Augmentation of Agricultural Output using Farm Ambience Sensing Tool (FAST)

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***Abstract*: One of the major problems in present day agriculture is low productivity. To improve the output of the field, it is of utmost importance that the farmer not only has the items required but also the knowledge to implement them effectively. A viable solution is the FAST (Farm Ambience Sensing Tool) - a multi-sensor tool which detects the conditions of the agricultural area and notifies the farmer.**

I. INTRODUCTION

One of the most important factors affecting the farm's production is water. Excess or deficit of moisture content in the soil can be highly detrimental to the agricultural output. A moisture sensor calibrated to the field's soil type and crop type will notify the farmer about the recommended water content.

Soil analysis is performed by using a nutrient testing sensor (based on AVR microcontroller, available commercially). Apart from detecting the levels of Nitrogen, Phosphorous and Potassium, it can also evaluate soil pH, soil conductivity and soil salinity.

A temperature sensor is also included which, like the moisture sensor, can be duly calibrated for high quality output. Low temperatures render area unsuitable for cultivation.

The amount of sunlight also play a very crucial role. A photosensitive module, with a threshold for light sensitivity, would detect when the sunlight is excessive and damaging. This can be further extended to automatic shades (umbrellas) which open up to protect the crops underneath.

Lastly, a weather sensor is present which notifies the farmer about the impending weather conditions and rainfall – thus, giving him time to prepare for the change.

The output of all the sensors are redirected to a single board which displays the factors in safe/danger zones or low/medium/high levels. Thus, the FAST is an ultimate gadget for a farmer.

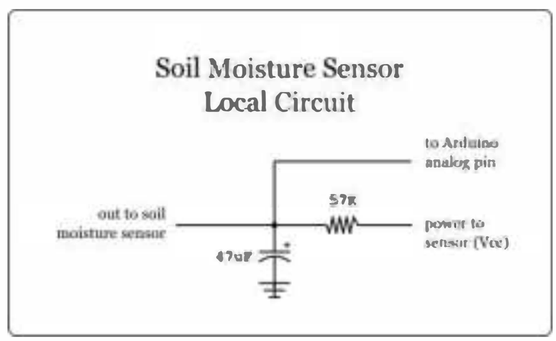
We shall discuss each of the mentioned units in detail below and in the end the integration of all of them.

II. MOISTURE SENSOR

The moisture sensor uses very simple technology and is highly cost effective. The type of sensor we are building in this module is a resistive sensor. The resistive type of moisture sensor is the most crude. The general idea is that we want two probes -- metal rods, kept about equal distance apart, that we can bury in the soil. We will need an electrically non-conductive material to help keep the rods in their fixed position. And we will also want the probes to be insulated everywhere except where we want to take a reading. It uses these two probes to pass current through the soil, and then we read that resistance to get the moisture level. More water makes the soil conduct electricity more easily (less resistance), while dry soil conducts electricity more poorly (more resistance).

The circuit is mainly a voltage divider - the soil moisture sensor is one half and the 57K resistor is the other half.

There is also a noise filter - the 47uF capacitor going to ground and an output so that the Arduino can take a sensor reading. The basic circuitry has been shown below.



Once these connections are done, the output is displayed in the LCD screen.

III. LIGHT SENSOR

The photosensing unit primarily comprises of the light dependent resistor. The resistance of the LDR decreases when the amount of light it detects increases. The level of light across the LDR changes the voltage level measured by analog pin 0. You'll notice in the above screen shots that the voltage is near 5V when maximum light is shined on the LDR

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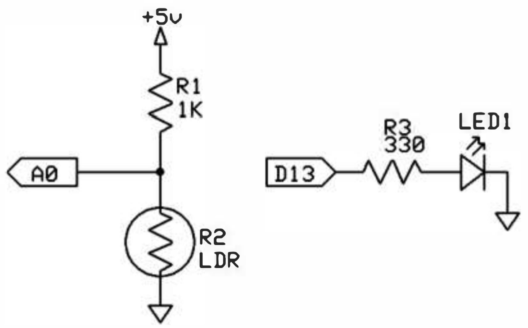
and near 0V when minimum light is shined on the LDR. The blink rate of the LED is scaled to a value between 100 and 1000 µsec by way of the Arduino map() function.



map(value, fromLow, fromHigh, toLow, toHigh)

- value – number to scale
- fromLow – lower bound of value's current range
- fromHigh – upper bound of value's current range
- toLow – lower bound of value's target range
- toHigh – upper bound of value's target range

The map() function uses integer math so, fractional remainders will be truncated (not rounded or averaged). We will require an A/D converter that maps input voltages between 0 and 5 VDC into an integer value between 0 and 1023. This conversion is achieved by the Arduino analogRead() function where the pin number of the analog pin to read is specified. This function returns a integer value between 0 and 1023 which can be displayed on the LCD.

IV. TEMPERATURE SENSOR

We would be using analog sensor TMP36 for temperature sensing. These sensors use a solid-state technique to determine the temperature. That is to say, they don't use mercury (like old thermometers), bimetallic strips (like in some home thermometers or stoves), nor do they use thermistors (temperature sensitive resistors). Instead, they use the fact as temperature increases, the voltage across a diode increases at a known rate. (Technically, this is actually the voltage drop between the base and emitter - the Vbe - of a transistor.) By precisely amplifying the voltage change, it is easy to generate an analog signal that is directly proportional to temperature. There have been some improvements on the technique but, essentially that is how temperature is measured.

Because these sensors have no moving parts, they are precise, never wear out, don't need calibration, work under many environmental conditions, and are consistent between sensors and readings. Moreover they are very inexpensive and quite easy to use.

It is very similar to the LM35/TMP35 (Celsius output) and LM34/TMP34 (Farenheit output). The reason we went with the '36 instead of the '35 or '34 is that this sensor has a very wide range and doesn't require a negative voltage to read sub-zero temperatures. Otherwise, the functionality is basically the same.
To convert the voltage to temperature, simply use the basic formula:
Temp in °C = [(Vout in mV) - 500] / 10

V. NUTRIENT SENSOR

The conventional practice of soil sample collection and analysis is costly and time consuming when applied at the intensity needed in variable-rate fertilizer management systems. A more efficient approach would be to sense soil macronutrient (nitrogen, potassium, and phosphorus) status in real time as a machine moves across a field. This approach requires a system that can extract nutrients from the soil, coupled with sensors that can rapidly measure nutrient levels in the soil extracts. ISE sensors could measure nitrate, phosphate, and potassium concentrations at levels typical in agricultural soils. An ISE nutrient sensing system might be used to target fertilizer to sub-field areas where it would be beneficial, and to reduce fertilizer application in sub-field areas where nutrient concentrations are already sufficient. Such a system could provide lower production costs and reduce environmental impacts, benefiting both producers and consumers.

All these sensors are integrated using a single ARDUINO board and the results are displayed on and LCD.

VI. RESULTS AND INFERENCES

The equipment is easy to use and affordable as well. The quality can be improved depending on the requirement.

VII. REFERENCES

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