

# Queensland Academy

for Science, Mathematics and Technology

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*Solar-Powered Bushfire Detection System Prototype*

# The History of Bushfire Prevention

- Fire towers and physical patrols by fire fighters at the scene
- Utilisation of satellite infra-red scanners is prevalent
- The advantages of deploying UAVs as a swarm include massive scalability, low communication overheads, reduced need for human supervision, and resilience against individual failure.



# Prototyping a Solar-Powered Bushfire Detection System

## Research Question

How can a rise in temperature be used as an indicator to initiate preventative measures for bushfires in rural areas?

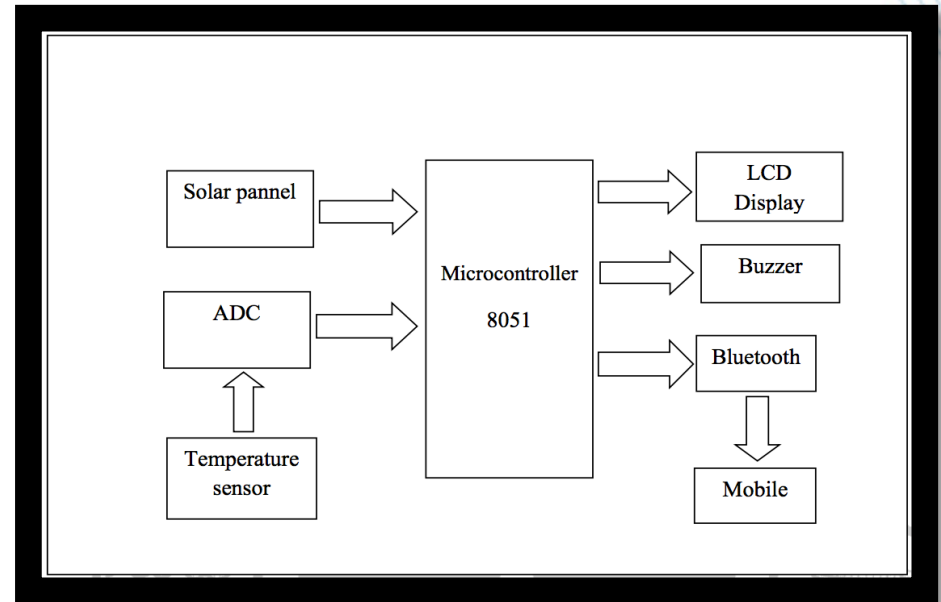
## Context

Bushfires are becoming a regular occurrence in regional Queensland, New South Wales and other international destinations. With the aid of this technology, an increase in temperature will alert the fire brigade of the increased likelihood of bushfires in rural localities.



# Basic Functionalities

- When the sensor records a temperature above 39 degrees Celsius (*Australia-wide agreed temperature that is deemed dangerous*), a siren will sound and a **red** LED will illuminate.
- Subsequently, a Bluetooth notification will be sent to the paired mobile from the Bluetooth-enabled module. The block diagram below shows the elements of the circuitry.



# Variables

Independent	Dependent	Controlled
<ul style="list-style-type: none"><li>-Nil-</li></ul>	<ul style="list-style-type: none"><li>Whether each component delivered the desired output</li></ul>	<ul style="list-style-type: none"><li>Same parts were used</li><li>The amount of voltage and current flowing through the circuitry.</li></ul>





# Methodology Phase 2 : Constructing the Prototype

- Understanding the electrical requirements of the system allowed the commencement of the construction phase after the appropriate parts were acquired.
  - (Parts sourced from S.P. Laboratories Bengaluru, India)
- Using the previously developed schematic diagram, the physical construction involved the programming of the **ATMEL 8-bit Microcontroller** through Embedded-C (*computer programming language*)
- *The following code was programmed into the microcontroller:*

```
#include <lcd.h>
#include <uart.h>
#include <adc.h>

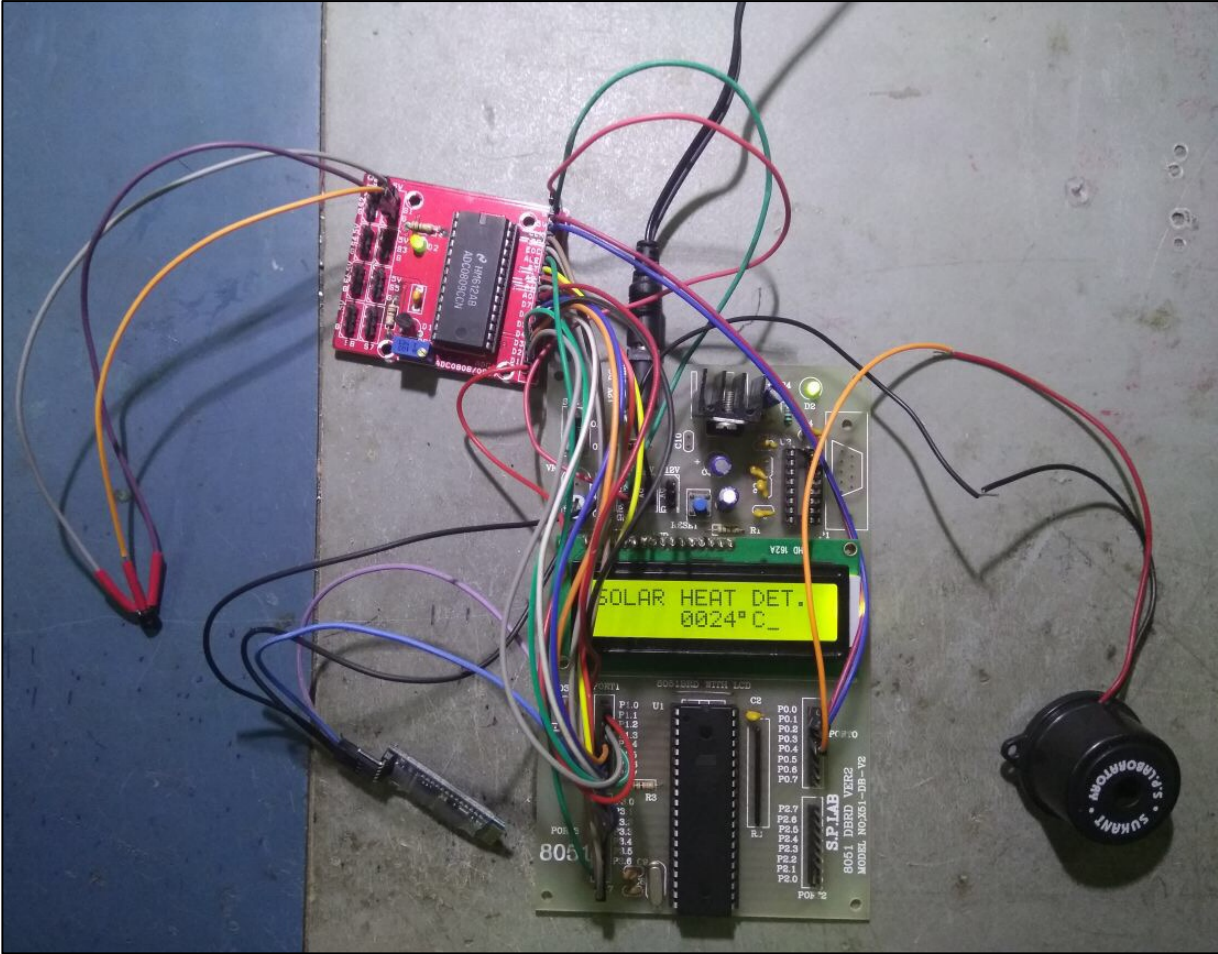
char text[]={"SOLAR POWERED THERMAL HEAT // unsigned int i;
SENSOR"}; // int j=0;
void main() lcd_ini();
{ uart_ini();
adc_ini();
buz=0;
lcd_cmd(0x80);
lcd_string("SOLAR HEAT DET.");
//lcd_cmd(0xc0);
// lcd_string("DETECT:");
/*i=0;
while(text[i]!='\0')
{
lcd_data(text[i]);
lcd_delay(100);
// lcd_cmd(0x18);
//lcd_delay(300);
i++;
}*/
while (1)
{
//for(i=0x80;i<=0x8f;i++);
/* for(i=0;i<34;i++)
```



# Methodology Phase 3: Assembling the Hardware

- While providing an understanding of the design of the circuitry, the schematic diagram clarified how it was to be wired. From the diagram, the following instructions were derived:
  - I. The **8051** is powered up by connecting the solar panels to it.
  - II. The **ADC0809** is powered up by connecting **5V** and **ground**.
  - III. **ADC Clock Pin** is connected to **P0.0 pin of 8051**
  - IV. **ADC OE pin** connected to **P0.1 pin of 8051**
  - V. **ADC ALE pin** connected to **P3.7 pin of 8051**
  - VI. **ADC ST pin** connected to **P3.5 pin of 8051**
  - VII. **ADC A2 pin** connected to **P3.4 pin of 8051**
  - VIII. **ADC A1 pin** connected to **P3.4 pin of 8051**
  - IX. **ADC A0 pin** connected to **P3.2 pin of 8051**
  - X. **Data pins of ADC D0-D7** is connected to **P1.0-P1.7** respectively. (*example: ADC D0 connects to P1.0*)
  - XI. Temperature Sensor (LM 35) is powered up by connecting **5V** and **ground**.
  - XII. Temperature Sensor (LM 35) output is connected to **S1 pin of ADC**
  - XIII. Bluetooth Module () is powered up by connecting **5V** and **ground**
  - XIV. Bluetooth module **TX pin** is connected to **P3.0 pin of 8051**
  - XV. Bluetooth module **RX pin** is connected to **P3.1 pin of 8051**
  - XVI. Buzzer is connected to **P0.3 8051** and another pin is connected to **ground**

# Methodology Phase 4: The Untested Model

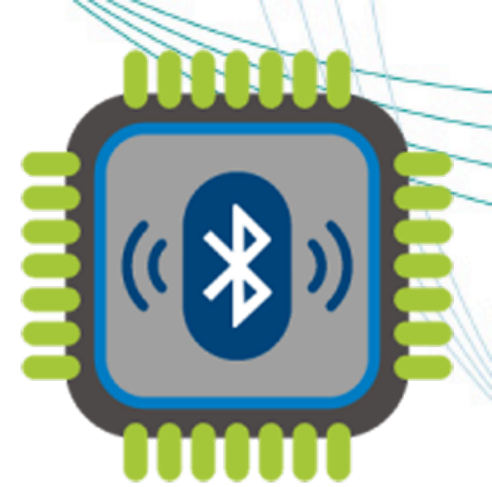
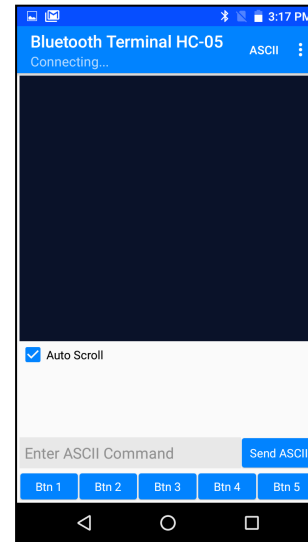
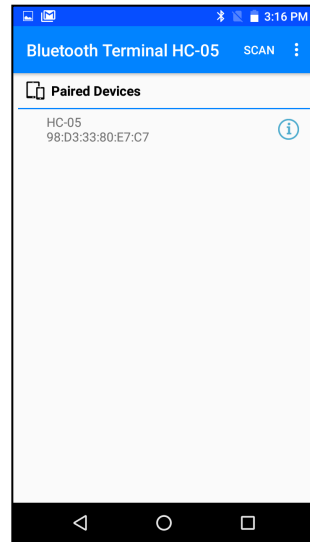
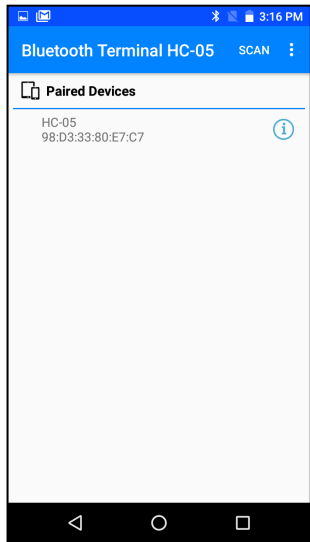


# Bluetooth Pairing

1) Open the Bluetooth Terminal HC-05 app and press the scan button.

2) Select the device HC-05 and enter the code '1234' and then enter.

3) You will return to the homepage. After returning, press the HC-05 button and you will be directed to a black dialogue box.



**Bluetooth  
Terminal  
application**

# Temperature Emulation Testing

## *(steam testing)*

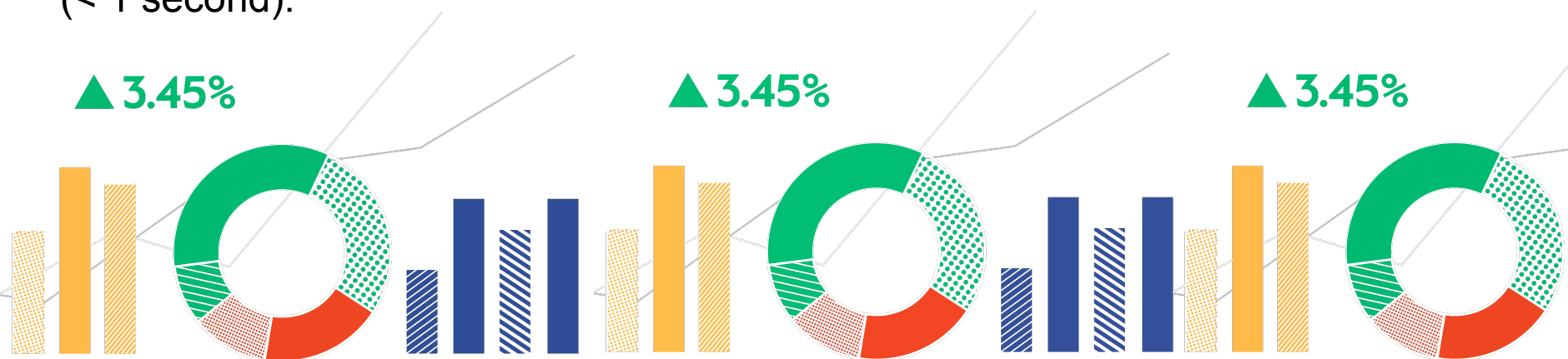
1. Place the sensor under direct sunlight or a sunlight emulating device.
2. Boil 500mL of distilled water.
3. Hold the temperature sensor into the steam of the boiled water and watch the LCD display show an increased temperature value.
4. Once the temperature value is greater than 39 °C, watch the red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

# Testing Data Phase I:

## (a) Component Testing in Relation to Temperature Changes

		LCD Display	Temperature Sensor	LED Flashing	Siren Sounding		LCD Display	Temperature Sensor	LED Unilluminated	Siren Sounding
Trial 1	Temperature Sensor (T > 39)	Y/N	Y/N	Y/N	Y/N	Temperature Sensor (Temperature < 39)	Y/N	Y/N	Y/N	Y/N
Trial 2		Y/N	Y/N	Y/N	Y/N		Y/N	Y/N	Y/N	Y/N
Trial 3		Y/N	Y/N	Y/N	Y/N		Y/N	Y/N	Y/N	Y/N

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



# Testing Data Phase II:

## (b) Boundary Case Testing – Boiled Water Method

### Trial 1:

Testing (Sound)	T<38	T<38	38	39	40	>40	>40
Yes				Yes (Pass)	Yes (Pass)	Yes (Pass)	Yes (Pass)
No	No (Pass)	No (Pass)	No (Pass)				

### Trial 2:

Testing (Sound)	T<38	T<38	38	39	40	>40	>40
Yes				Yes (Pass)	Yes (Pass)	Yes (Pass)	Yes (Pass)
No	No (Pass)	No (Pass)	No (Pass)				

### Trial 3:

Testing (Sound)	T<38	T<38	38	39	40	>40	>40
Yes				Yes (Pass)	Yes (Pass)	Yes (Pass)	Yes (Pass)
No	No (Pass)	No (Pass)	No (Pass)				

# Data Analysis & Areas for Improvement

- ❑ The overarching aim of the model is to notify the residents and emergency services.
- ❑ As stated in the preamble, the model induces many limitations that hinder its viability in today's society.
- ❑ Additional sensors of other bushfire indicators should be added. An example of this is a humidity or smoke sensor.
- ❑ Using this inexpensive technology, we can reduce the reliance of residents on weather bureaus in areas prone to bushfires *like* regional Queensland and New South Wales in Australia.
- ❑ As the harsh terrain of bushfire-prone areas is often a victim of torrential rain, it is essential that a water-proofed body requires to be developed to ensure smoother industrial utilisation.



# Evaluation of the Prototype & Scope for Future Research:

- ❑ The range of the Bluetooth module is a mere 30m. To ensure that assets (homes, farms and gardens) are not reduced to ashes, GSM technology, radio and televised broadcasts of messages can aid in doing so.
- ❑ When testing the device we used boiling water. This increased the temperature rapidly and reduced accuracy in testing.
- ❑ To ensure better testing of the device for industrial usage, it will be better tested under the natural heat of the sun to test the gradual increase in temperature as oppose to an unrealistic increase in temperature.
- ❑ Develop a water-proof (rain-proof) body for the device.
- ❑ Look for alternative ways to avoid false-alarms (i.e. from campfires or cigarettes)





# The Economic Viability

- There lies a benefit of the model since its components are rather inexpensive.
- This would result in an increased demand as a result of the inexpensive nature of the prototype.
- If the aforementioned additions are implemented, successful utilization of the prototype is bound to occur.

# Conclusion

- ❑ The system can successfully detect analogue signals and convert them to digital signals to attain actionable information.
- ❑ It completes the **3-step DCC principle** of *detect, comprehend and communicate*.
- ❑ Families can be saved from losing their lives to the heat-induced phenomena while not fuelling the ever-evolving fire of climate change.

# Acknowledgements

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- ❑ **Dr. Kirsten Hogg** – for her continued guidance throughout the development of the system and the quality creation of the poster.
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