HONORS COLLEGE
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Arduino EFM: Developing a Microcontroller Powered Electric Field Change Meter for Lightning Research

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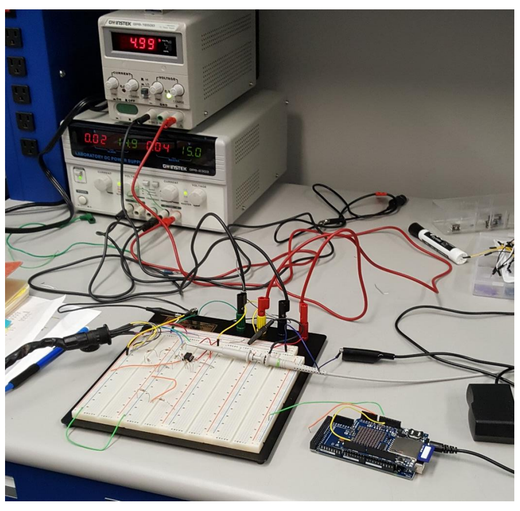
Introduction:

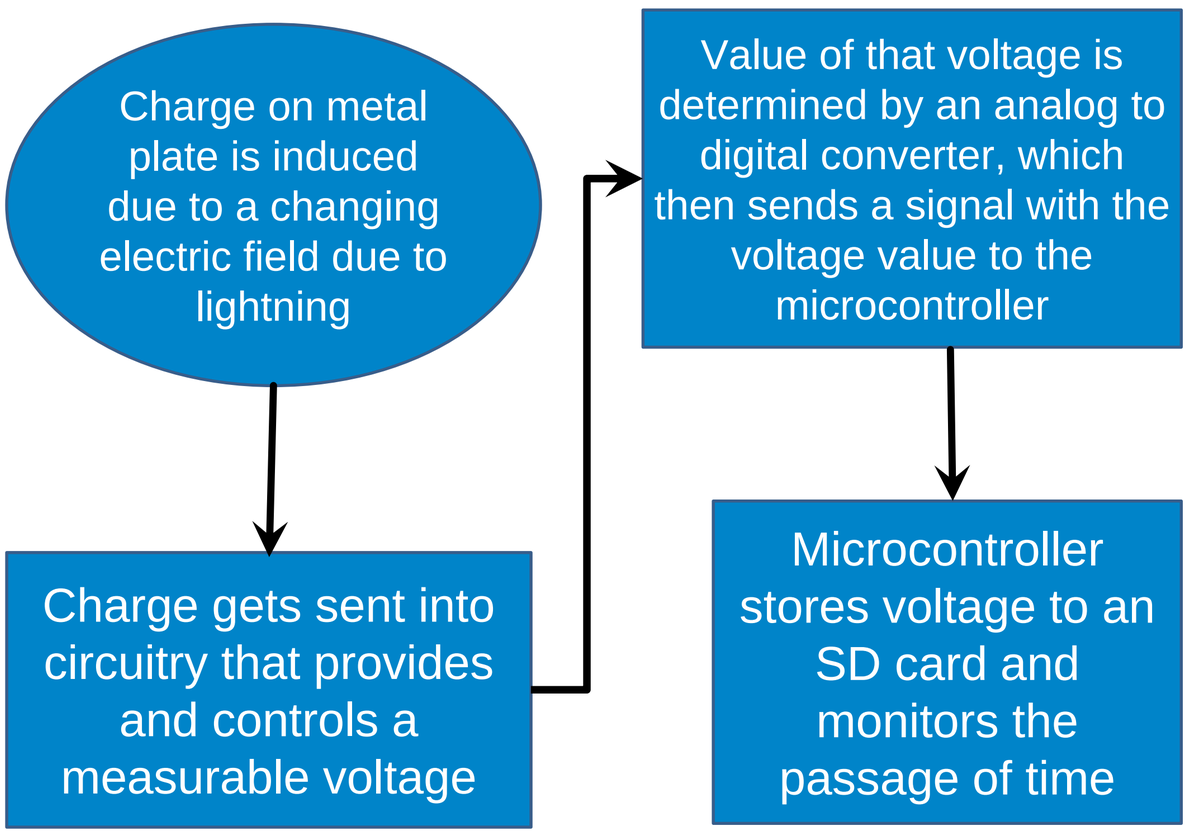
To better study lightning, scientists have developed sensors that detect changes in the electric field due to lightning strikes. However, electric field change sensors can be prohibitively expensive. One of the more costly components of a sensor is the digital acquisition system, which is typically a pricy desktop computer. This computer regulates the system and stores the data gathered by the device.

To help reduce the cost of lightning sensors, the Arduino EFM project set out to see if it is feasible to replace the often costly computers with fairly cheap microcontrollers, much smaller and simple computer chips. Microcontrollers require more programming knowledge and are more restrictive in what they can do, but they are significantly cheaper than the desktops currently in use.

As the data and resulting system shows, microcontrollers can be an excellent, cost-effective alternative for computers in situations where extreme speed is not required, thus drastically reducing sensor cost.

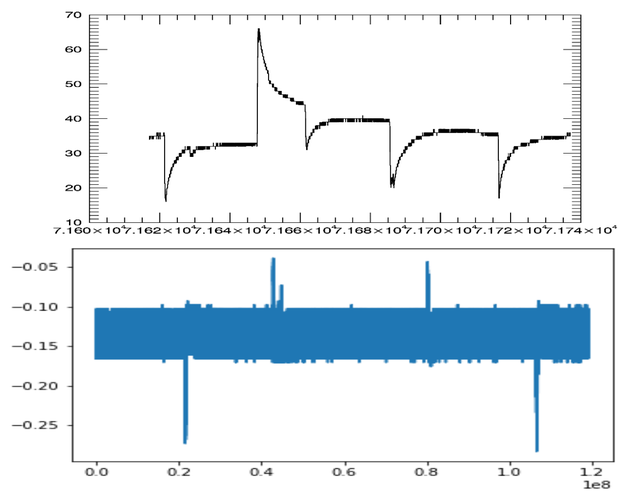
Sensor Operation and Design:



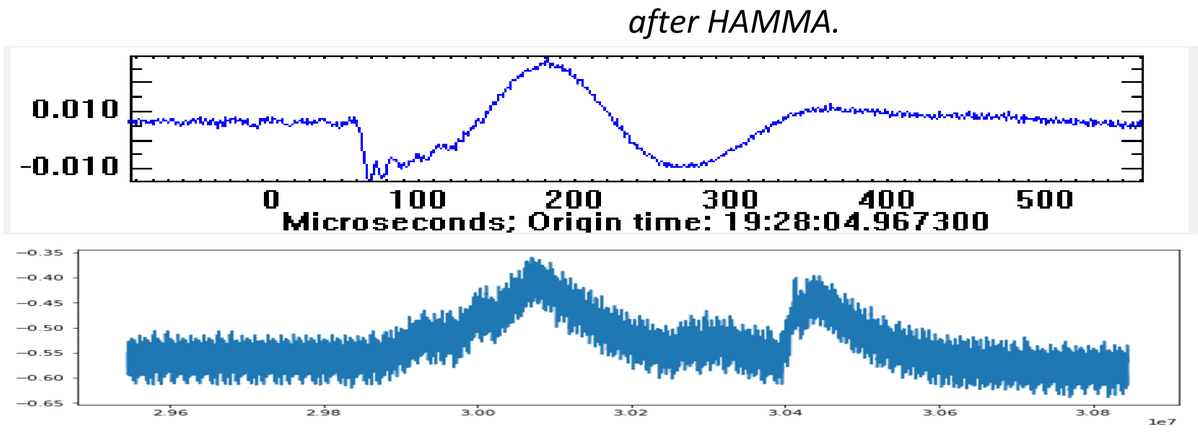


Data Analysis and Comparison:

To show that using a microcontroller instead of a computer is a feasible way to manage a sensor system and data storage, the project was compared to another electric field change meter in use at UAH, HAMMA, as well as an electric field mill at SWIRLL.



***Left**: Above is data from the electric field mill at SWIRLL showing the Voltage over 2 minutes; below is the same 2 minutes of data and the Voltages picked up by the Arduino EFM project. Sample is taken from 19:53:37-19:55:37 on 8/4/2017.*
***Below**: The top graph is the HAMMA data for a flash occurring at 19:28:04 on 8/4/2017 with Voltage over microseconds. The lower graph is the Arduino EFM data for that same flash. The units are the same, but the Arduino picked up the flash slightly after HAMMA.*



Impact and Conclusion:

As the data in the previous section shows, the sensor controlled by the microcontroller produces similar results to existing sensors that use computers. This similarity demonstrates the feasibility of using a microcontroller in situations in which extremely high sample rates are not required. Thus, the Arduino EFM project accomplished its goal of showing that microcontrollers are a feasible, cost-effective alternative to more expensive computers in controlling lightning detector systems and storing data.

In addition, there is a much broader significance for the scientific community at large. Although using microcontrollers for lightning sensors was tested here, any scientific sensor or detector that does not require any extreme specifications can use microcontrollers for their systems. Thus, most applications that require a computer to log data can drastically reduce their costs by using microcontrollers. Changing to microcontrollers would allow the scientific community to produce more sensors for less cost, meaning more data and potentially more findings. The success of this study should encourage other researchers to try using microcontrollers in their sensors.

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ATMOSPHERIC SCIENCE

SWIRLL
Severe Weather Institute
Radar & Lightning Laboratories