Chaotic LED Fireflies

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Here we couple LED oscillators together to produce some interesting effects for an exclusive optical touch to your robot.

As seen in the circuit diagram in **Figure 1**, instead of using the discharge pin on a 555, the timing capacitor can be charged and discharged using the output (via a preset P1). If we assume the 555's output resistance is very low (i.e. use a bipolar rather than a CMOS 555) this circuit provides a 50:50 mark-space ratio whose output frequency is independent of load. However, if we deliberately increase the output resistance by using a series resistor (R1) the timing will now also be dependent on the current taken by the load (because R1 will effectively drop the available charging voltage to the P1/C3 timing circuit).

Now, imagine a number of such oscillators whose outputs are connected to each other via current limiting resistors and bicolour LEDs (**Figure 2**).

A possible constellation of oscillators and LEDs, each with their own symbol from Figures 1 and 2, is shown in **Figure 3**. Each oscillator's timing will be dependent on the state of the other oscillators because these will determine the current that flows through the LEDs. For example, if all the outputs are High (or all Low) there will be no potential differences and so no current will flow through the LED circuits. In this case, all the oscillators will be at maximum frequency. Other combinations of outputs will light some of the LEDs and these currents will thus effect each oscillators timing. Chaos rules! The R1s therefore couple the oscillators to each other. A switch across each R1 allows control of the coupling.

Setting the oscillator frequencies to about 2 Hz with the P1s shows the complex flashing of the LEDs switching between off, red and green. Sometimes the LEDs seem to settle down pulsing together. This is rather like an electronic version of what is observed in nature when a group of fireflies congregate in a bush — they pulse together and maybe our little circuit is a simple version of this rather complex natural feedback system.

If the frequency is raised to ca. 100 Hz, varying mixing (beating) of the flashing red and green colours cause a 'wave' of changing colour to go through the array of LEDs.

Including light dependent resistors (LDR) in series with R1 might be a way of making each of our LED fireflies 'see' each other. Even without the LDRs, with three or more coupled oscillators there might also be the intriguing possibility of observing chaotic behaviour of the oscillators.

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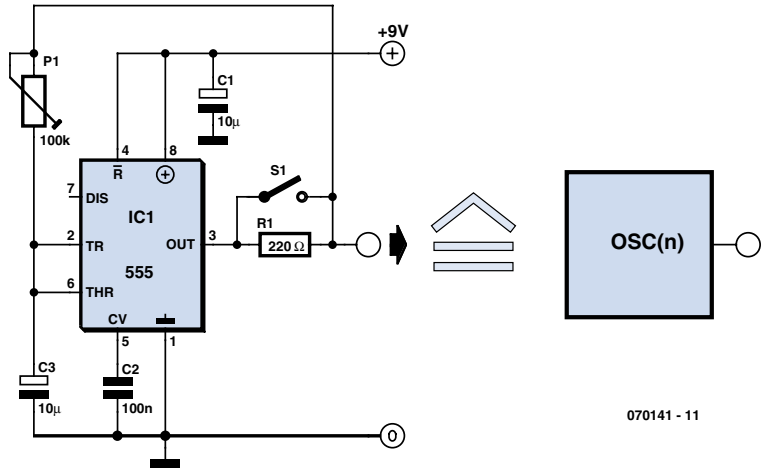

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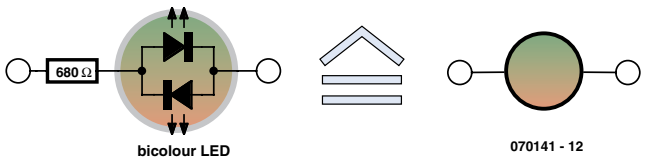

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