the periodic table which is calculated based on the relative distance from point to corners. Create a 2D array in the front panel of vi and call the csv file into that array.

3.2.4 Identifying the element

a. Calculate the new green marker position.
b. Call the distance function for the each row in the look-up table.
c. Look for the minimum distance for the all the rows in the look-up table.
d. Fetch the element name of the minimum distance row in the look-up table.

This algorithm helps in reducing false detection such that any table movement and camera height changes won't influence final result.

3.3 User interface creation

After tracking the periodic table and finding the element's position my next challenge was to create an interface for student to play periodic table quiz. As part of this I created an array of questions for student to identify an element's position on periodic table. I designed my interface in such way that on left hand side there is a small panel for showing the question and student can answer the question by placing the green marker on the periodic table. The live feed of the periodic table is placed next to the question panel section. After each answer student needs to confirm their answer by clicking the OK button under the question. The system also provides an indicator to show whether the student's answer is correct or not. For example if the student answers the question correctly the indictor will blink in green but if the answer is wrong the indicator will be in rest state. Interface also has a section to show the correct element name over which student has placed his marker. Additionally the interface also provides final score of students answers.

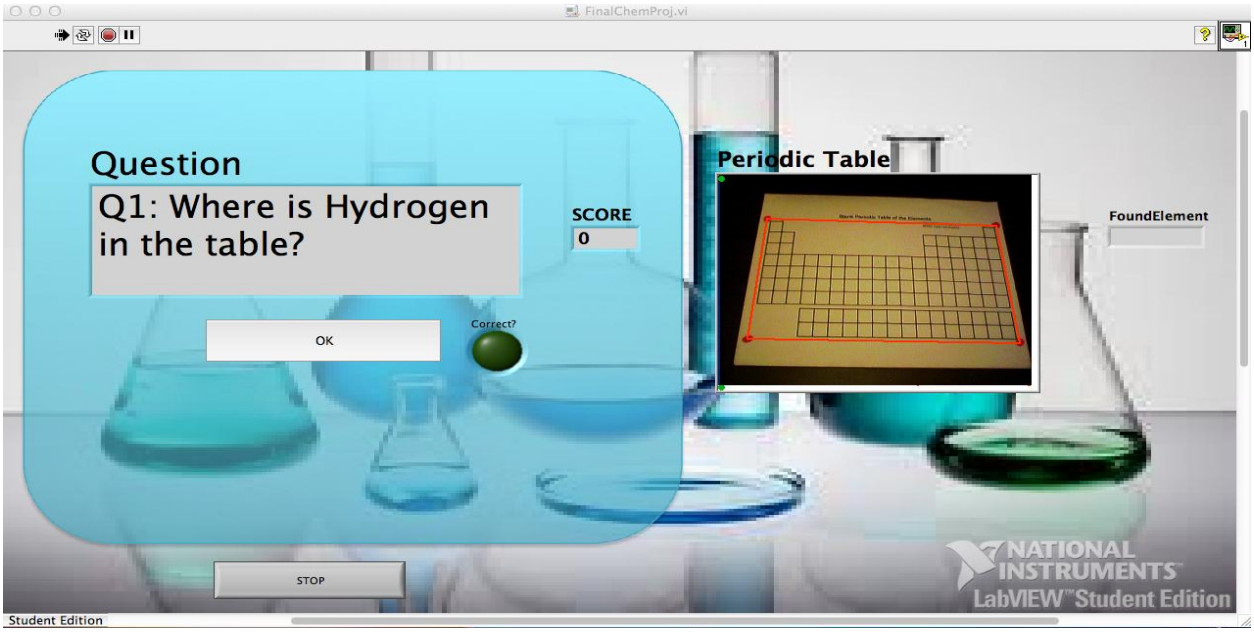

Fig 5: User Interface

4. Testing

As part of usability testing, I tested this system with two high school students and one Tufts undergraduate student. Participants 1 and 2 were high school student and were familiar with the periodic table, element name and their symbols. Before the actual test I gave a brief introduction of my system and asked them to play the quiz. During testing I did not give any instruction.

Below is the demographic information of users:

User #	Age	Computer Background	Area of study	Profession
User1	12	Frequent user	NA	Student
User2	14	Frequent user	NA	Student
User3	19	Expert	Computer Science	Student

4.1 Summary of Observations and Conclusions

Participant1:
Time taken: 4 Minutes
Suggestion: In case of a wrong answer indicator should change to red.

Participant2:
Time taken: 3:20 Minutes
Suggestion: Blank periodic table should display atomic number to make it easier to find an element.

Participant3:
Time taken: 1:40 Minutes
Suggestion: Score needs to be updated after each question/answer.

Participant 1 and 2 were high school students so they were familiar with the periodic table and elements. Also they were frequent computer users but were new to interactive and computer vision concepts and hence took some time to familiarize with the system.

The third participant was an undergraduate student at Tufts university and was familiar with the technology but had some difficulty identifying elements name.

4.2 Results

To conclude, I got many valuable suggestions from this usability testing. The entire testing exercise was very interesting and helped me to look at the system from both designer as well as a user's perspective. Users helped me to identify some areas which were missed during the implementation such as updating the scores after each Question and Answer, atomic numbers to make it easier to identify an elements position etc. Users gave both positive and negative feedback for some of the features and I will try to incorporate as many user comments in the future design.

5. Limitations and Future Work

Participants reported some limitations and problems during usability testing. Future research will be conducted to solve these problems. Beside that because of time constraints I was not able to implement some features as per my initial design:

Molecular Structure Formation: Augmented Reality system which aids in designing and interacting with the molecule structures by selecting elements from current periodic table.
Help option: Currently there is no help menu which can help a student in using this system.

Aswathy Dinesh

I received my Masters in Computer Science from Mahatma Gandhi University, India. I am currently working towards a Graduate Certificate in Computer Science at Tufts University. My interests include interface design and development.

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