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Android + Arduino Wirelessly Controlled Labryinth

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Abstract - *The transmission of information between two or more points that are not bound by an electrical conductor is wireless communication. The radio is the most popular wireless technology. IR wireless networking, satellite communication, broadcast radio, microwave radio, Bluetooth, Zig-bee, etc. are the main forms of wireless communication. This thesis proposes wireless communication using the Bluetooth module HC-05 and Bluetooth interfacing with Arduino. This thesis discusses the working concept of an Arduino board and its implementations. The Arduino board can provide a fast tool for VLSI test bench growth, particularly for sensors. Fast processing and a quick interface are the key advantages. Today , the number of people using open source software and hardware devices is rising. Technology adds a new dimension day after day by making difficult problems seem simpler and more interesting. Such open sources, highly accurate, have free or basically low costs. Mobile apps are an increasingly growing segment of the global mobile industry in the developing world of technology. In order to give consumers a rich and fast user experience, mobile apps are developing at a meteoric pace. The layered Android mobile framework for the development of mobile applications is discussed. The purpose of the work is to develop a Labryinth Maze that can be run with an Android Application. The Labryinth Maze is managed wirelessly using an Android smartphone.*

1. INTRODUCTION

Labyrinth is a physical skill game consisting of a box with holes on top of a labyrinth, and a steel marble. The aim of the game is to try to tilt the playfield, without letting it fall into any of the holes, to direct the marble to the end of the maze. A suspended maze surface that rotates on two axes, each controlled by a knob, is featured in some versions of the game. Instead, an Android app is used to wirelessly navigate the labyrinth maze. Bluetooth is a form of wireless communication used using radio waves to transmit voice and data at high speed. It is used by several different types of devices for short-range radio communications, including cell phones, computers and other electronics. There is a range of about 10 meters for the Bluetooth module and a data transfer rate of 3 Mbps. One of the leading and most widely favoured mobile phone systems is the Android operating system. Due to their size and portability, the affordability of smart phones is growing day by day. To monitor the Labryinth Board, the android smartphone must be tilted. This project uses an Android framework with the ability to monitor any form of computer that uses Bluetooth to provide remote access from a smart phone. The Arduino is an open source microcontroller that can be easily programmed, disabled and reprogrammed at any time. The Arduino platform, launched in 2005, was developed to provide hobbyists, students and professionals with an affordable and simple way to build devices that communicate with their environment using sensors and actuators. It is an open source computing platform, based on simple microcontroller boards, that is used to build and program electronic devices.

2. METHODOLOGY

The main objective of this project is to demonstrate and conduct serial communication between the Bluetooth module and the Arduino. The methodology is kept as basic as possible. Before designing the project, few aspects such as cost-effectiveness and flexibility in design, structure etc. were taken into account. Our system aims to achieve the target to design a system that can provide following functionalities with a simple and easy-to-use interface. The main objective of this project is to provide highly efficient Arduino and Bluetooth communication so that any form of Android device can be connected to the board to send and transfer data from one end to the other.

2.1 Hardware

The system consists of following hardware:
a) Arduino UNO (ATMEGA 328P)
b) Bluetooth module (HC-05)
c) Smart phone
d) Stepper Motor
e) Breadboard and jumper wires
d) Wooden boards, nails and keyboard rods.

The Arduino UNO Microcontroller is going to serve as the maze board's brain. The microcontroller will determine the board movement. The Arduino UNO includes an ATMEGA 328P microcontroller chip.

Fig -1: Arduino UNO

The Bluetooth module will serve as an interface between the microcontroller and the smartphone. For the device, we will use the HC-05 Bluetooth module that can be used as either a receiver or a transmitter. Generally, our transmitter will be a mobile phone and the Bluetooth module will be the receiver. The Bluetooth module will provide the microcontroller with the commands issued by the smartphone.

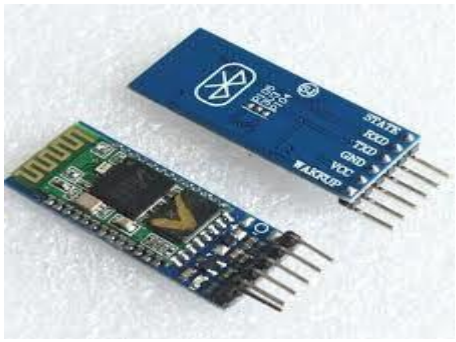


Fig -2: HC-05 Bluetooth Module

The servo motor is usually a simple DC motor operated with the aid of an external servo mechanism (a traditional closed-loop feedback control system) for precise angular rotation. It is connected to the microcontroller and the servomotors are fixed with the wooden panel in the design to allow angular rotation in the axis of x and y.

Fig -3: Servo Motor

2.2 Software

Arduino software is used to provide the microcontroller with instructions for all the functions of this device. The programming language 'C' for encoding is here. The software is written in C language to implement this project. Using burner tools, the programme is burned into the microcontroller. The software is stored in the microcontroller's EEPROM, which is located on the Arduino board. The data and instructions for going forward, backwards, left and right are put through this program.

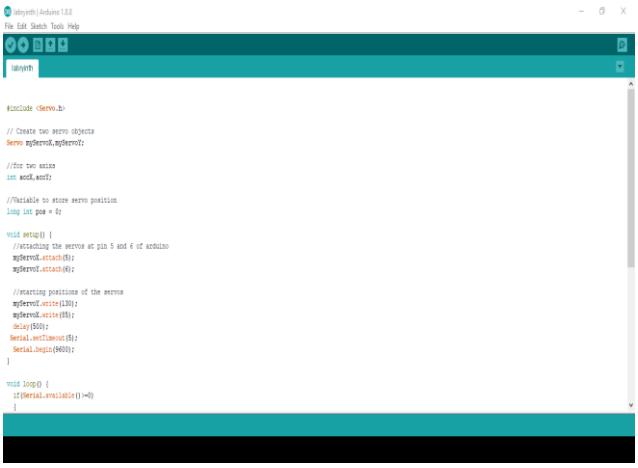


Fig -4: Arduino IDE with source code

MIT App Inventor is a drag-and-drop visual programming tool for designing and building fully functional mobile apps for Android. A screenshot of the softwares interface is shown below.

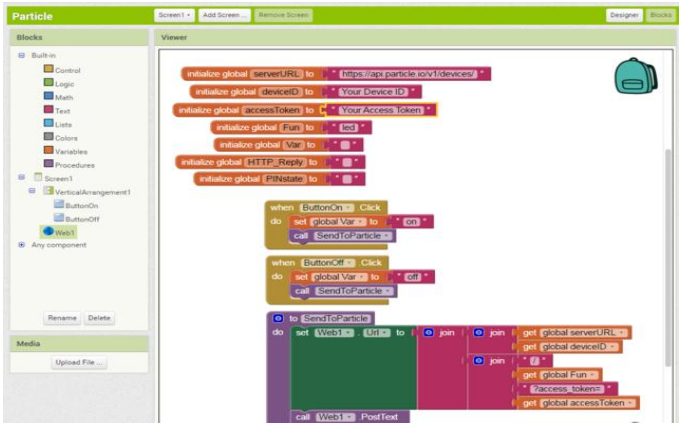
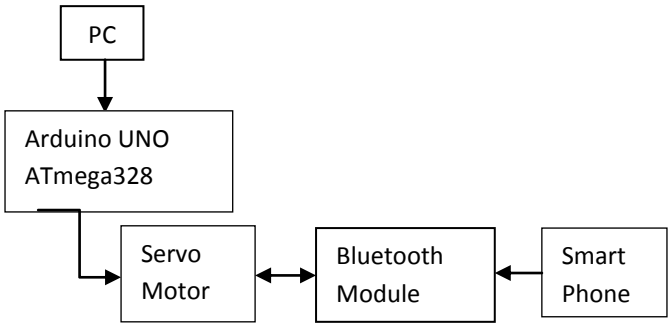


Fig -5: MIT App Inventor Interface

2.3 Block Diagram



3. Implementation

The proposed project consists of the following three sections:

a) Input section
b) Microcontroller section
c) Output section

The input section consists of the Android application built on the MIT App inventor which will be interfaced with the HC-05 via the microcontroller section comprising of Arduino UNO. Finally, the movement of the board designed is the output section.

4. Hardware Design

The hardware is the heart of this project. It consists of mainly a base and two pillars to hold the frame. There are a variety of materials that fit our requirements but we choose only the most appropriate one. We opted for durable wood. It was light and easy to handle while cutting and modifying to fit the size we required. A handsaw was enough to cut and shape the wood as per the required dimensions. It mainly consists of six rectangle pieces which made up the frame on four sides and two pillars to suspend the frame in the air. There is a need to join the frame to the pillars but also allow it to keep it moving. So for this, two screws were used on the two ends to connect the frame to the pillars. The Y axis of the project was successfully created.

Now for the X axis, we need to cut out a flat piece of wood which would eventually hold the maze in place, acting as a base for the maze. We need to connect this flat piece of wood to the frame on the other axis of the frame, adjacent to the one we connected the pillars to. Here again we used a pair of screws on either side and made sure that they are joined well but are also movable for motion. We also applied oil to these joints to smoothen out the motion. All the dimensions started from first selecting the size of the flat piece of wood that would house the maze. For this we used an A4 paper as a template and worked our way around it.

There was about 1.5 –2 cm spacing between the flat wood piece and the outer frame. That way there was enough room for movement. Once the flat wood piece and the frame was completed, we decided to make the Base next. The Base of this whole project had to be strong to hold all the weight of the components and the other hardware parts. So the use of a durable thick wood slab that was previously used for a bed was necessary. This ensured longevity and durability. We simply took 3cms x 4cms larger than the frame for the dimensions of the Base.

Once the Base, the frame and the inner wood piece were done, we used recycled wooden rods for pillars in our project. The pillars were recycled from the frame of a bed. Therefore we were sure of its durability and longevity. The pillars were glued onto the base and the frame and wooden piece were screwed in to the pillars, therefore completing the hardware requirement.

Fig -6: The wooden setup

The next thing to do was to attach the two motors onto the hardware. These two motors would be responsible for controlling the complete movement of the hardware. One motor was to be mounted onto the frame, to move the inner wooden piece. This would act as the X axis. This motor will be responsible for the X axis motion of the board.

Place the motor onto the board with the help of double sided tape and regular tape to hold it in place. For the other motor, raise the position the motor was supposed to be place at with the help of a wooden pillar placed flat on to the Base. This raised the motor

making it easier to connect to the frame. The motor was place adjacent to the X axis motor onto this flat wooden pillar. This motor was to be mounted on the pillar to move the frame. This would act as the Y axis.

We decided to place the motor onto the flat pillar with the help of double sided tape and regular tape to hold it in place. The next thing to do was to make metal brackets that would physically connect the motors with the hardware. For this, we took the help of keyboard spacebar keys. Since keyboard spacebar keys are built to sustain millions of clicks, we knew it would be reliable and durable for our project. We used two different types of keyboard spacebar keys. One big and one small. The big one was used on the Y axis motor and the smaller one was used on the X axis motor, simply because of the distance between the motor and the frame/piece.

The Y axis motor was further away from the frame, compared to the X axis motor and the inner base. The way the X axis motor connects to the inner base was that we required to make only one 90º bend and it would stick flat onto the inner base. At the other end we made another 90º bend to fit into the motor blades. This was held down with paper and tape. The Y axis motor required some planning as to how to fix it to the frame. On one side we had to make a 90º bend for the motor blades and on the other end another 90º bend. This whole spacebar key was also bent in the centre by 90º. At the other end of the key, we had to attach it to the frame. For this I made a hole in the frame for the spacebar key to fit. But there wasn't any drill-bit that was small enough to make such a fine hole. Therefore we improvised. We made the smallest hole possible, but since it was still big, we used a piece of plastic and tape to cover up the size of the hole. We also modified that end of the spacebar key with another 90º bend to make it a hook.

The motor side key was also made into a hook with another 90º bend. This was then sealed from the outside with tape and plastic to ensure the hook doesn't come off. Once this was done, we were ready with the hardware part. Now we had to assemble the components and test the fitting and motion of the project. As soon as we connected the motors to our Arduino and started the test run, we realized that the motors weren't held down with enough force which made the whole motion very disoriented. There the motor was to be held down with more force. We also had to calibrate the motors with the position of the frame, so that it aligns with the phones orientation when connected. We initially planned to make use of plastic/metal brackets to hold down the motors. But this meant adding weight to the frame, which we wanted to avoid. Therefore to hold down the motors, we then used an instant adhesive. This seemed to have worked very well in stabilizing the motion and reducing the stutter, earlier caused by the motor. The motion was instantly smoother and controlled.

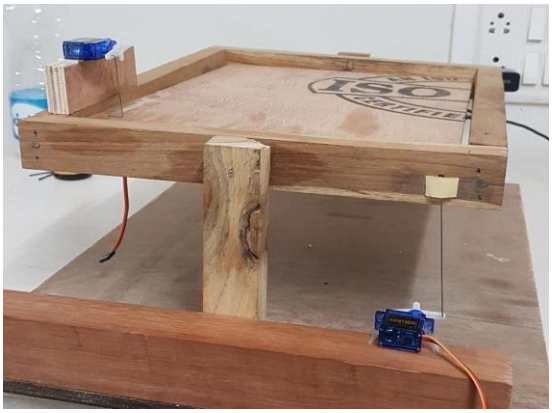


Fig -7: The setup with motors attached

Coming on to the maze, we decided to go with Foam Board. The design of our maze has a start and an end section indicated by different colors to make it look more attractive to the audience. We have placed a marble ball on the maze which will move as directed.

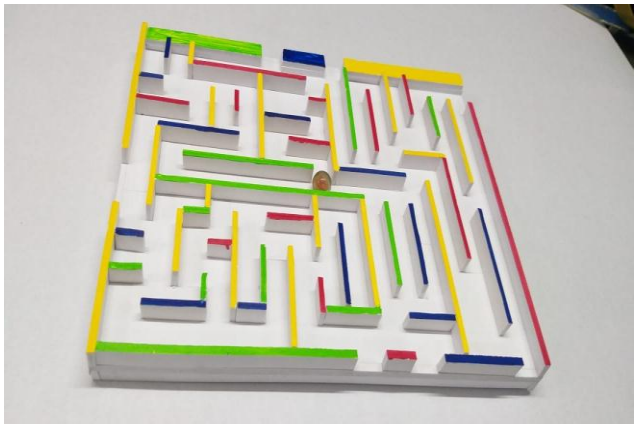


Fig -7: The Maze

4. Results and Analysis

We first started with identifying the three wires from the motors as Ground, Vcc and Signal. Ground was connected to ground of Arduino, Vcc of the motors was

connected to 5V of the Arduino and signal wires were connected to pin 5 and pin 6 for the two motors.

Next we setup the HC05. It has four pins that we needed to connect. Vcc and Ground were connected to the Arduino's Vcc and Ground. The transmitter (Tx) of the HC05 was connected to the receiver (Rx) of the Arduino, and the receiver (Rx) of the Hc05 to the transmitter (Tx) of the Arduino. For the bluetooth module, we had initially connected 5V.

Due to the voltage being too high, the bluetooth module did not work. After some analysis we identified the issue and changed the supply to 3V from the Arduino. After that the bluetooth module worked the way it was intended to.

When we connected both of them to the same voltage supply from the Arduino, we were having issues starting the motors and the bluetooth module at the same time. Only either one was on at one point. After some more troubleshooting, we realised that there wasn't enough current being supplied to the bluetooth module or motors at one point of time.

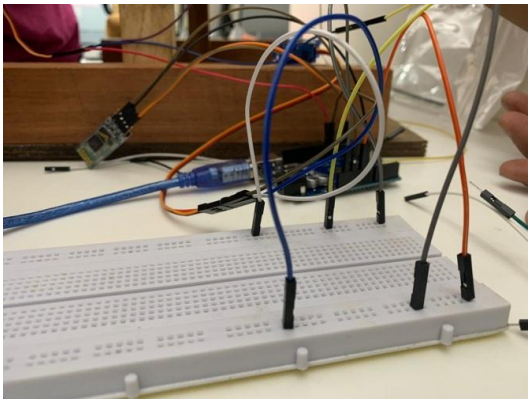


Fig -8: Breadboard Connection

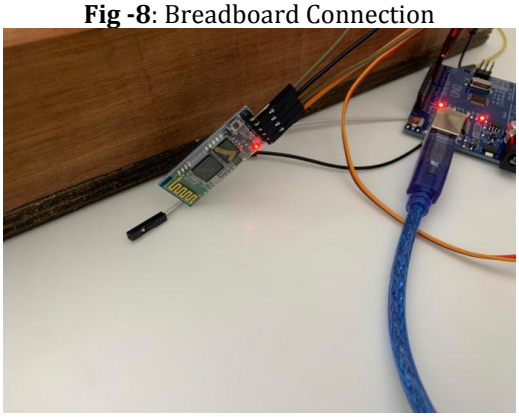


Fig -9: Arduino Testing and HC-05 interface

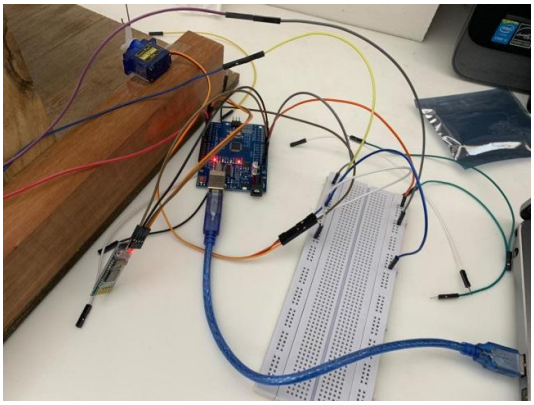


Fig -10: Circuit Connections

We resolved this by implementing efficient wiring using the same circuitry. After this both, the bluetooth module and the motors were receiving enough current to work as intended.

Fig -11: Result

4. Advantages, Disadvantages and Applications

Foam boards are lightweight and easy to cut and shape. It is ideal for model making, although foam board can be relatively expensive. Card clad foam board is - foam with thick card applied to either surface. It can be cut and shaped easily, using hand tools and light equipment such as fretsaws.

Foam board is acid-free and pH neutral. It is also non-toxic to humans. It is produced without CFCs, which stands for chlorofluorcarbon, a harmful ozone-depleting substance. The polystyrene panel and two paper sheets are fully recyclable and will therefore not end up in a landfill.

Foam board is extremely versatile in terms of usage. Foam board can easily be cut with a heavy-duty craft knife to form different shapes and forms. For example, you can use the material for model buildings, whether

residential, commercial or industrial. You can purchase it in many different widths and lengths that will easily facilitate common scale model sizing. It can also be used for various craft projects or even life-size cut-outs.

Foam board, when cut, provides a clean, straight edge. It offers a lightweight, strong and rigid surface for presentation statistics, charts and graphs. Because it is pH neutral and acid-free, it offers a suitable surface for the adhesion of photographs. Foam board is UV-treated, so it resists yellowing with age. Therefore, it can be part of long-term presentation needs. It is a popular material for interior signage for retail or commercial businesses. These boards are able to be transported easily and stored readily.

Advantages of Bluetooth Module:

1. Ease of use.
2. No LOS (Line of sight) required for data transfer.
3. Less power consumption makes its usage very practical.
4. 2.4 GHz radio frequency ensures world wide operability.
5. The data rate is high i.e around 3Mbps.

The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users.
It has various advantages as follows:-
1. Inexpensive
2. Simple, clear programming environment
3. Open source and extensible software
4. Open source and extensible hardware
5. Cross-platform

Our project is robust and easy to use system. There is no need for extra training of that person who is using it. All the control would be in your hands by using this home automation system. The schematic of Arduino is open source, for the future enhancement of the project board can be extended to add more hardware features.

The limitation that can be faced is that we have used Arduino UNO AtMega328 which specifically requires a CH340 driver. So we had to externally install a driver in our laptop. Even after installing the driver and connecting the microcontroller to the laptop, it worked properly the first few times and then it crashed. We understood that most of Arduino's sold are the clone versions. As soon as we realized it, we had to buy another Arduino, this time the original, which increased the costs.

Also we understood that HC-05 works on a specific amount of voltage, at first we went ahead with our discussed circuit but as soon as the voltage was supplied the HC-05 stopped working. Thus we had to buy a new one and slightly change the circuit to provide the HC-05 with appropriate voltage.

In this project we are using Bluetooth. In Bluetooth communication, the range of communication is less compared to radio communication. Also it is required to setup a reliable connection between the two devices. We are using wood to implement the base of the game and the maze. This is due to its low weight and ease of availability but it is prone to water damage. Whereas if we use metals, we will be increasing the weight of the project and thus the cost. Also we had to fabricate the complete mechanical structure ourselves.

The problems in terms of time and testing we faced during this project was creating our own bluetooth app for the communication. Due to bluetooth, the communication will be reliable but it won't be precise but we have ensured to make the connection and the movement as spontaneous as possible.

Applications:

1. Handheld device, music players, other electronic systems.
2. Wireless communication of devices like keyboard, mouse, printer, etc.
3. Wireless internet access using Bluetooth Dongle.
4. Home automation

5. CONCLUSIONS

In the communication arena, Bluetooth wireless technology is becoming a popular standard and is one of the fastest growing areas of wireless technology. Although a cell phone these days is clearly more than a phone, the number of apps being created on a wide variety of mobile phone platforms is incredible. Our primary objective is to implement this wireless technology into an immersive maze game. We have implemented the design and implementation of a low cost, reliable and scalable design model. Bluetooth communication between a smartphone and a microcontroller is feasible. It can be used to build robots with military applications on a big scale. This

allows for further application development based on the Android operating system. Such as sensor-based systems (accelerometer, gyroscope) etc. The creation of Android apps in the MIT App Inventor is simple and cost-free. With tremendous smart phone in markets, it is bound to have many more applications in near future. It is robust, sensitive and fast moving, hence can be applied in various other operations. As a conclusion we can say that, despite some of the problems, Bluetooth remains a very promising technology, with plenty of medium and long term applications. This technology is probably the only one which has a good chance to become widely available among mobile devices.

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