QUEENSLAND ACADEMIES
Science Mathematics
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# Solar Powered Thermal Sensor for Detecting Bushfires

A prototype thermal sensor was developed that could be used in remote locations to provide early detection of bushfires.

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## Research Question:

Can a low cost bushfire detection system using renewable energy be designed to provide early warning in remote locations?

## Background:

Catastrophic fires have been a feature of Australian spring and summer months for several decades. In 2009 a fire event known as Black Saturday saw 400 separate bushfires in Victoria, Australia take the lives of 173 people.


Climate change may be responsible for hotter and drier weather conditions in many parts of the world. It has been estimated that the length of the fire weather season has increased by 19% globally since 1979.

In Australia many bushfires are started in remote inaccessible areas by lightning strikes. Monitoring of remote areas is difficult and often a large fire front has developed before it has been detected by emergency services. Current approaches to fire detection include fire observation towers, monitoring by light aircraft and increasing using of infra-red satellite technology.

## Design Specifications:

- Solar powered device with rechargeable battery
- Heat sensor and smoke detector
- Visual and audio alarm triggered by temperature and smoke thresholds
- Wireless signal sent to paired mobile phone following alarm
- Low cost robust unit that can be located outside in remote locations

## Design Approach:


## Materials:

- **Power Supply:** Solar Panels
- **$\mu$Controller:** 8051 – V2
- **Bluetooth Transmitter:** HC-05
- **ADC (Analogue to Digital Converters):** ADC0809
- **Temperature Sensor:** LM35 ±0.25.C
- **Buzzer:** 3V – 20V
- **Wires x 20**
- **Liquid Crystal Display:** LCD-016M002D
- **Rechargeable Battery:** FG20121
- **800mA Low-Dropout Linear Regulator:** LM1117
- **ATMEL 8-bit Microcontroller with 8K Bytes:** AT 89S52
- **General Purpose Rectifiers (Glass Passivated):** 1N4001
- **Printed Circuit Board x 3**
- **Resistors x 5**
- **Green LED x 1, Red LED x 1, Orange LED x 1**

## Prototype:

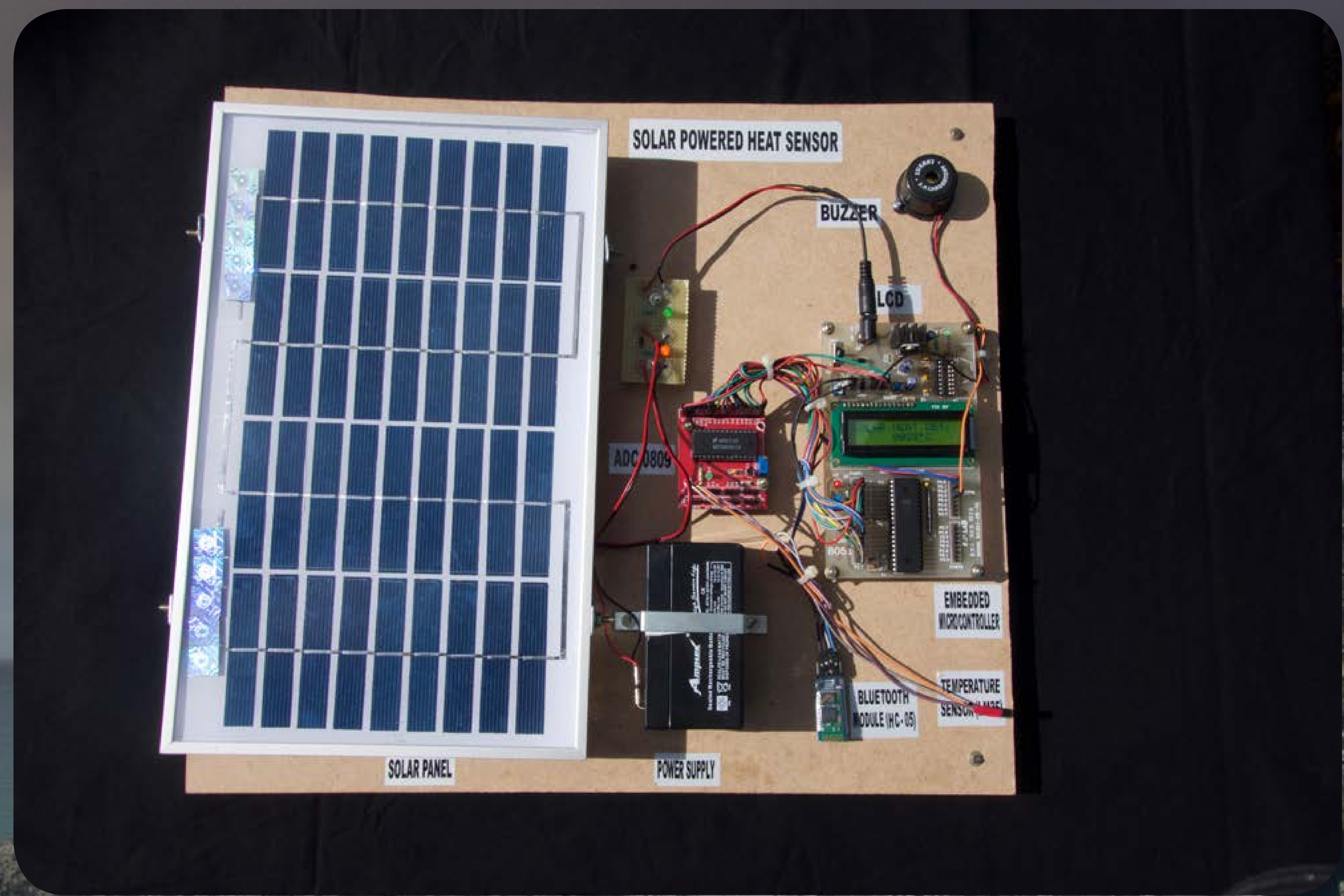


Figure 2. Photograph of prototype using temperature sensor only

## Prototype Construction:

**Circuit**
A schematic diagram of the device circuit was drawn using Proteus Schematic Software. The circuit was assembled using the schematic diagram.

**Software**
The micro-controller was programmed using embedded C code. Download the Bluetooth Terminal application. Pair the Bluetooth-enabled device with the model (HC-05).

**Power**
Connect all components and the battery wires to the battery and the black power cord to the 8051 (microcontroller) PCB and ensure that all components are powered up. Check that the indicator green LED on Voltage Regulator PCB is on. Ensure the solar panel is exposed to sun light.

## Design Testing:

1. Boil 500mL of distilled water.
2. Hold the temperature sensor into the steam of the boiled water and watch the LCD display show an increased temperature value.
3. Once the value is greater than 39°C watch the red LED illuminate and flash and listen for the siren to sound.
4. Once the siren sounds, maintain the temperature sensor in the steam and watch the paired device relay the pre-programmed notification.
5. Once the siren sounds, remove the temperature sensor out of the steam and wait until the LCD Display shows a temperature less than 39°C and wait for the siren to silence and the LED to stop flashing.
6. If any of the above reactions do not take place or are delayed, note the delay or absence of the reaction for troubleshooting purposes.
7. Repeat steps 1 – 6 thrice to ensure that each component remains entirely functional.

## Functional Results

| Trial | Temperature | LCD Display | Temperature Sensor | LED Flashing | Siren Sounding |
|---|---|---|---|---|---|
| 1 | T >39°C | Y | Y | Y | Y |
| | T <39°C | N | N | N | N |
| 2 | T >39°C | Y | Y | Y | Y |
| | T <39°C | N | N | N | N |
| 3 | T >39°C | Y | Y | Y | Y |
| | T <39°C | N | N | N | N |

Each component returned the desired output and therefore, the circuit worked completely with negligible delays (< 1 second).

## Boundary Testing:

I verified whether the temperature that the components illuminated, sounded and notified was precisely 39°C I used the boundary case to do so. The results are as follows:

| | Sound Test | | | | | | |
|---|---|---|---|---|---|---|---|
| Trial | <38°C | <38°C | =38°C | =39°C | =40°C | >40°C | >40°C |
| 1 | N | N | N | Y | Y | Y | Y |
| 2 | N | N | N | Y | Y | Y | Y |
| 3 | N | N | N | Y | Y | Y | Y |

## Future Work:

- Increase the number of sensors on the device to include smoke and humidity sensors
- Blue tooth mobile linking has limited range and needs to be upgraded to GPS to work in remote locations
- Field testing insitu to ensure durability of prototype

## Conclusion:

Overall, this prototype system can successfully detect analogue signals (temperature) and convert them to digital signals. These digital signals can reliably activate visual and audio alarms and transmit information via blue tooth. Improvements in the prototype will hopefully lead to a successful sensing system for bushfire detection in remote locations. This design could help protect people, property and wildlife from bushfires in the future.