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Project Write Up and Implementation  
  
 Our project pertained to Smart Home technology and devices by implementing voice control with a smartphone to accomplish tasks with an Arduino UNO microcontroller through Bluetooth communication via a 1Sheeld module acting as an intermediary. The motivation for our project was due to my group’s fascination and interest in Smart Home technology. My partner and I both realized that Smart Home devices will become more and more popular and used in the next coming decade as more ordinary people will turn to technology and simple, easy to use devices to make their everyday, household daily routines and tasks easier to accomplish.   
 Our project had three hardware elements – an Arduino UNO microcontroller, a 1Sheeld module, and smartphone app. The 1Sheeld module used Bluetooth to communicate with the smartphone app, and it was directly stacked on top of (connected to) the Arduino UNO microcontroller so it could communicate with the microcontroller directly. The smartphone app has different functionalities that work with the 1Sheeld module, such as voice control, text-to-speech, internet and weather API, clock timing libraries, etc. This allows for the entire project to perform various tasks on the UNO microcontroller by using these 1Sheeld libraries which are compatible with the smartphone.

Our main learning objective and outcome was to first get a simple LED light on a bread board to turn on and off based on voice control through a programmed activating word spoken through the smartphone app. The smartphone app communicated with Bluetooth to the 1Sheeld module which toggled the pin on the microcontroller to alter the LED state. This learning objective was accomplished and we then focused on expanding our project to cover more functionalities such as the ones mentioned above. Next, we explored the 1Sheeld API’s to get the weather and traffic functionalities to work. This was accomplished by having a command be spoken into the smartphone which sent this data info via Bluetooth to the 1Sheeled module. The 1Sheeld module would use internet API library to communicate with the UNO microcontroller to use the internet API to receive the desired data (weather forecast, traffic information, etc.) and send that data back to the smartphone. The smartphone would then communicate tell the user the desired information. This learning outcome took a lot of trial and error as we had issues with the internet API’s and parsing the JSON information from the API back to the UNO microcontroller. Once we were able to print out the JSON data in order to figure out how to parse the data, our objective of using the internet API to perform these tasks was fulfilled as one of our learning objectives.   
 Another learning objective was using the clock functionality to set up alarms, timers, and timer broadcast with the 1Sheeld module. This was an easier objective as it only required the 1Sheeld module to fetch data from the smartphone app timer and had the smartphone app use text to speech communication to tell the user the timer information. (We didn’t get the alarm set up just yet but that is something we hope to do in future works, discussed later in the paper). Lastly, our objective of playing music was accomplished by using another API to fetch music streaming data for the smartphone as well.   
 The learning objectives were all accomplished, which fulfilled our learning outcomes, but we also had to learn how to set up and configure the hardware to work in the first place. It took a while to stack the 1Sheeld module on top of the UNO controller and configure the microcontroller and 1Sheeld to communicate (which involved a lot of trial and error with various 1Sheeld libraries). It also took a good amount of time to set up the smartphone application and have it read the 1Sheeld module and be able to communicate with it.

All of these learning outcomes took a lot of trial and error as well as research to understand how to accomplish our objectives. However, by doing this project, I learned way more about using different types of Arduino microcontrollers and how to read datasheets of different microcontrollers besides the Astar microcontroller we used in class. I also learned about the 1Sheeld module and its different libraries and function calls which can be applied to other Sheeld modules I might use in the future. Lastly, I learned how to use different API’s with 1Sheeld that can allow embedded systems such as the UNO microcontroller to perform various tasks. This was different than in class where we learned how to toggle bits on the microcontroller to perform tasks; instead, in this project I used libraries, function calls, and module API’s to perform various functionalities which I believe greatly expand my knowledge of embedded systems and give me more versatility when working with these types of hardware devices. Lastly, there was similarity with this project and things we learned in class, such as the external interrupts we used with our microcontrollers. We had a while loop that continued to listen until one of the commands was spoken into the phone by the user. After this command, the microcontroller would then execute the task based on the user command, and then go back to the infinite while loop. This was very similar to class projects with ISR’s, button and timer interrupts, and a main() infinite while loop that continued to run and wait for new interrupts. Thus, there was a lot of reinforced learning from out project that overlapped what I learned in this course with our Astar Atmega microcontroller projects and labs.

Future works of our project consist of building on and improving the current functionalities we currently are working with our microcontroller, as well as adding more functionalities and versatilities so that we can cover more Smart Home technology needs. The first aspect would include examples of traffic or weather functionalities that are more dynamic and “needs” based. For example, the location is hardcoded with the API for these functionalities so that the microcontroller will obtain weather and traffic information based on the hardcoded location that we put into the software aspect of our project. Instead, my partner and I hope to make our project more dynamic by having the smartphone obtain the global coordinates (by using something like Google Maps API) so that the user will be able to obtain weather and traffic information wherever there location is in the world. Moreover, the commands to set up the 1Sheeld interface are “glitchy” and not user friendly, as our command phrases and words must be spoken very clearly and in a quiet environment in order for the smartphone to pick up the correct words as well as the exact phrases in order to execute the desired task(s). We are hoping to somehow more the commands more fluid, so that the phone can understand what the user desires based on keywords (such as “weather”, and “traffic” instead of “what is the weather right now”) as this would allow the smartphone app to execute our desired tasks despite loud background noise or if the user says a similar, but not exact, phrase into the phone.

The second aspect of future works consist of adding more functionalities to the project. For example, the 1Sheeld module can add in tweets, make posts on social media websites, etc. We hope to add in these features in the future with out project. Furthermore, we wanted to add in sensors and bypass the smartphone app so that the sensors would directly communicate via Bluetooth to the 1Sheeld module if possible. This could be used for something like a door opening or closing, which would activate a sensor, and then would send a signal to the 1Sheeld module. This could trigger the UNO microcontroller to either toggle and LED light or make an alarm noise to let the user know that someone was opening or closing a door. This would be quite the enhancement to our Smart Home learning objectives and another future work we hope to one day implement with our current project.

Overall, our project overlapped with a lot of the coursework and topics we learned in our embedded systems class. Moreover, it also expanded my knowledge of embedded systems by using new hardware and different modules, libraries, and functionalities. The project was a great learning experience and I hope to continue to learn and partake in more embedded system projects in the future!

*References*

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