



Detecting Cosmic Ray Muons Using the Arduino and Raspberry Pi

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Abstract

The goals of the project is to setup the Arduino and connect it to the computer to view the simulated muon data, setup the Raspberry Pi to a monitor, and setup Dropbox in Raspberry Pi and automate Dropbox uploading so that the Arduino's data can upload to Dropbox automatically. To accomplish these goals, the Arduino and the Raspberry Pi need to be set up. Dropbox needs to be setup on the Raspberry Pi and then by installing programs, Dropbox will automate uploading on the Raspberry Pi.

Introduction

Cosmic Rays are high forms of energy radiation that have subatomic atoms called muons. Muons arrive at the Earth's surface are created indirectly as decay products of collisions of cosmic rays with particles of the Earth's atmosphere. The Arduino has a physical programmable circuit board and a piece of software that runs on the computer. The Raspberry Pi is a small computer that runs Linux operating system. The Raspberry Pi setup consisted of installing the operating system Linux in the Micro SD card. The goals of this project was to setup the Arduino and connect it to the computer to view the data, setup the Raspberry Pi to a monitor, and setup Dropbox in Raspberry Pi and automate Dropbox uploading so that the Arduino's data can upload to Dropbox automatically.



Fig 1. Image displays a cosmic ray shower. In cosmic ray showers, particles ionize produce electromagnetic radiation in the atmosphere.

Setup

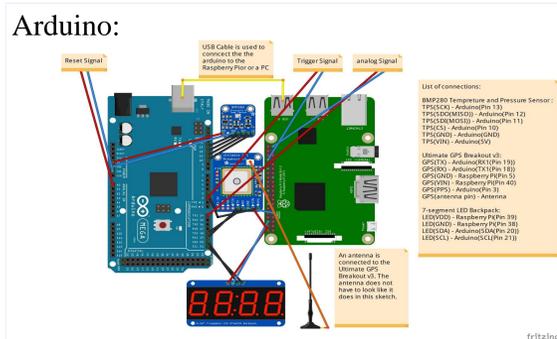


Fig 2. Displays the wiring for the Arduino and the Raspberry Pi. The outline consists of connecting wires on the Arduino circuit board MEGA 2560 and the Raspberry Pi.

- Programmed to read the data detected from the Cosmic Rays by a code.

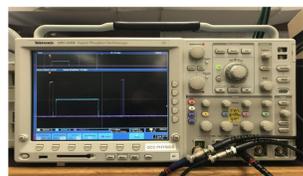


Fig 3. The oscilloscope displays data of the cosmic rays in square waves. The wires connected to the oscilloscope from the Arduino are the Analog, Trigger, and Reset outputs.

- The Arduino software needs to be installed and the code to detect muons needs to run.
- Arduino circuit board needs to be connected to the computer so the data could be displayed on the Arduino software program.



Fig 4. Displays how the circuit boards are wired based on the provided outline.

Fig 5. Shows function generators that simulate muons by creating square waves.

Raspberry Pi:



Fig 6. Shows the Raspberry Pi setup connected. USB ports connects to the keyboard and the mouse. HDMI was connects to the monitor and the power USB connects to an outlet.

Instructions

Dropbox on the Raspberry Pi:

- An account needs to be created on Dropbox or an existing account can be used.
- Install a program Dropbox Uploader by using Terminal (terminal is used to send commands to send to the computer).

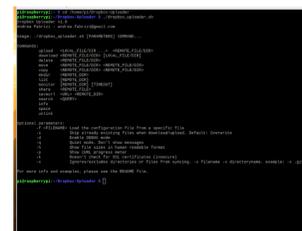


Fig 7. Terminal is open when Dropbox Uploader is open. The program demonstrates the various options a file can undergo.

- The program in Terminal will ask for a an access token.
- Clicking on "Create App" on the Dropbox website it will show Dropbox API and that will generate an access token
- Dropbox Uploader manually transfer files to and from the Raspberry Pi-Dropbox.

Automate the Dropbox Uploading:

- Installing a program crontab in terminal automates the transfer of files from the local file directory to the Dropbox remote file directory.
- Crontab allows the option of automating at a specific time.

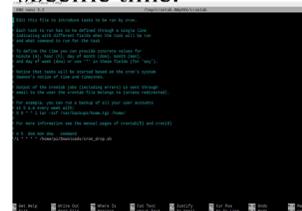


Fig 8. Terminal is open when crontab is open. This displays the how the time can be set to automate. Time set is 1 minute.

- Install a program named Processing in the Terminal of the Raspberry Pi.
- Processing allows the Raspberry Pi to read the data that the serial monitor displays on the Arduino program.
- This automates the data onto Dropbox when Processing is running.

Data

	Voltage	Hours	Minutes	Seconds	t	t1	Analog Output
967	1.5150	10	48	2	58663	741312	
970	1.5150	10	48	2	51777	757607	
973	1.5150	10	48	2	52891	773903	
976	1.5100	10	48	2	54004	798198	
979	1.5200	10	48	2	55118	806495	
982	1.5150	10	48	2	56232	822791	
985	1.5100	10	48	2	57345	839086	
987	1.5150	10	48	2	58459	855382	
990	1.5150	10	48	2	59573	871676	
993	1.5150	10	48	2	60686	887972	
996	1.5150	10	48	2	61800	904268	
999	1.5150	10	48	2	62914	920563	
1002	1.5150	10	48	2	64028	936860	
1004	1.5175	10	48	2	65141	953155	
1007	1.5150	10	48	2	66255	969448	
1010	1.5100	10	48	2	67369	985745	
1013	1.5100	10	48	2	68482	1002041	
1016	1.5150	10	48	2	69596	1018336	
1019	1.5100	10	48	2	70710	1034632	
1022	1.5150	10	48	2	71823	1050928	
1025	1.5150	10	48	2	72937	1067224	
1028	1.5175	10	48	2	74051	1083518	
1031	1.5150	10	48	2	75164	1099813	
1034	1.5200	10	48	2	76278	1116107	

- The data displays the voltage, hours, minutes and seconds
- Displays the temperature, pressure, latitude, longitude.

5minute-trigger:	Pressure	latitude	longitude	altitude	satellites
Temperature	63788.93	4045.4038N	7345.3666W	23.00	4

Conclusion

- After following the instructions on the final step to automate the Arduino's data to Success to automate the Arduino's data to Dropbox.
- Success of automating the data in 1 minute.
- The data only uploads to Dropbox when the program is running.
- Some errors occurred when following the instructions.

Acknowledgments

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References

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- Raspberry+Pi+3+Labled at DuckDuckGo, duckduckgo.com/?q=raspberry%2Bpi%2B3%2Blabled&t=raspberrypi&iax=images&ia=images&iai=https%3A%2F%2Fcodeclubprojects.org%2Fen-GB%2Fraspberry-pi%2Fgetting-started%2Fimages%2Fpi-labelled-names.png.