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# ARM based Embedded System with ZIGBEE for Green house monitoring and control

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## ABSTRACT

Increased demands for grains and agricultural products have expedited the commercialization of agriculture in India. To support commercialization it is necessary to develop supporting advance technology for agricultural. More than 50 countries in the World are fully using green house technology for cultivation of crops on commercial scale. Monitor and control the green house different controller based system have been developed, to handle the system complexity, interfacing of number of sensors, and networking with low power consumption it is necessary to develop advance processor based green house controller system.

In this paper ARM based embed system with ZEEGBEE to monitor and control the microclimate parameter of green house on regular basis, is presented. System also employs keyboard and LCD for display of data and ZEEGBEE for wireless transmission of data to remote computer monitoring.

***Keywords-*** *ARM Controller, Zig-BEE Protocol*

## 1. INTRODUCTION

A recent survey of green house has reviewed that there are more than 50 countries in the world, where cultivation of crops is undertaken on a commercial scale under cover. India is on the verge of commercialization of agricultural. To expedite the commercialization of agricultural in India it is necessary to develop cost effective sophisticated green house controller with latest technology.

Digitally greenhouse monitoring and controlling of a system based onATMEL89s51 is proposed in [1]. This system comprises of external peripheral such as Analog to digital converter, external interface of actuator and other devices. 89c51 based system also has less internal memory hence limits software overhead required for making system generic. For wireless monitoring of green house controller RF communication is proposed in [2]. RF wireless transmission has less data rate and implementation needs more power consumption. There are many wireless systems, developed with Bluetooth technology but ZIGBEE protocol provides low cost and low power connectivity for equipment and consumes less power than other protocol.

Many of the embedded system developed for green house controller employs standard signal conditioning circuits which limits the range and sensitivity of sensor. Special circuits are used for signal conditioning of following sensors; temperature: 0-100˚C (RTD-PT100) temperature sensor is used. Humidity sensor HS200/HS230 is used of improved sensitivity. Simple LDR is used for sunlight monitoring the transistor BC547 NPN is used in novel way for soil moisture measurement.

## 2. SYSTEM HARDWARE

### System model

***Sensor and Actuators***

Parts/ components of the system: • sensors (data acquisition system) • temperature sensor (PT100) • humidity sensor (HS2000) • light sensor (LDR) • BC547 as a moisture sensor • liquid crystal display (hitachi's hd44780) • actuators relays for devices to control water pump, cooler, heater, artificial lights.

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***ARM7***

LPC2148 is ARM7TDMI-S Core Board Microcontroller that uses 16/32-Bit 64 Pin (LQFP) Microcontroller No.LPC2148 from Philips (NXP).It is having inbuilt ADC & two UARTs.

***ZigBEE***

ZigBee is a low data rate, low power consumption, low cost, wireless networking IEEE 802.15.4 protocol targeted towards automation and remote control. ZigBee compliant wireless devices are expected to transmit 10-75 meters, depending on the RF environment and the power output consumption required and will operate in the unlicensed RF worldwide (2.4GHz global, 915MHz Americas or 868 MHz Europe). The data rate is 250kbps at 2.4GHz, 40kbps at 915MHz and 20kbps at 868MHz.XB24-Z7WTI ZigBEE model is connected to UART of ARM controller which will transmit data to receiver connected to PC which is located away from Greenhouse and Greenhouse parameters can be observed on PC.

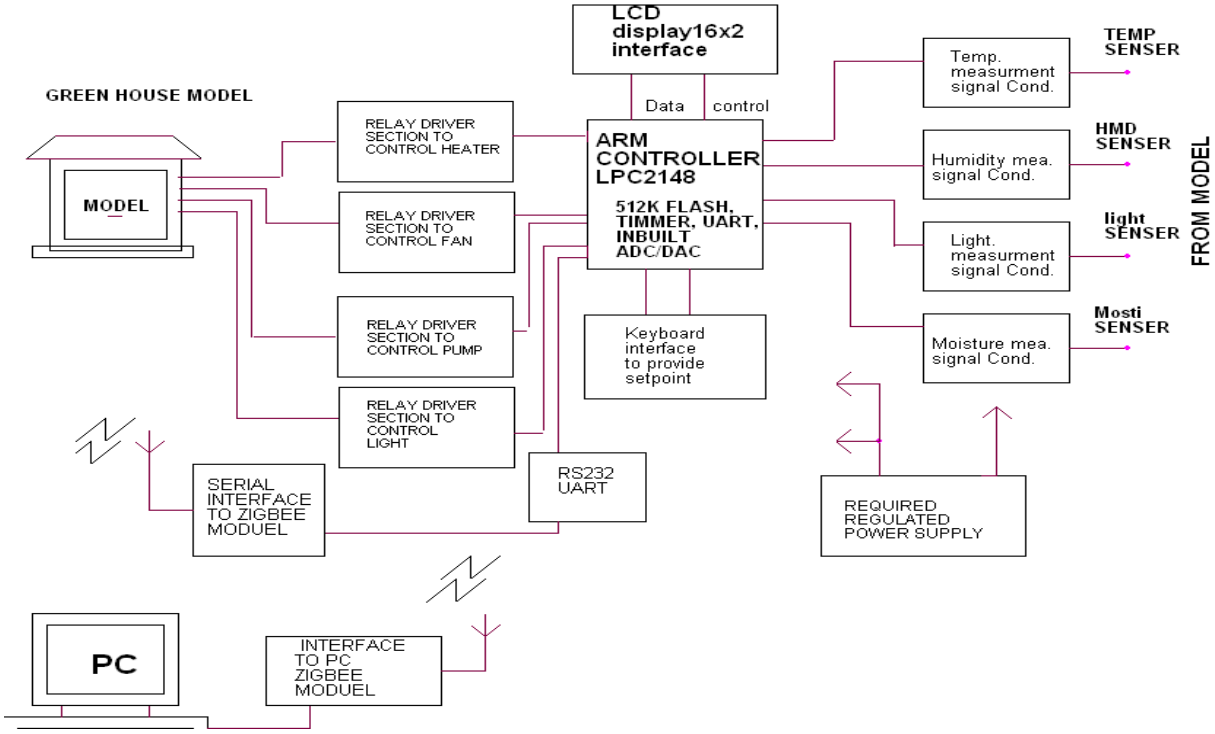


***Fig.1Block Diagram***

**Design of Signal Conditioning Blocks**

Different parameters to be monitored, their range and type of sensor:

- Temperature: 0-100˚C
- Humidity: 0%-100 %
- Light concentration: 0%-100%
- Moisture measurement: 0%-100%

***Temperature Measurement and signal Conditioning***

For temperature measurement Resistance Temperature Detector (RTD) sensor, PT-100 having linear range 0 ˚C to 100 ˚C and sensitivity and 0.0039/˚C is used.PT 100 is connected in one arm of the bridge and resistors of rest of the arms are selected such that at 0˚C the bridge is balanced and 0V appear at the output of the bridge circuit .The

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resistance of the sensor changes with respect to temperature, widely specifying RTD is having positive temperature coefficient.

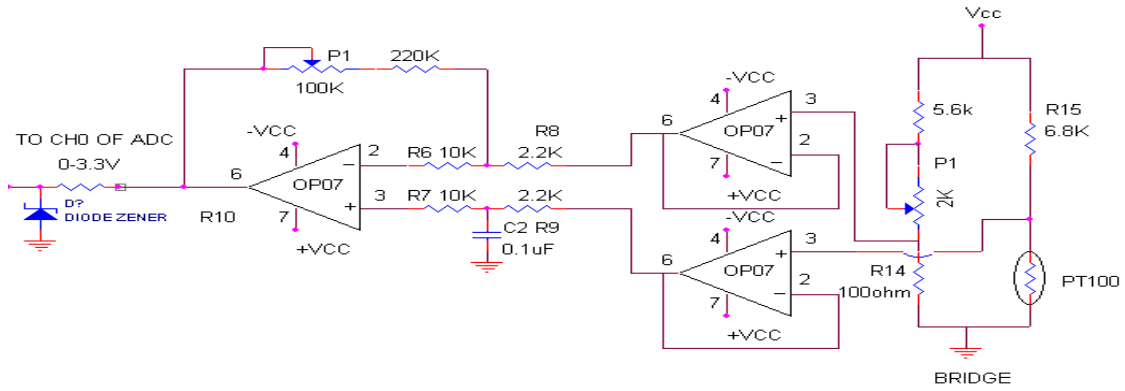


***Fig2.Temperature signal conditioning block***

***Humidity Measurement and signal Conditioning***

The relative humidity of the atmosphere can be measured with the help of humidity sensor SY-HS-230 having sensitivity 0.025V/% relative humidity. The sensor gives output in mV directly proportional to relative humidity. By providing the external biasing and faithful amplification of the DC mV, relative humidity from 0% to 100% can be calibrated. The amplification is done with the help of diff. Amplifier having gain from 1.5 to 2.5 and is adjusted to 0-5V for a span of relative humidity.

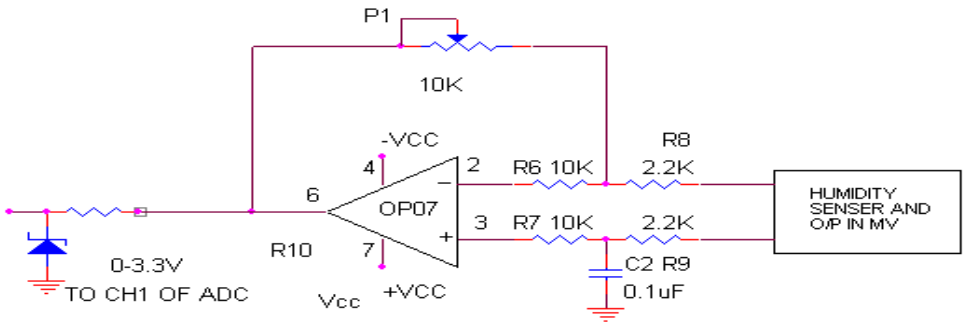


***Fig.3Humidity Signal Conditioning block***

***Sun light Measurement and signal Conditioning***

To measure and calibrate this parameter a nonlinear sensor i.e. light dependent resistor (LDR) having maximum resistance of 20K to 100K and Sensitivity of 6ohm to 100 ohm/Lux.LDR is connected in parallel a trim pot to have a maximum resistance of combination in full dark. This parallel combination is connected in series with potential divider arrangement of high value resistor. To avoid the loading effect the output from LDR is buffered with the help of OP-amp. It is then applied to amplifier circuit. The amplifier is working in diff. Mode. Another input to the amplifier is from another section of LDR which is inserted to remove the effect of ambient temperature to a proper compensation. To develop this block general purpose Op amp LM324 is used which is having 4 op-amps in a single pack.

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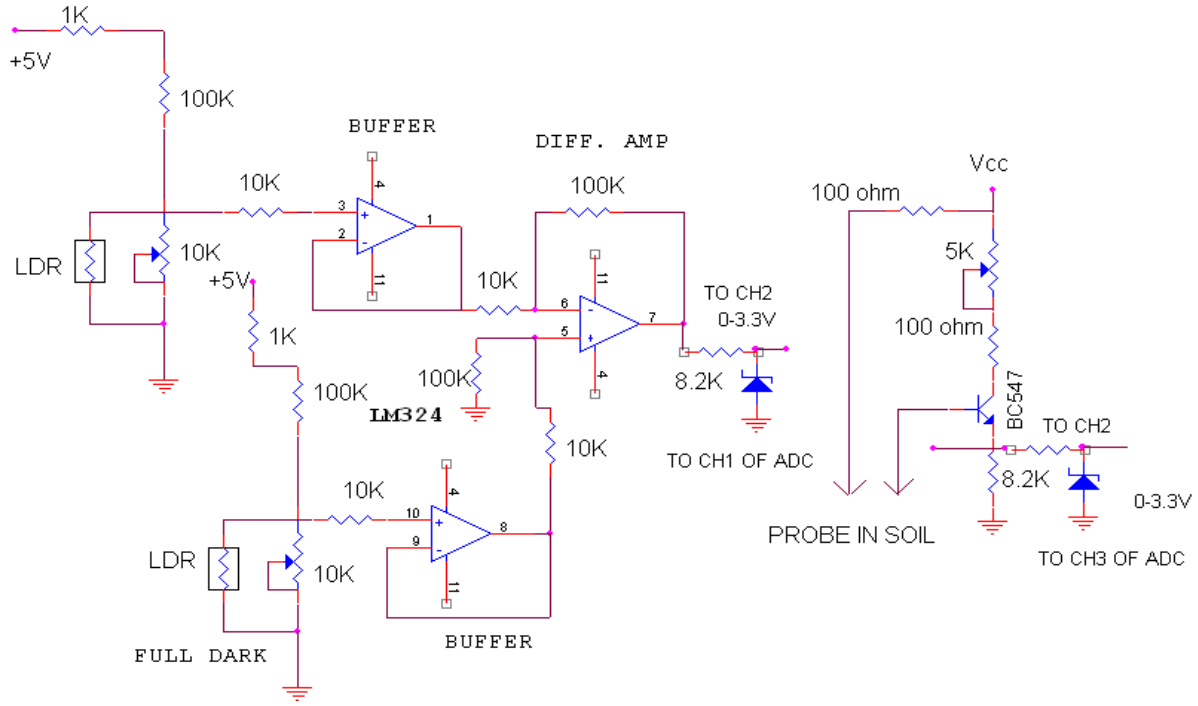


*Fig.5 Sun light Signal conditioning block*

***Moisture measurement and signal conditioning***

Water content of soil is measured using NPN Transistor BC547 having Vce(max) 100V,Ic(max) 100-150ma,hfe: current gain 400-500.The base bias to transistor is provided from +5V and one trim pot. Base and emitter terminals are inserted in soil using suitable probe. As per the water content in soil, transistor works in active region and will change its collector or emitter current which is proportional to the moisture content in soil.

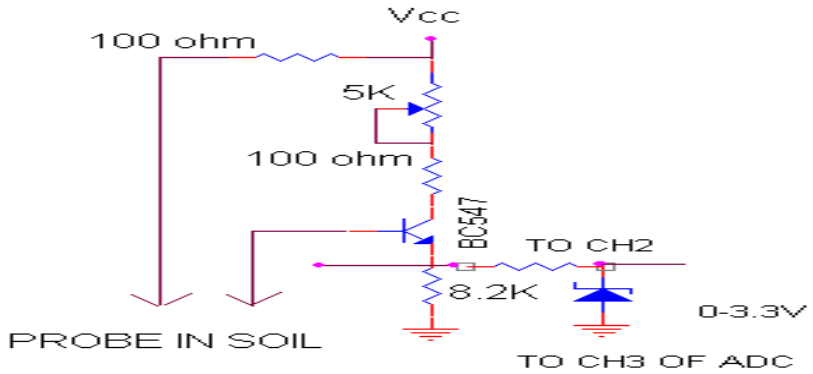


*Fig.6 Soil moisture signal conditioning*

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**Keypad Design**

Hexadecimal keyboard is used to provide the set point for various parameters to the system. Keypad is designed using priority encoder IC 74148 which will give direct decimal number of key, which is pressed. The circuit diagram is as shown in fig.

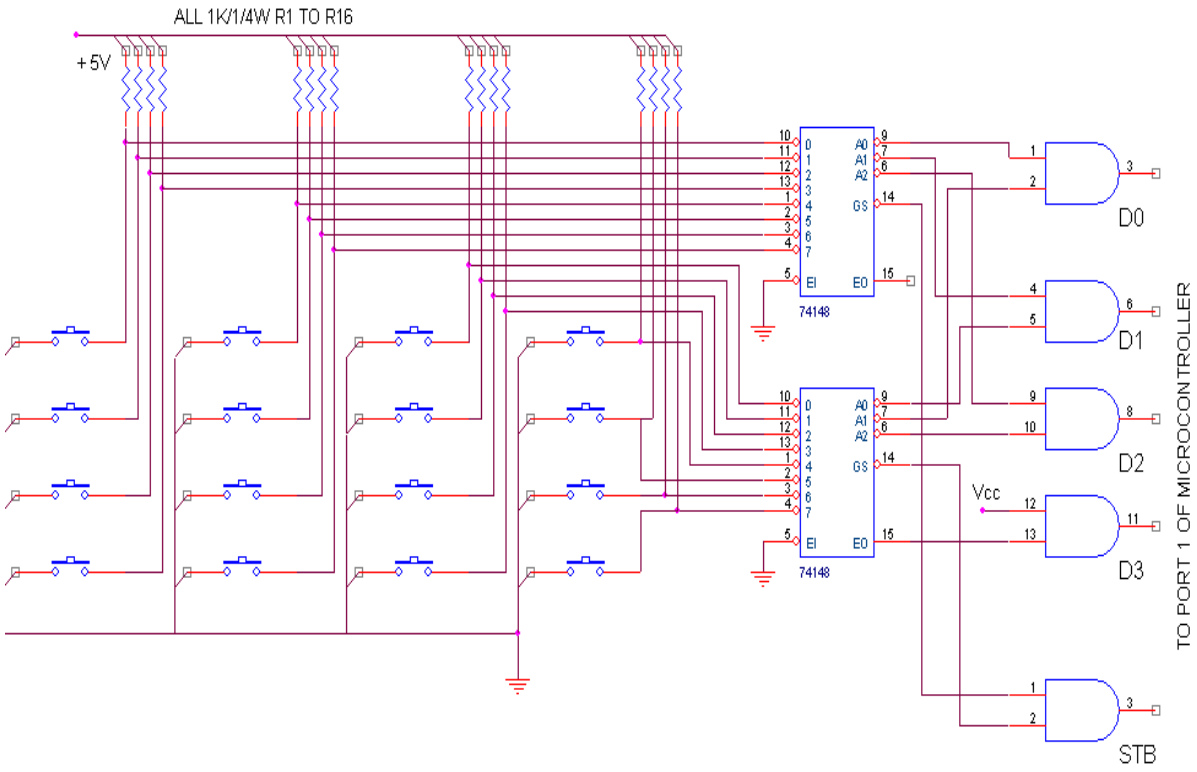


***Fig.7 Keypad circuit***

**Opto-coupler Isolation and relay driver Section**

To turn on light, fan, pump, heater relay drive circuit is used. The Isolation is provided to four relay driver circuit using opto-coupler to avoid noise pickup.

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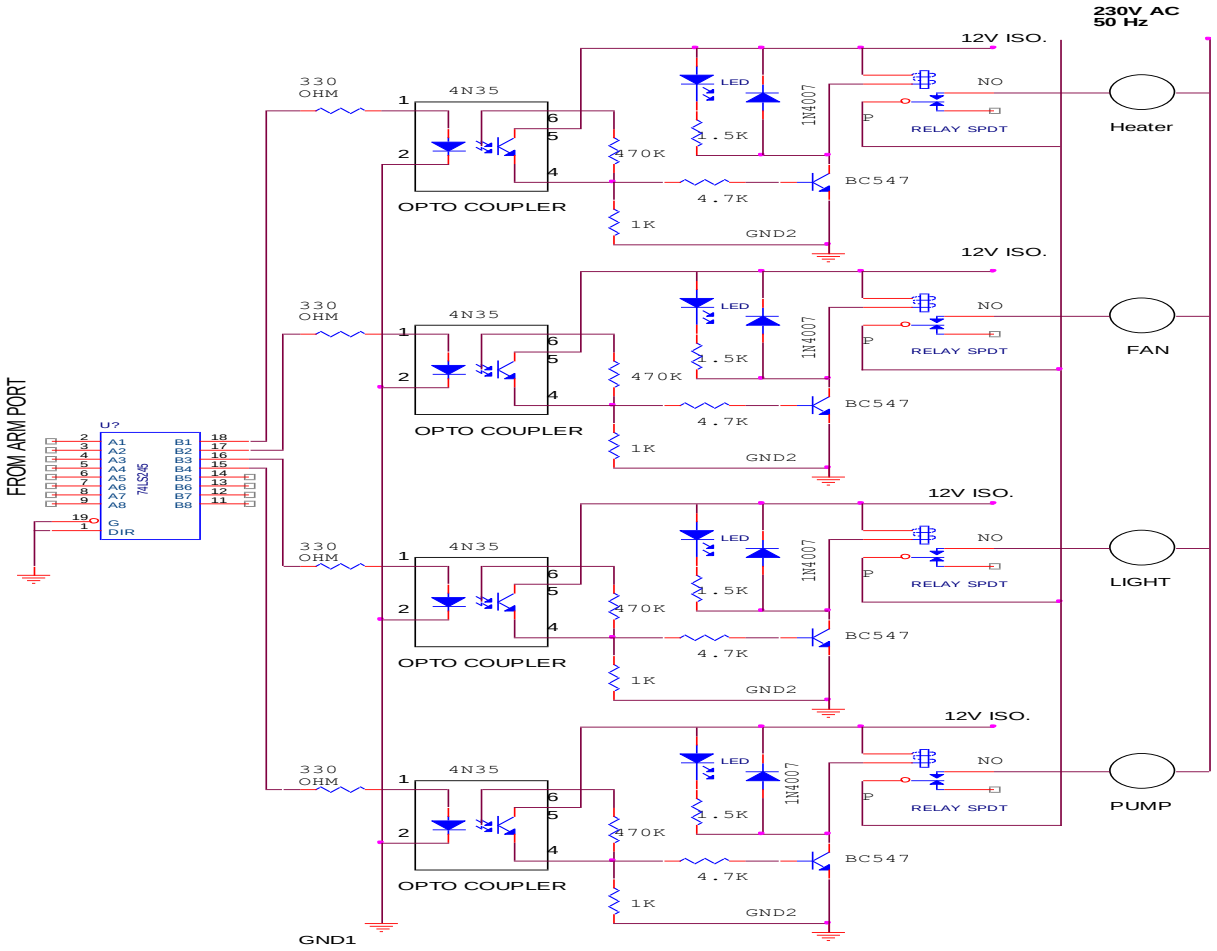


**RELAY DRIVER WITH ISOLATION**

***Fig. 8 Relay driver with Isolation***

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## 3. GRAPHS

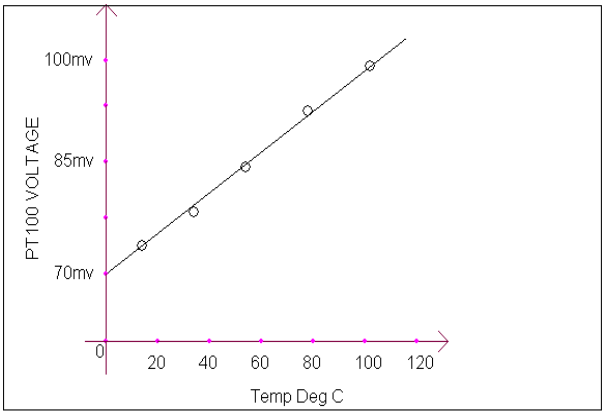


***Fig.9.Graph of temperature Vs PT-100 output***

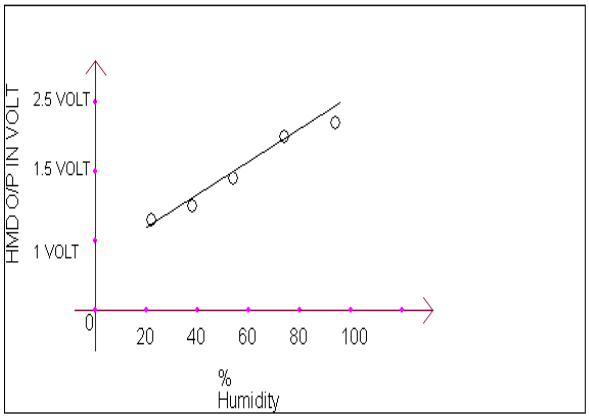


***Fig.10.Humidity VS sensor output***

## 4. CONCLUSION

Designing the ARM based system for measurement and control of the four essential parameters for plant growth, i.e. temperature, humidity, soil moisture, and light intensity, has been followed. The results obtained from the measurement have shown that the system performance is quite reliable and accurate. Agricultural control system industry in several areas of agricultural production, will result in reliable control systems that will address several aspects of quality and quantity of production. Greenhouse status can be observed on PC, located away from the greenhouse due to use of ZIGBEE technology.

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