Home Automation using Embedded Design

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Abstract— The main objective of this project is to maintain the room the temperature, and to provide the security from the intruder, and to remove the darkness in the room by remote light on/off control. The room temperature is monitored by temperature sensor and it is given to ADC then the ADC output is given to the microcontroller. Then the microcontroller will take the necessary action by giving control to the fan or to the heater. IR Sensor and detector is used to provide security from the intruder and it is converted into voltage and given to the micro-controller. The photo detector is used to light on/off control and converted into voltage and given to the microcontroller.

Key words: ADC, Home Automation

I. Introduction

Home automation (also called domotics) is the residential extension of "building automation". It is automation of the home, housework or household activity. Home automation m ay include centralized control of lighting, HVAC (heating, ventilation and air conditioning), appliances, and other systems, to provide improved convenience, comfort, energy efficiency and security. Home automation for the elderly and disabled can provide increased quality of life for persons who might otherwise require caregivers or institutional care.

A home automation system integrates electrical devices in a house with each other. The techniques employed in home automation include those in building automation as well as the control of domestic activities, such as home entertainment systems, houseplant and yard watering, pet feeding, changing the ambiance "scenes" for different events (such as dinners or parties), and the use of domestic robots. Devices may be connected through a computer network to allow control by a personal computer, and may allow remote access from the internet.

Automation of home is ideally suited for modern Homes, Apartments, Commercial complexes, Hostels, Hospital and other places where automation is necessary for controlling the room temperature.

The proposed block diagram is shown in figure 1. The room temperature was measured by temperature sensor and it is sent to signal conditioner for amplifying, isolating, filtering etc., then the output is fed to the ADC where it converts the analog signal into digital signal and the output of ADC is given to the micro-controller.

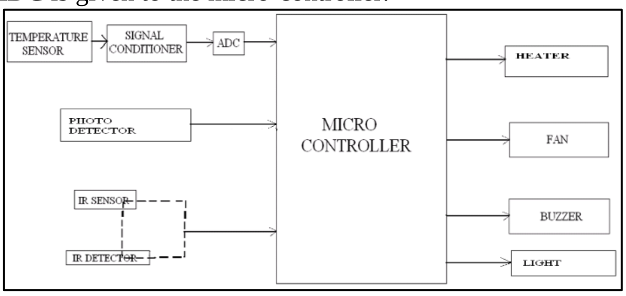

Fig. 1: Proposed Block Diagram

The micro-controller performs the necessary control action for the different constraints and produces the output to the fan or heater. The photo detector will detect the presence of light and it automatically of the switch off the small light (Night lamp).The micro-controller performs the necessary control action for the different constraints and produces the output to the light. The IR Tx & Rx will sent and receive the 38kHz frequency whenever the frequency cut will occur then the micro-controller will perform the control action for the different constraints and produce the output to the buzzer.

II. Functional Blocks

The proposed block diagram is split into sections and each section is explained in sufficient detail to fabricate present design and these principles.

The major blocks of the system are

1) Power supply
2) Micro controller AT89C51
3) ADC converter
4) Temperature Sensing Circuit
5) IR transmitter and receiver circuit
6) Photo detector circuit
7) Alarm circuit

A. Power supply

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then providers a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. The circuit diagram of power supply is shown in figure 2.

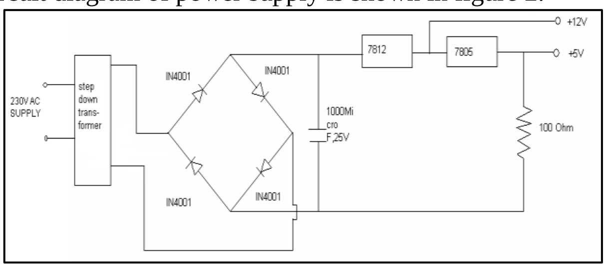

Fig. 2: Circuit diagram of Power supply

A regulator circuit removes the ripples and also remains the same dc value even if the input de voltage varies, or the load connected to the output de voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

1) Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op-amp. The advantages of using precision rectifier are it will give peak voltage output as DC; test of the circuits will give only RMS output.

2) Bridge Rectifier

When four diodes are connected as shown in fig, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and negative potential at point B. The positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through RL, through D3 through the secondary of the transformer back to point B. This path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3. One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. Through RL this current develops a voltage since current flows through the load (RL) during both half cycles of the applied voltage; this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

This may be shown by assigning values to some of the components shown in views A and B. Assume that the transformer is used in both circuits. The peak voltage developed between points X and Y 400 volts in both circuits. In the conventional full-wave circuit shown in view A, the peak voltage from the center tap to either X or Y is above 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 volts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 400 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage that the conventional full-wave rectifier circuit.

3) Filter

It is a bridge type rectifier, which give full cycle conduction output. The capacitors based filter section smooth the rippled DC and make it as pure DC. The smoothing level is increased by increasing filter capacitor value.

4) IC Voltage Regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in single IC, IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

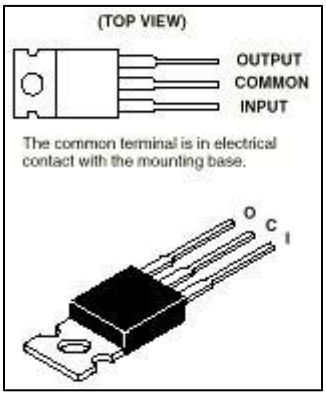

Fig. 3: IC 7805

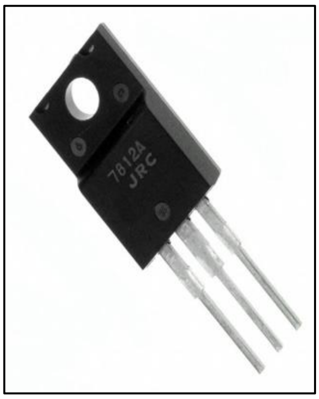

Fig. 4: IC 7812

A fixed three-terminal voltage regulator has an unregulated dc input voltage Vi, applied to one input terminal, a regulated dc output voltage, V0, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

- For ICs, micro controller, LCD -------5 volts
- For alarm circuit, op-amp, relay circuits ------- 12 volts

B. Micro controller AT89C51

By combining a versatile 8-bit CPU with flash on a monolithic chip, Atmel AT89C51 is a powerful, highly flexible and cost effective solution to many embedded control applications.

At the heart of the project is flash-based microcontroller IC AT89C51. AT89C51 is a low power high performance CMOS 8-bit microcontroller with 4KB of flash programmable and erasable read only memory (PEROM). It is manufactured using Atmel's high-density, non-volatile memory technology and compatible with the industry standard MCS-51 instruction set.

The on chip flash allow the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer.

This micro controller the whole project depends on its software programming. This micro controller will be doing on three main processes one is to automatically maintain the room temperature, second is to provide the security from the intruder, and the last one is to automatic switching of light control.

C. Temperature Sensing Circuit

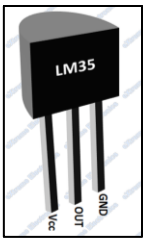

Fig. 5: Pin Diagram of LM35

The LM35 series are precision integrated-circuit Temperature Sensors whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear Temperature Sensors calibrated in

Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of C at room temperature and C over a full -55 to +150C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It CAN be used with single power supplies, or with plus and minus supplies. As it draws only 60 ?A from its supply, it has very low self-heating, less than 0.1C in still air. The LM35 is rated to operate over a -55 to +150C temperature range, while the LM35C is rated for a -40 to +110C range (-10 with improved accuracy). The LM35 series is available packaged in hermetic TO-46 Transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 Transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package. The output of LM35 is given to the operational amplifier and then to ADC.

D. ADC Converter

Analog to digital converters (ADC) are utilized broadly in signal processing systems for converting analog signals into digital signals. The function of an analog to digital converter (ADC) is to accurately convert an analog input signal into digital output represented by a coded array of binary bits. The output bits are generated by processing the analog input signal through the number of comparator steps. An ADC receives an analog signal as input and provides (generates) a digital code corresponding to strength of the analog signal at various time instances as output. The number of bits in the generated digital code represents the resolution of the ADC. A reference signal is often used by an ADC in providing such conversions. The digital output signal represents a number that is proportional to the current magnitude and/or amplitude of the analog input signal. A/D converters are often used with microprocessors to convert an analog signal to corresponding digital signal which is to be processed by microprocessor. A/D converters of the parallel type and the serial and the parallel type are advantageous for high speed operation. Such A/D converters generally comprise a plurality of comparators for comparing an analog input signal with analog reference voltages and an encoder for converting output signal of the comparators to a multi bit digital signal. Multi-stage pipelined analog to digital converters provide efficient high speed conversion of analog signal to digital equivalents. A/D converters are employed in a wide variety of applications.

Many modern electronics systems require conversion signals from analog to digital or from digital to analog form. Circuits for performing these functions are now required in numerous common consumer devices such as digital cameras, cellular telephones, wireless data network equipment, audio devices such as MP3 players, and video equipments such as DVD players, high definition digital television (HDTV) equipment , and etc. here, the ADC0804 IC is used to convert the analog value into digital value.

E. IR Transmitter and Receiver circuit

This door monitor circuit uses an infrared beam to monitor door & passageways or any other area. When the beam is broken a relay is tripped which can be used to sound a bell or alarm. Suitable for detecting customers entering a shop, cars coming up a driveway, etc. The IR beam is very strong. Distances over 25 feet can be monitored. A 12V DC supply is required to power the circuit. A 12V wall adaptor is fine. Provision has been made so that only one power supply needs to be used to power both units. The relay is rated to switch mains voltages.

The door monitor transmitter board consists of two square-wave oscillators, one running at approx. 250Hz and the other running at 38kHz. The 38kHz frequency acts as a carrier wave and is required by the IR receiver module on the receiver board. This carrier wave is “ANDed” or modulated by the 250Hz frequency to produce an output signal that contains bursts of 38 kHz at a rate of 250Hz. This signal is used to drive an infrared LED.

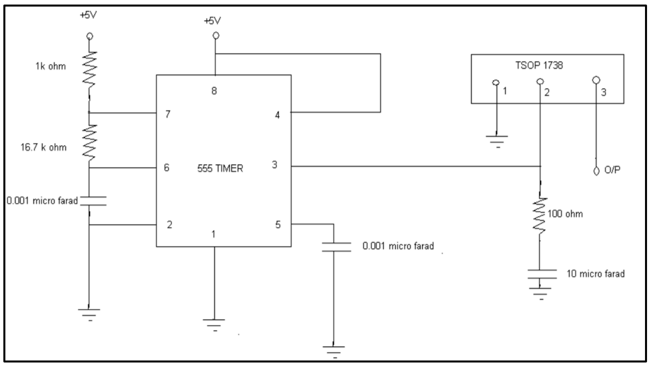

Fig. 6: IR Transmitter and Receiver circuit

The oscillators are made by using two 555 timer ICs set up as “astable” (free running) multivibrators. IC1 is used for the 250Hz oscillator. Resistor R1 and R2 and capacitor C1 set the frequency. Another 555 chip, IC2, is used for the 38KHz oscillator. Resistors R4 and R5 and capacitor C3 set the frequency. Notice the diodes D1 and D3. These are provided to create a “symmetrical” output. Normally the external capacitor C1 (C3) charges through resistors R1 and R2 (R4 and R5) and discharges through R2 (R5). Without the diodes this output waveform would have a longer “high” time than the “low” time. The diode bypasses resistor R2 (and R5) when the capacitor is charging, so that it is only charged via R1 (or R5). This gives the same charging and discharging time and so the output waveform has equal high and low times.

The charge time (output high) is given by:

$$T_{HIGH} = 0.693 \times R1 \times C1 \text{ (or } 0.693 \times R4 \times C3)$$

The discharge time (output low) is given by:

$$T_{LOW} = 0.693 \times R2 \times C1 \text{ (or } 0.693 \times R5 \times C3)$$

The output frequency = $1 / (T_{HIGH} + T_{LOW})$

The output from the IC1 is coupled via diode D2 and resistor R3 to the ‘trigger’ input of IC2. When the IC1 output is low it stops IC2 from running and IC2’s output is forced high (no IR LED current). When IC1 output is high, IC2 runs and the IR LED is pulsed at 38KHz.

The Waitrony IR LED is driven directly from the output of IC2. Resistor R6 sets the maximum LED current. With a 12VDC supply the current is about 45mA (the LED drops 2V across it when conducting). Lowering the value of R6 will increase the current through the LED thus boosting the signal strength. This may be necessary if the kit is used outside in direct sunlight or if you need “very long range”. Keep in mind that the maximum current that the 555 can handle is 200mA.

If the distance to be monitored is less than about 10 yards then you will need to fit the 5mm shrink tubing over the IR LED. This narrows the radiating angle of the IR beam and makes it much more directional. The IR output is strong. It can easily bounce off walls etc to give false readings.

The door monitor receiver consists of an IR receiver module that detects the incoming IR beam from the transmitter. The IR signal is used to keep a capacitor charged which in turn holds a relay operated. When the beam is broken the capacitor discharges and the relay releases. An IR receiver/detector module, RX1, is made up of an an amplifier/filter circuit tuned to detect a 38kHz frequency. The output pin is low whenever a 38kHz signal is detected.

When the IR beam is present the relay is operated. Not all Receiver Modules are the same. IR decoder module looks for a manufacturer-specific leader code before it decodes the modulated signal. The door monitor project produces an NEC compatible Leader code. The Kodenshi PIC37043LM and PIC12043LO decoder modules are the ones that are used in this project. If you use the incorrect IR decoder module the relay will not be operated continuously but will drop out after less than a second after power is applied.

The output of RX1 is the 250Hz signal from the transmitter. This signal is passed via transistor Q1, capacitor C1and diode D2 to capacitor C2. C2 is fully charged during the high portion of the signal. It starts to discharge during the low portion of the signal via LED L1, resistor R4 and transistor Q2. However the discharge time is much longer than the off time of the signal so the voltage across C2 is always enough to keep transistor Q2 on and therefore the relay operated. When the beam is broken the output of RX1 is high. Transistor Q1 is off and capacitor C2 is no longer being recharged. It will eventually discharge to the point where transistor Q2 will turn off and the relay will release. The "turn off" delay is determined by the time constant of resistor R5 and capacitor C3. With the values used it is approx. half a second. Capacitor C1 prevents a steady DC voltage on the collector of Q1 from charging C2. This would occur if the beam was not present or the beam was a continuous 38kHz signal. In other words, the receiver module will only respond to a pulsed 38kHz signal.

LED L1 gives a visual indication when the IR beam is present and is used to help with installation and setup. Zener diode Z1, resistor R6 and capacitor C4 provides a stable 5.6V supply for the IR module. The relays used should be mains rated: 250V/12A; 120VAC/15A.

F. Photo Detector Circuit

Photo sensors or photo detectors are sensors of light. In this circuit the light falling on the phototransistor will be from an Infrared Light Emitting Diode (LED) but otherwise it is the same as the phototransistor circuit shown above.

When the light falling on the phototransistor (Q1) is blocked, its conductance will decrease and the voltage across Q1 will rise. When the voltage rises above 1/2 of the supply voltage the output of the comparator will turn ON and the LED will be lit.

In this circuit, the input supply is given to the resistance an input LED will glow. The photo transistor will sense the input light and switch on the output LED. Whenever the photo transistor will does not sense the input and the output LED will not glow.

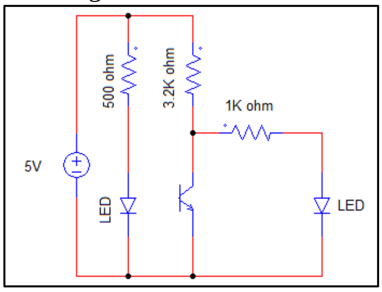

Fig. 7: Photo detector Circuit

G. Alarm Circuit

An alarm gives an audible or visual warning of a problem or condition. Alarm clocks can produce an alarm at a given time. Alarms in an operation and maintenance (0&M) Monitoring system, which informs the bad working state of(a particular part of the) system under monitoring. Here, buzzer is used as an alarm. This alarm produces sound when an intruder is found.

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Son alert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulse the sound on and off.

III. Simulation Result

The Keil C51 Compiler is a full ANSI implementation of the C programming language that a supports all standard features for direct support of the 8051 architecture have been added. The Keil A51 macro assembler supports the completer instruction set of the 8051 and all derivatives. Software files are created by the µVision IDE and are passed to the C51 Compiler or A51 Macro Assembler. The compiler and assembler process source files and create reloadable object files. The LIB51 library manager allows you to create object library from the object files created by the compiler and assembler. The BL51 Linker/Locator creates an absolute ELF/DWARF file using the object modules extracted from libraries and those created by the compiler and assembler. The µVision symbolic, source-level debugger is ideally suited for fast, reliable program debugging. The Simulated output results are shown in figure 8 and figure 9.

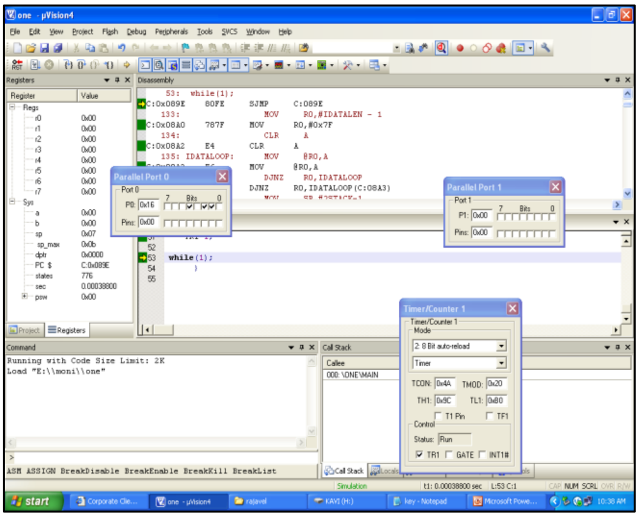
Fig. 8: Output window

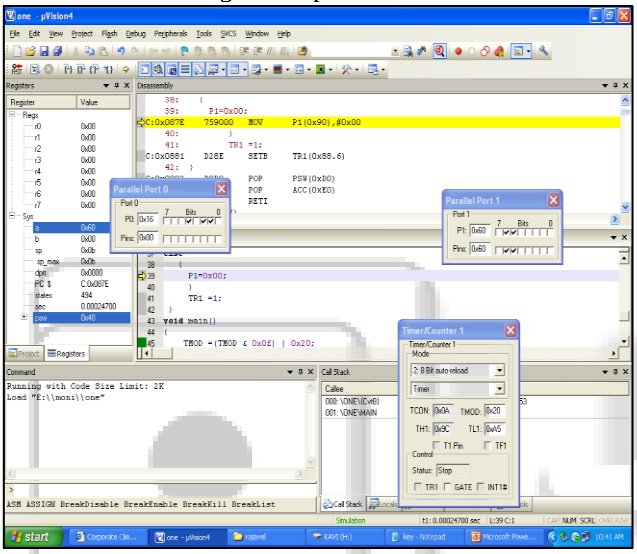
Fig. 9: Output window with change in status

The hardware setup and is shown in figure 10. The output of LM35 is noted and tabulated in table-1.

Temperature in °C	O/P Voltage in V
25	0.25
27	0.27
30	0.30
33	0.33
35	0.35

Table 1: LM 35 Output

The output of the temperature sensor is low, so that amplifier is used. The amplified output is shown in table-2.

O/P of LM 35 (°C)	O/P
27	1
0.3	1.5
0.33	2

Table 2: Op-amp output

The amplified output is converted into digital signal to perform the desired action with the help of ADC converter and the readings are tabulated in table-3.

O/P	ADC O/P
1	00110011
1.5	01001100
2	01100110

Table. 3: ADC Output

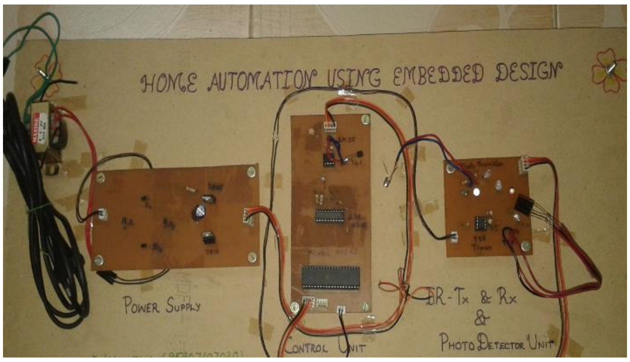

Fig. 10: Hardware setup of Home Automation System

IV. CONCLUSION

Thus, the "Home Automation Using Embedded design" solves the problem of maintaining room temperature; provide security from the intruder, and a remote light on/off control using micro-controller at the cheaper cost. This project provides a model which can be used anywhere and occupies less space.

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