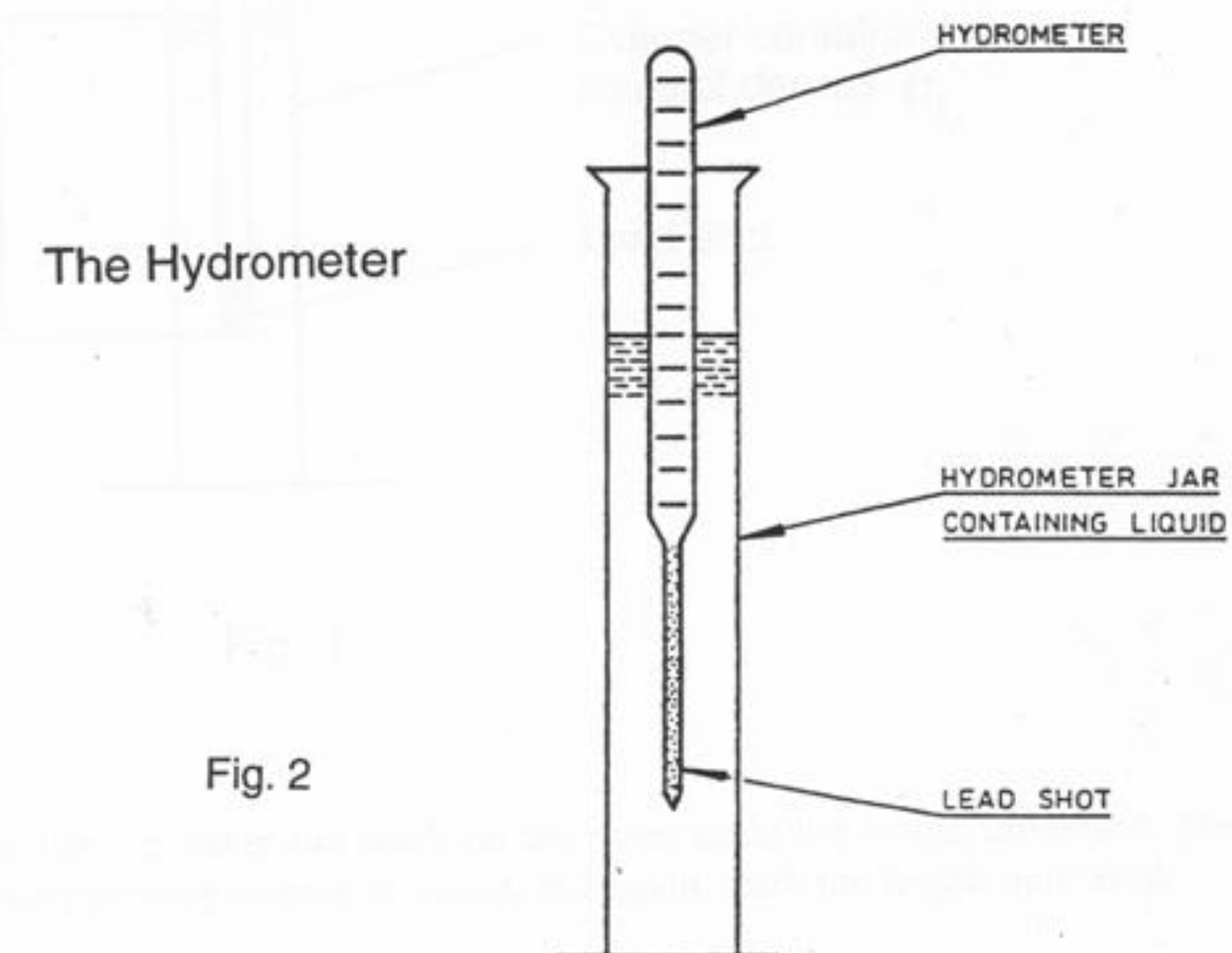


Digital Hydrometer

Chris Dionysopoulos, Adam Williams
{cdiony, adamwill}@umich.edu

Introduction: Digital Hydrometer to assist in Specific Gravity calculations

- During the brewing process, there are many factors that can effect the end result of a good tasting high quality beer.
- One of the main tools that is used to gauge the quality at various points of a brew is the hydrometer
- Hydrometers measure the specific gravity of a liquid in relation to water. This calculation is dependent on external variables to be properly corrected.
- There are three different scales usually found on a hydrometer. These scales indicate the Specific Gravity, the alcohol by volume (ABV) and the sugar content of the brew.



Problem Description: Describe the problem in a few words

- There are many environmental factors that affect the accuracy of the hydrometers reading.
- Room temperature, liquid temperature and air pressure are the main factors to correct and account for in taking accurate measurements with a hydrometer.
- To adjust for temperature in calculations, the following formula is used:
$$\text{Correction}(@59F) = 1.313454 - 0.132674 * T + 2.057793e-3 * T^2 - 2.627634e-6 * T^3$$

where T is in degrees F.
- Most of the hydrometers on the market are made of poorly manufactured glass and are prone to break easily
- In addition to the need to take accurate measurements for current and future uses, the only digital hydrometer sold for brewing is upwards of \$2500
- As a proof of concept this device was made using tools ranging in the hundreds of dollars.
- With a refined design, this cost can be brought down significantly

Proposed Solution: How did you solve the problem?

- To create a device that would help brewers with all the calculations needed to receive an accurate specific gravity, we combined various sensors and a microcontroller to save and display the correct data.
- Using a custom glass housing, we created a device that maintains the correct level of liquid to compare our specific gravity measurements against.
- Using a hall effect sensor, we are able to calculate the distance the hydrometer probe travels and receive the unadjusted specific gravity reading
- An infrared sensor calculates the temperature of the liquid.
- An external environment sensor finds the correct room temperature.
- To display the data, we interfaced with a 128x128 bit display that allows for the presentation of past measurements and the current readings.
- Two buttons on the device let the user navigate between historic settings, taking new measurements, and viewing the current readings in real time.

Communication & Sensors

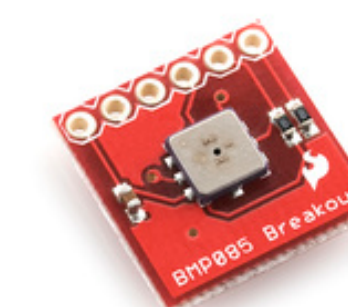
- Analog Hall Effect Sensor
 - Used for hydrometer reading
 - A magnetic field reading that needs to be adjusted for distance measurements
 - Allows for the separation of the sensors from the brew process for anti-contamination purposes



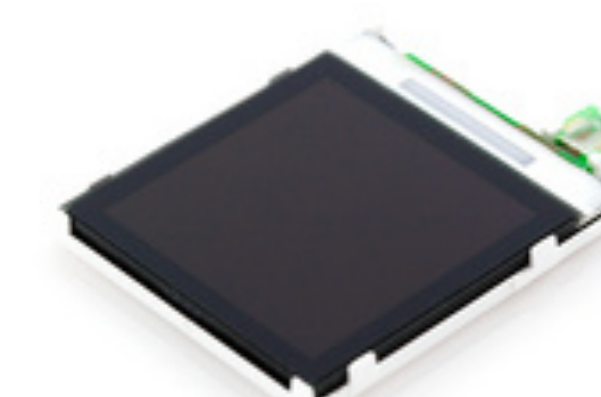
- Infrared Temperature Sensor
 - Separates the thermometer from the brew, allowing less contamination potential
 - I²C interface



- Barometric Pressure Sensor
 - Uses an I²C interface



- Color LCD
 - 128x128
 - SPI Interface



- Environment Temperature Sensor
 - Provides room temperature reading for calculation adjustments
 - I²C interface



- I²C Bus
- SPI Bus

Conclusion

Using **easily accessible** electronic parts, we were able to create a **digital aid** to the brewing process for a fraction of the price of the commercial options. This device allows for accurate calculations that take **environmental variables** into account and stores the **data for future use**. This option, though cumbersome in prototype, is the proof of concept we were looking for. In the future, we expect that home brewers with a technical interest will be able to **build a similar device for their own use**.