Microprocessors Lab

Project Report

Automatic Appliance Controller with Room Visitor Counter

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Objectives

1. To count the number of people inside a room at any instant of time.

2. To switch on the lights when somebody enters an empty room.

3. To switch off the lights when everybody leaves the room.

Strategy

We used use of two Infrared transmitter-receiver pairs at the doorway to capture inward and outward movement. Blocking of either of these pairs indicates movement in the doorway. If the receiver closer to the exit is blocked before the receiver closer to the inside, it indicates inward movement, i.e. the number of people inside the room increases by 1. The same logic applies in reverse. Lights were supposed to switch on when the visitor count went from 0 to 1 and switch off when it went from 1 to 0.

The Electronics involved

We could not find very sophisticated IR sensors in Lamington road, so we had to make do with a simple IR sensitive diode (part of an IR Rx-Tx pair). The circuit can be broken down into four parts –

1. Transmitter Circuit

This was a very simple circuit to make. It simply consisted of connecting the IR Diodes to a 555 timer IC in monostable mode. The IC acts as a pulse generator, generating a continuous stream of IR pulses. Time period of the pulse was approximately equal to 1.1RC.

2. Receiver Circuit

This was a slightly tricky circuit to make. Again, it could be divided into two parts.

2.1. Receiver Circuit

IR Receiver Diode was linked to the timer 555 IC through a CL 100 switch. When the IR diode was conducting, HIGH voltage was appearing on pin 2 of the 555 (switch was in ON state), and LOW voltage was appearing on pin 3 (output). The exact opposite of this was happening when the light was blocked. The change in voltage on pin 3 was the foundation of our project.

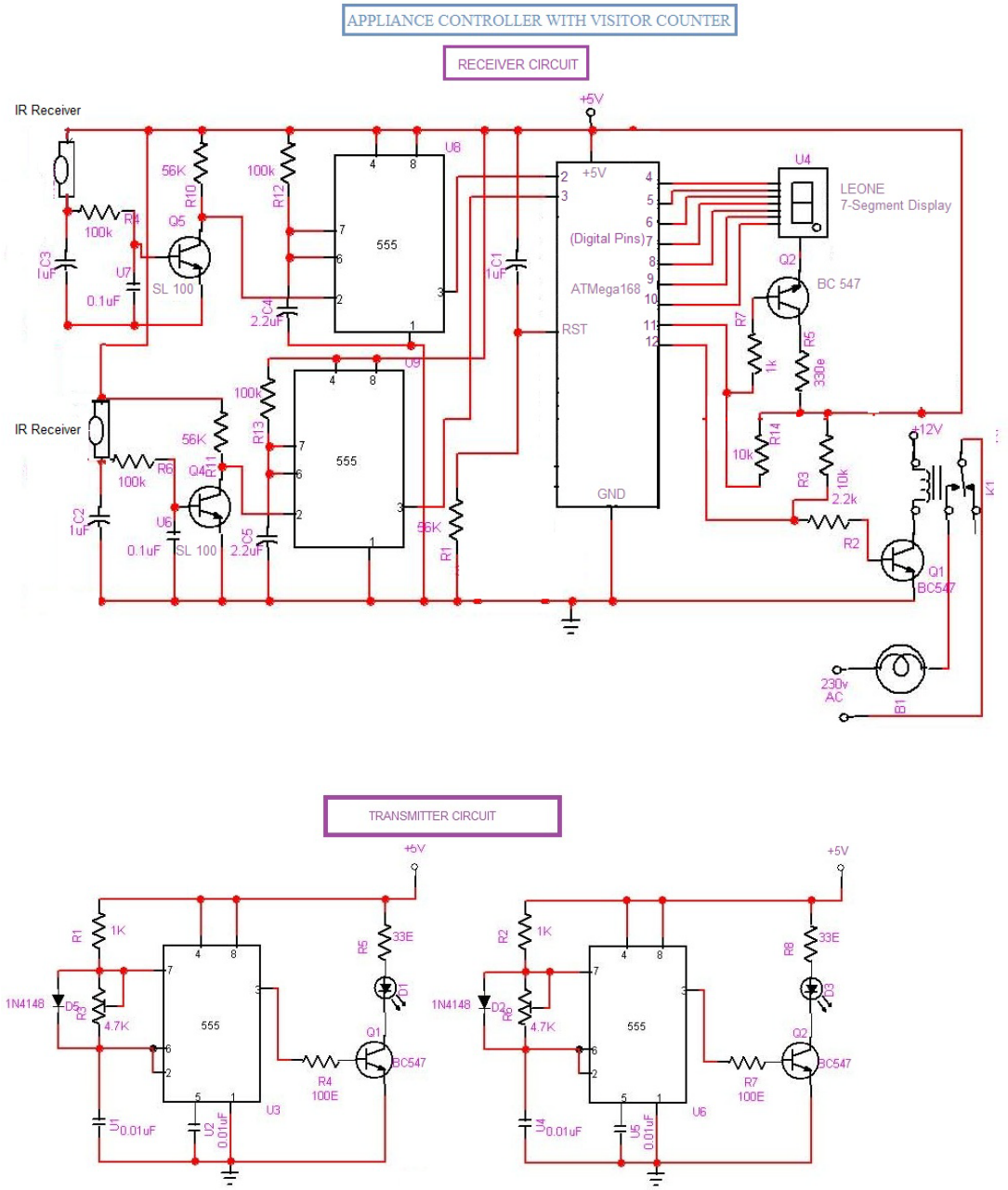
2.2. The 7 – Segment Display

Digital Pins 4-10 of the AtMega168 were connected to the 7 segment display, which was powered by pin 11 through a BC 547 switch. LOW output on pins 4-10 lighted up the corresponding segment of the display.

2.3. The Lighting Circuit

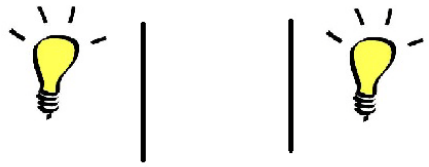
The Lighting worked through a relay, and the BC 547 switch. When the switch was ON, current would flow through the relay, throwing the pole to the NO pin, and powering the bulb. The switch was switched ON by giving LOW voltage through digital pin 12 of the AtMega168. This would happen when the visitor counter showed 0.

The circuit diagrams are shown below:

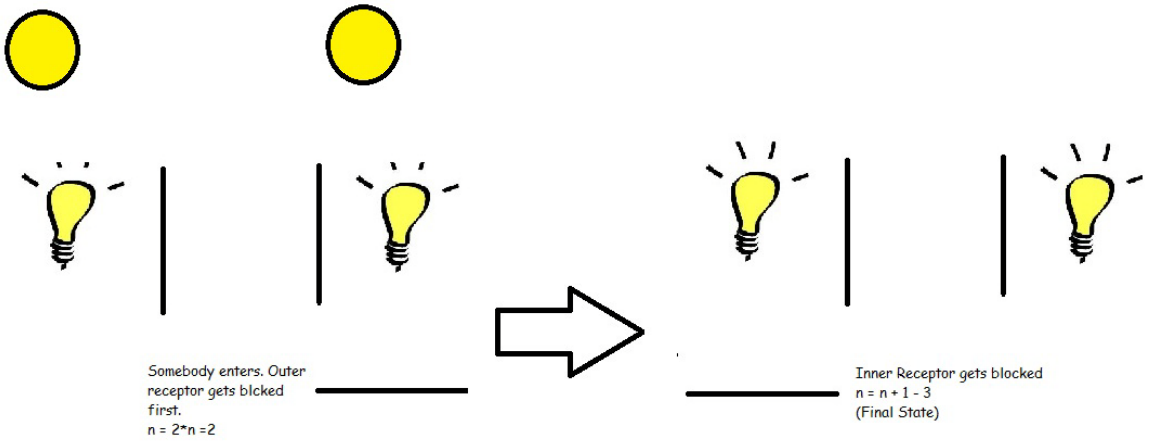


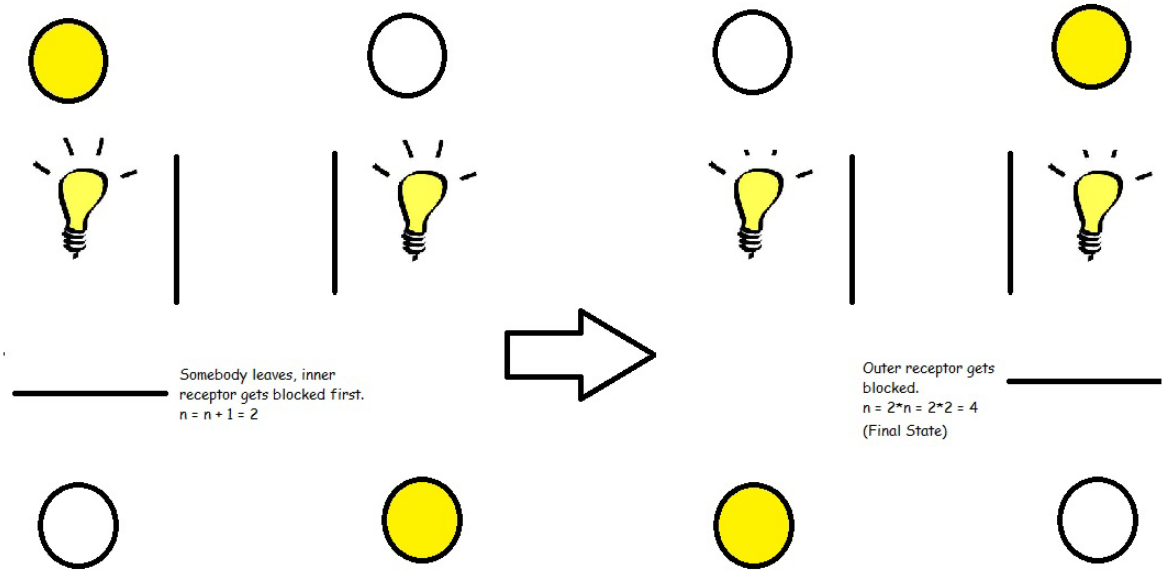
Programming Logic

The programming logic we used was very simple. Every time the outer receptor got blocked, a dummy variable n would be multiplied by 2, and every time the inner receptor got blocked, the dummy variable n would be incremented by 1.
Taking the initial value to be 1, the state at the end of the loop when somebody entered would be 2*n + 1 = 3.
When someone exited it would be 2*(n+1) = 4.Depending on whether it was 3 or 4 the counter would be incremented or decremented and the value would then be reset to 1. In pictures –



At time t = 0, n = 1





The change in signal would be tested by the use of interrupts at the pin 3 (Output) of the 555 Timer IC.
To switch the appliance off, a signal would be sent from pin 12 to the relay switch.

The code was subsequently modified to multiply n by 3 instead of 2. This was done so that complete walk-throughs could be distinguished from midway returns.

(1*2*2 = 4 = (1+1)*2)

(1 + 1 + 1 = 3 = 1*2 + 1) were problems with the older logic. No such problem takes place when the multiplicand is 3.

Cost of project: Rs. 150 only (barring wires, resistors, capacitors, breadboards)

Problems faced, measures taken

1. One problem we faced was connecting the relay to the bulb. Swapnali Ma'am, NTP Sir, and Prof. Sarin helped us out with this by soldering the bulb holder wires to crocodile clips which would be attached to the relays, as also connecting wires from the relay which would go to the breadboard. This was overcome, and we saw that the relay was working fine independently.

2. IR Radiation was not getting sufficiently blocked some times. This was overcome by first using Styrofoam caps on the receiver, and then replacing the IR pair by a photodiode, and switching off the lights. Thanks again are due to Prof. Sarin for his suggestions and help.

3. The IR Receiver circuit would sometimes inexplicably stop working. The problem was invariably solved by replacing the capacitor, though we could not figure out the reason for this. On NTP Sir's suggestion we tried changing the resistor attached to the transistor switch, to make the switch work more efficiently. This solved the problem.

Possible causes of initial failure

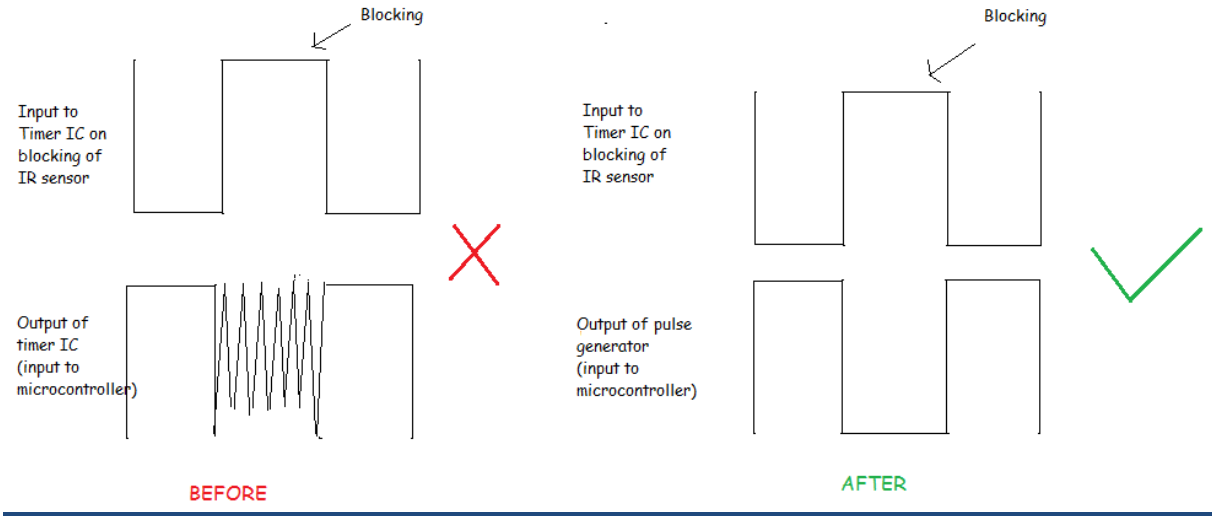
1. The sampling of the IR signal was happening too quickly, not giving enough time for the microcontroller to process the sequence, and calculate the number of visitors. It was also registering an interrupt for every single pulse it missed. This was resulting in 10-20 interrupts being registered every second, while the blockage had just been placed once and never removed.

2. The sensors were picking up random signals leading to inaccuracy of results.

Solution to the problem

1. As expected, the problem was the 1st point listed above. We modified the circuit a little bit to counter it. The output of the timer IC (pin 3) was used to power a pulse generator. The signal to the Arduino board was taken from the negative pulse terminal of the pulse generator. As you know, the negative pulse generator is at a constant voltage of +5V. When the pulse generator is switched off, this voltage falls to zero. The small pulses that are

generated by continuous blocking of the IR sensor diode are not slow enough to switch the pulse generator back on again. Thus, the pulse generator remains switched off until we unblock the IR sensor. The diagram below compares the two scenarios



Result

The circuit worked perfectly well. The only problem is with the blocking of IR sensors. However, this can easily be overcome with better quality receiver-transmitter pairs.

Things we learnt

1. Working of timer ICs.

2. Working of transistor as a switch

3. Theory of interrupts

4. Use of IR Tx-Rx pairs should be avoided

Work Division

1. Abstract – Devashish, Mukund
2. Components and circuit diagram – Devashish, Mukund
3. RX Circuit Assembly – Aashimi
4. TX Circuit Assembly – Devashish
5. Programming Logic - Aashimi, Devashish, Mukund
6. Circuit Debugging –Mukund, Devashish, Aashimi
7. Coding (7 segment display) – Mukund
8. Coding (Loop, Interrupts) – Aashimi
9. Code debugging – Aashimi, Mukund
10. RX Circuit Modification and Redesign – Aashimi, Mukund
11. Relay Circuit Modification - Aashimi
12. Report - Mukund