بسم الله الرحمن الرحيم

Hardware Graduation Project

Dr. Sufyan Samara

Student Name	*Number ID*
Ibtisam Kharrosheh	*12028305*
Beesan Demaide	*12028733*

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Dedication:

قال تعالى: (قل اعملوا فسيرى الله عملكم ورسوله والمؤمنون)

Thanks to God first. Without His grace, we would not have reached this stage of success in our educational journey.

To the one who delivered the message and reached the nation, our Master Muhammad, may God bless him and grant him peace.
To the one who taught us success and patience... To the one who taught us to give without waiting.

To those who taught us and endured hardships to reach where we are.
To those whose prayers were the secret of our success.

To all our family members, friends, and companions.

To everyone who enlightened our path with knowledge and knowledge.

Here is this humble work.

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Firstly, we thank our supervisor, Dr. Sufyan Samara, for his continuous support and encouragement.

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Disclaimer:

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Abstract:

The game involves the player hitting the moles that appear in front of him on the table. There are five unique moles, each with a distinct behavior, such as laughing or spraying a small amount of water when struck. In addition, a special mole will appear during the game, rewarding the player with additional points when hitting it. The game will contain levels from easy to difficult, and the player's score will also appear on the screen.

In the second phase of the project, a robotic arm was added to the game to make it more interactive. The arm was programmed to identify moles by their color and then move to the correct position to hit them. Once the arm hits a mole, it adds points to the player's total score. Each level has a time limit, so the arm must move quickly to hit as many moles as possible before time runs out.

Chapter 1: Introduction

Statement of the problem:

The conventional games do not generally possess the qualities of being interactive or engaging enough, which will be able to hold the player enslaved towards it. This unique project aims at bringing this whack-a-mole game alive and making it with enjoyment, but also making it a few mechanical and programming riddle to fill the gaps in this kind of market. Moreover, the game helps in the development of some skills such as quick-thinking and hand-eye coordination, which add up to the challenge for the gamers. Apart from that, this project will serve as an effective educational instrument for a student who wants to learn about the practical parts of programming along with robotics and make an entertaining yet educational platform.

Objective:

Our game developed for availing creative ideas and practically applying the theoretical concepts studied in computer engineering for creating an interactive game. While it is fun, it is also quite challenging because the player has to strike the correct number of moles within a specific time frame so that collected points earn him the necessary speed. The game comprises so many entertaining activities which range from sounds to challenges and more, making it both fun and educational. Players can also go for a challenge with the robotic arm for collecting even more points. The game is based on the action of air pressure while the camera detects the location of the moles. Besides that, some pistons activated by compressed air are used; in this way, the mechanical aspect of the gameplay deepens.

Scope of work:

The project aims at designing and implementing an interactive Whack-a-mole game that exhibits various mole actions, including laughing and spraying water when hit. Multiple game levels will be created, wherein each level will be initially easy and subsequently become more difficult as players progress. A robotic arm that can recognize the mole by its color, swinging at it, will be mechanized. Moreover, a tracking system will show how many times players have appropriately hit the mole and how many lost points.

The project does not contain the development of any artificial intelligence that will predict mole movements or any connection to gaming consoles like PlayStation or Xbox. Also, it will not include some enhanced graphics effects with 3D representation.

The robotic arm will be capable of moving its arms in three dimensions using three motors: along the X-axis, Y-axis, and Z-axis. The hit will be administered by the means of a pneumatic piston. On the control side, a Raspberry Pi will be used for working and controlling the entire system. The project is inclusive of image processing, which may be accelerated and upgraded by adding other features in the future. By that virtue, this project initiates as an innovative and unique idea in the interactive gaming field.

Importance of the work:

Whack-a-mole game is important because it goes a long way in documenting the concept of dynamics and its practical application using Image Processing techniques, seeing it identifies colors that are a principal part of the game's mechanism. Core idea to implement the game is important seeing it connects scientific subjects like dynamics and programming, therefore students and developers get to know how to apply these concepts in an extremely entertaining and interactive context. The principle of air pressure used in the game, helps add a unique mechanical element, thus increasing user experience. The game also features a camera on a robotic arm used to track the movement and give more interaction for the player and the machine and show the seamless integration between robotics technologies and programming through a dynamic platform.

Organization of the report:

Chapter 2: Constraints, Standards, and earlier course work

2.1 Constraints

- *Hardware Limitations:*

There were some technical issues that came up while we were working on the project. It is important to note that the Raspberry Pi is not as advanced as most processors, so it is slower and this makes image processing difficult. Additionally, the robotic arm has difficulty in determining the correct position due to movement restrictions. Additionally, the air compressors are effective but sometimes their response is slower which causes the game to lag. Also, the camera depends on the lighting conditions which helps in identifying and locating the mole.

- *Cost:*

The cost of the project was somewhat high due to the number of expensive parts and also the presence of more than one part in the project from the air compressors to the robotic arm, which required designing and building them to have a number of motors and also designing them using a 3D printer, in addition to other parts of the water pumps and also the cost of the Raspberry Pi and its memory holder inside.

- Safety Constraints

There are certainly concerns when operating air compressors, as it is necessary to ensure that there are no leaks during work, and also because of the use of high voltage for the selector switch such as 220 volts, it was necessary to protect ourselves by placing packaging boxes on the relay parts for protection.

2.2 Standards

Using software such as the Raspberry Pi platform and Arduino IDE, the code is developed in Python and C++. Through them, the robotic arm and other parts of the project are controlled due to the presence of a number of libraries that are additional features to work well. To deal with images and keep the code clean, we also used libraries such as OpenCV.

2.3 Earlier coursework

- ☐ *Microcontrollers have helped us learn how to work with tools like the Raspberry Pi and Arduino, to control the arm, air compressors and other devices.*

- ☐ *Digital circuit design has created the path for how electronic components like motors, air compressors and other devices must be designed and connected in order to work very well.*

- ☐ *The use of image processing techniques allows objects to be identified and analyzed using cameras to determine the location and color of moles during play.*

- ☐ *Critical analysis is used as a troubleshooting tool for mechanical problems, such as in a robotic arm and in software improvements for smooth operation.*

Chapter 3: Literature Review

Games like Whack-a-Mole are fun because they require quick thinking and quick reactions. These games have been improved to make them more interactive and engaging. But this game is not only used for fun, it is also used to help people acquire new skills, such as improving hand-eye coordination and quick thinking. After conducting a number of studies, it has been proven that these games are useful for physical therapy because they help players practice moving quickly and accurately.

Adding a robotic arm to the game makes it more exciting and challenging.
There are a number of uses for arms in factories, such as picking up or collecting things, but when added to games, it makes them more interactive with the real player.

For this project, the robotic arm can move to hit the moles, making the game more interactive. Although controlling the arm is not considered an easy task because it requires high speed and accuracy to hit the mole before it falls, this is done by using tools such as Python to make the game work well.

Cameras and image processing:

Using the camera in the project to work on identifying the locations of the mole and detecting its color to process the images well. OpenCV libraries are used to facilitate working with images and identifying objects at the specified time. However, there are a number of problems that we face, such as poor lighting that may affect the camera's operation. Also, the Raspberry Pi is not as fast as the rest of the processor. Despite these things, its use allows the arm to track the mole and detect it.

Working on this project helped in learning about robotics, programming, and mechanical work. It combines many fields such as image processing from the camera, how to move the arm, and gaining practical experience in tools such as Raspberry Pi, motors, and air compressors.

Chapter 7: Result and Conclusion

7.1 Result

The game was developed to be operated by a robotic arm by determining the location of the moles using the camera and working to hit them based on the location and color. More than one system was integrated to work together, as mechanical operations were combined with the image processing system, such as air pressure, to make the game more difficult.

The game features a number of levels that may range from easy to medium to difficult, as each level is characterized by a faster reaction and a more accurate number of hits. Also, adding interactive elements to the project, including the laughing mole, water spray effects, and points collected in each level, increased the level of enjoyment of the project.

7.2 Conclusion

The project has proven to be a successful application of computer engineering terminology because it forms a link between mechanical design, robotic arm and programming to design the game well. The arm is used to detect and hit moles, which is a practical application for image processing, and also controls the operation of motors to move the arm and move the distinctive mole, which adds a distinctive feature to the game.

During the design, we faced a number of problems, including mechanical design problems and developing image processing on the Raspberry Pi, but solutions were found for such problems and practical experience was gained in tools such as Python, Raspberry Pi and air-pressured mechanisms. The project also achieves the purpose of entertainment and the ability to control the arm and motors and combine them.

Chapter 8: Discussion and challenges we encountered and their solution:

8.1 Discussion :

To create the project, we combined mechanical systems, programming, and robotics, which represent different aspects of engineering, demonstrating the power of combining different disciplines, as game design not only encourages entertainment and play, but also helps in quick thinking, accuracy, and problem solving.

This practical training during the project contributed greatly to deepening our understanding of engineering problems in the real world and how to deal with their solutions, use them and know how they work. Also, the theoretical knowledge we gained in our studies during the project, such as programming techniques, image processing and mechanical dynamics, was applied practically in a useful and rewarding way.

8.2 challenges we encountered and their solution:

8.2.1 Image Processing Limitations:

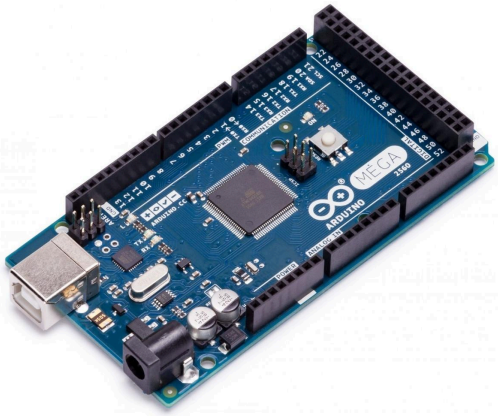
Poor lighting affected the camera's ability to detect and locate moles, so we used OpenCV libraries and also improved the code by reducing the frame in which moles appear to work to speed up the vision and distinction of moles.

8.2.2 Mechanical Design:

The movements of the robotic arm were not accurate enough and its ability to know and identify the position in which moles might be located was not easy to define, especially in programs such as Arduino IDE, so a special Uno was used for the arm, which is loaded with libraries for the UGS program that give the correct location for the appearance of moles and thus train the arm on them.

8.2.3 Safety Concerns:

Operating air compressors and high voltages poses risks during testing and play, so we encased the components and air pressure parts in protective cases to prevent contact and then implemented safety systems during operation.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