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Biomimetic Based Interactive Master Slave Robots

T.Anushalalitha[1], Anupa.N[2], Jahnavi.B[3], Keerthana.K[4], Shridevi.S.C[5]

Dept. of Telecommunication, BMSCE
Bangalore, India.

***Abstract*— The system involves two identical robots, where the movement is controlled through mutual interaction. The basic idea is- "The Master controlling the slave". This idea basically depicts the biomimitic behavior of insects where the group is monitored and controlled by the "Food Instinct" proposed by a single individual to the entire group based on mutually interactive principle. The cohesive working of robot involved, replaces human resources in activities like material clearance, cargo shifting, earth removal etc.**

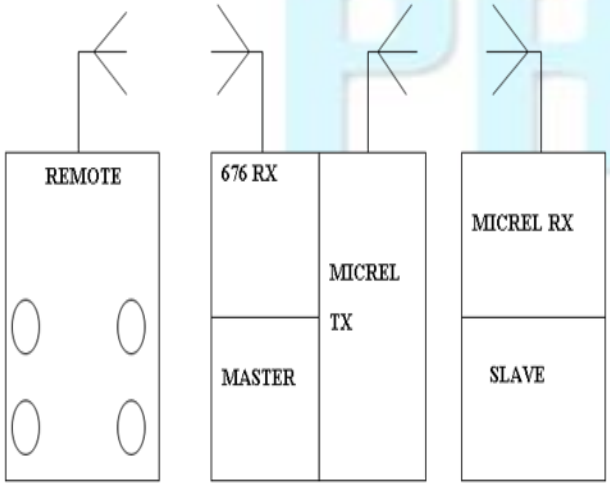
***Index Terms*— Master-slave robots, PIC 676, ATMEGA168**

I. INTRODUCTION

This system involves two identical wheeled robots that are capable of independent movement. The individual robot is well equipped with sensors that can sense and capture events in four quadrants namely N. E. W .S. The sensors connected at very specific to each robots. The Robots are equipped with sufficient data integrity to prevent false triggers. Sensor network is further managed to provide near and far triggers depending on the proximity of the two robots.

Sensors are arranged such that the master controls the slave. The master is controlled manually through wireless remotes. The movement of the master decides and controls the slave in a predetermined sequence.

II. BLOCK DIAGRAM



The wireless remote controls the master by sending some signals, and hence the master is controlled manually. The master performs actions as per the remote instructions. For every change in master's direction the slave performs some action. We use IR radiations for controlling the master and RF signals to control the slave.

The remote is coded such that it controls the actions of the master. Whenever the keypad is pressed the series of bits are encoded and sent through the IR led.

These bits are decoded at the receiver side i.e. at the master; these bits are sent to the microcontroller. The microcontroller recognizes the action to be performed and the instructions are sent to the motor driver which drives the motor and hence some action is performed by the master. The master can perform actions such as forward motion, reverse motion, spinning and pivot. These actions are controlled by the wireless remote. The master is basically designed to control the actions of the slave. It also has a encoder which encodes the bits received from the microcontroller. A series of encoded bits are sent to the slave using the SMD(surface mount device) transmitter. The master can control any number of slaves it depends the encoder we use.

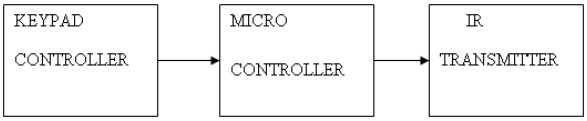
The proximity sensors are used to control the false triggers of the slave. These sensors are arranged such that the master will control the slave. It helps in maintaining the slave in the vicinity area. The output from the sensors is the input the microcontroller. The microcontroller decides the actions that must be performed by the slave to be in the vicinity area. These instructions are also encoded and transmitted to the slave. Two different microcontrollers are used for convenient purpose.

The master is provided with four proximity sensors. The sensor network is further managed to provide near and far triggers depending on the proximity of the two robots. The sensors will be the combination of visible and invisible light sensors. We also use the distance sensors to determine the distance between the master and the slave. The distance is indicated by the change in slave's action i.e. whenever the slave comes in the vicinity of the distance sensor the slave performs some reverse action to indicate that it's controlled by the distance sensor.

The two different microcontrollers are used to process the information obtained. The PIC microcontroller is used in

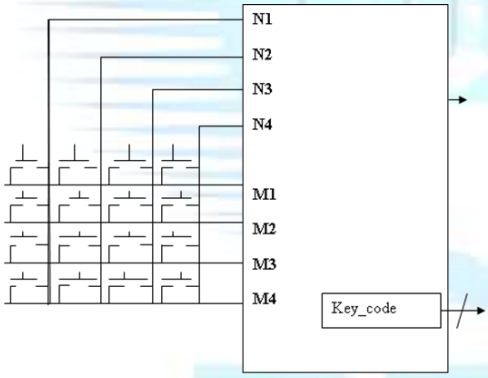
remote as well as master to process needs to be transmitted and received. The ATmega168 is used in master to process the information obtained from the proximity sensors in order to maintain the slave in the area of sight.

III. WIRELESS REMOTE



The block diagram of the wireless remote consists of a keypad controller, microcontroller and IR transmitter. The keypad controller has six keys each with different actions. The six actions performed are forward motion, reverse motion, spin left, spin right, pivot left and pivot right. The microcontroller is coded so as to implement the actions whenever a particular key is pressed. The key pressed is processed by the microcontroller and is transmitted to the master through the IR transmitter. The Infrared radiations are the short distance wireless signals which are transmitted through the IR led.

A. KEYPAD CONTROLLER

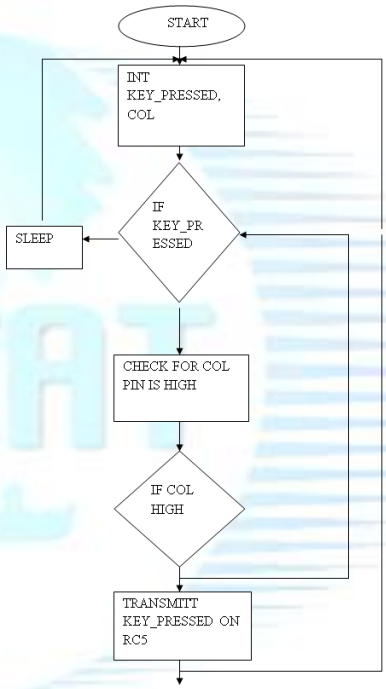


A keypad consists of a set of buttons that may be pressed to provide input to a microcontroller. A simple keypad has buttons arranged in an N-columns and M-row grid as shown in the figure. The device has a N outputs, each output corresponding to a column, and another M outputs, each output corresponding to a row. When we press a button, one column output and one row output go high, uniquely identifying the button. To read such a keypad from software, we must scan the column and row outputs. The scanning may be performed by a "keypad controller" . Actually, such a device decodes rather than controls. When the controller detects the button press, it strokes a code corresponding to that button into a register, key_code and sets an input high, kp indicating that a button has been pressed. Our software may poll this output and read register when the output is high. The pic 676 microcontroller is used for processing the pressed key.

B. MICROCONTROLLER (PIC676)

The pic 676 microcontroller is used for processing the pressed key. The Microcontroller checks for any key have been pressed. If not the microcontroller sleeps to conserve the power. Otherwise an interrupt is occurred and microcontroller goes to the subroutine to serve the interrupt by storing all the current status on the CPU. Now the micro checks for the column which has been pressed. If any of the columns corresponding to the row is high, the pressed key is stored in the pin RC5 and been processed and then transmitted.

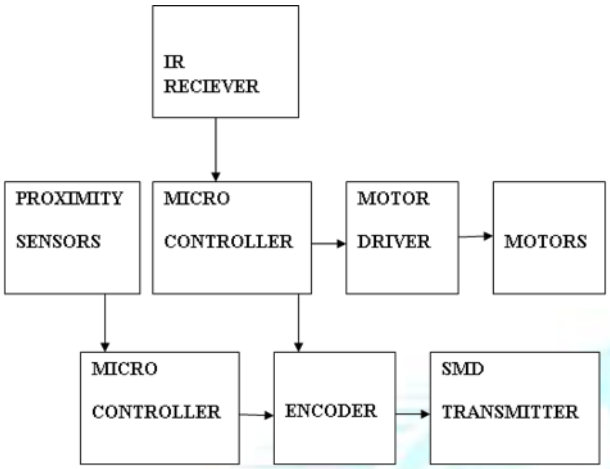
C. FLOW CHART



D. IR TRASMITTER/RECIEVER

The INFRARED uses electromagnetic wave frequencies that are just below the visible light spectrum, thus undetectable by the human eye. These waves can be generated by using an infrared diode and detected by using an infrared transmitter. An infrared diode is similar to a red or green diode except that it emits infrared light. An infrared transmitter is a transistor that conducts, when exposed to infrared light. A simple transmitter can send 1's by turning on its infrared diode and can send 0's by turning off the diode. Correspondingly, a receiver will detect 1's when current flows through its infrared transistor and 0's otherwise. The advantage of using infrared communication is that it is relatively cheap to build transmitters and receivers. The disadvantage of using infrared is the need for line of sight between the transmitter and receiver, resulting in a very restricted communication range. The frequency range for IR is 350MHz in UHF.

IV. MASTER



- The block diagram consists of IR receiver, proximity sensors, two different microcontrollers, motor driver, encoder, SMD transmitter and the motors. The IR receiver receives the signals and these are processed in the microcontroller. The processed output is given to the motor driver to drive the motors in particular direction as the manual instruction. And also to the encoder in order to encode the series of bits and then are transmitted to the slave through the SMD transmitter. The bits are transmitted serially to the slave. The number of the slaves depends on the encoder and the input to their address bits.

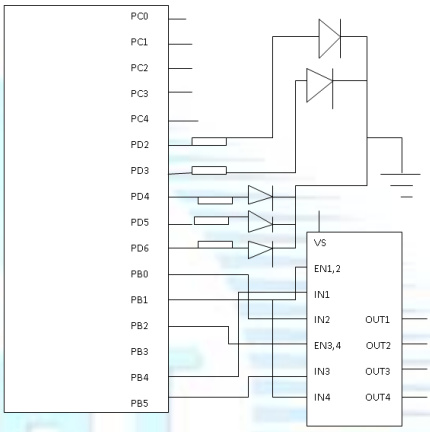
A. PROXIMITY SENSORS

- The proximity sensors can detect the presence of objects without physical contact. These often emit electromagnetic or electrostatic field or a beam of electromagnetic radiations, Ex- infrared, and looks for changes in the field or return signal.
- The object been sensed is often referred to as the proximity sensors target. The maximum distance that the sensor can detect is defined as nominal range. Proximity sensors can have high reliability and long function life because of the absence of mediator part and lack of physical contact between the sensor and the sensed object.

  Types of proximity sensors
  i. capacitive
  ii. Inductive
  iii. Magnetic
  iv. Photocell

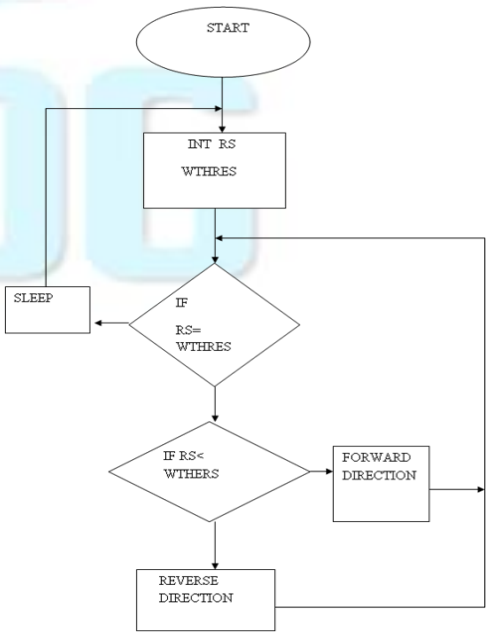
- A typical capacitive proximity has a 10mm sensing range. Conditionally the output of the sensor is always been difficult. A proximity sensor that measures current flow between the sensing electrode and the target provides freed outs in appropriate engineering unit. The sensor selection depends on the material to be sensed. When measuring the distance of a conducting surface proximity sensor tip size should be small when compare to the conducting surface for maximum linearity and accuracy. The distance between the target surface edges and the proximity edge should be atleast three times the gap length. Proximity sensors are divided into two halves and when these two move away from each other the signal is activated.

B. MICROCONTROLLER (ATMEGA168)



- The ATmega168 microcontroller is used to process the signal obtained from the proximity sensors. The advantage of using this is we can convert the analog signals to digital signals for the controlled motion. This is programmed such that depending upon the signal obtained from the sensors the microcontroller sends signals having the changes that have to be performed by the slave in order to maintain it in the area of vicinity.

C. *FLOW CHART*

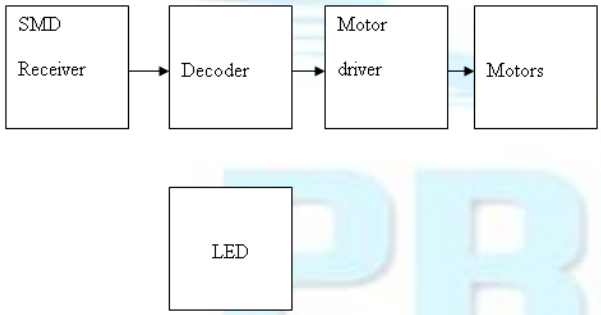


D. ENCODER

- The MICRF102 is a single chip Transmitter IC for remote Wireless applications. The device employs Micrel's latest QwikRadio technology. This device is a true "data-in, "monolithic device. All antenna tuning is accomplished automatically within the IC which eliminates manual tuning, and reduces production costs. The result is a highly reliable yet extremely low cost solution for high volume wireless applications. Because the MICRF102 is a true single-chip radio transmitter, it is easy to apply, minimizing design and production costs and improving time to market.

  The MICRF102 uses a novel architecture where the external loop antenna is tuned to the internal output stage. This transmitter is designed to comply with worldwide UHF unlicensed band intentional radiator regulations. The IC is compatible with virtually all ASK/OOK (Amplitude Shift Keying/On-Off Keyed) UHF receiver types from wide-band super-regenerative radios to narrow-band, high performance super-heterodyne receivers.
- The transmitter is designed to work with transmitter data rates from 100 to 20k bits per second. The automatic tuning, in conjunction with the external resistor, ensures that the transmitter output power stays constant for the life of the battery. The SMD works on the principle of superhet phase locked loop.

IV. SLAVE



The slave has an smd receiver, decoder, motor driver, led. The smd receiver receives the RF signals from the master. The decoder decodes the bits and these bits are transmitted to the motor driver in order to drive to the motors. The LED block is not connected to any of the blocks as it is only for the reference to the proximity sensors of the master.

The master can control any number of slaves. For this each and every slave has to be given unique number so that those can be addressed by the encoder. Hence the data sent to the decoder by a particular address will be the address of the slave which has to perform the relative actions. The slave can even be controlled as a sequence, each sequence performing different actions.

A. SMD RECEIVER

The MICRF002 is a single chip ASK/OOK (ON-OFFKeyed) RF receiver IC. This device is a true "antenna-in to data-out" monolithic device. All RF and IF tuning is accomplished automatically within the IC which eliminates manual tuning and reduces production costs. The result is a highly reliable yet low cost solution.

The MICRF002 is an enhanced version of the MICRF001 and MICRF011. The MICRF002 provides two additional functions over the MICRF001/011, (1) a Shutdown pin, which may be used to turn the device off for duty-cycled operation, and (2) a "Wake-up" output, which provides an output flag indicating when an RF signal is present. These features make the MICRF002 ideal for low and ultra-low power applications, such as RKE and remote controls. All IF filtering and post-detection (demodulator) data filtering is provided within the MICRF002, so no external filters are necessary. One of four demodulator filter bandwidths may be selected externally by the user.

The MICRF002 offer two modes of operation; fixed-mode (FIX) and sweep-mode (SWP). In fixed-mode the MICRF002 functions as a conventional superhet receiver. In sweep-mode the MICRF002 employs a patented sweeping function to sweep a wider RF spectrum. Fixed mode provides better selectivity and sensitivity performance and sweep-mode enables the MICRF002 to be used with low cost, imprecise transmitters The SMD IC is compatible with the superheterodyne receiver.

B. DECODER

The 212 series of decoders provides various combinations of addresses and data pins in different packages so as to pair with the 212 series of encoders. The decoders receive data that are transmitted by an encoder and interpret the first N bits of code period as addresses and the last 12_N bits as data, where N is the address code number. A signal on the DIN pin activates the oscillator which in turn decodes the incoming address and data. The decoders receive serial addresses and data from a programmed 212 series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then to the output pins. The VT pin also goes high to indicate a valid transmission. This will last unless the address code is incorrect or no signal is received. The output of the VT pin is high only when the transmission is valid. Otherwise it is always low..

C. MOTOR DRIVER

The IC L293D is used as a motor driver. The block diagram of L293D is as shown above. The output of the decoder or encoder is given to the motor driver in order to drive the motors. The left motor is driven by the input pins 2 and 7 along with the enable pin 1. The right motor is driven by the

input pins 10 and 15 along with enable pin 9. A led is connected in between the pin 3-6 and 11-14 in order to check the output.

D. TRANSMITTER/RECEIVER

Radio frequency (RF) uses electromagnetic wave frequencies in the radio spectrum. A transmitter here will need to use analog circuitry and an antenna to transmit data. Likewise, a receiver will need to use an antenna and analog circuitry to receive data. One advantage of using RF is that, generally, a line of sight is not necessary and thus longer distance communication is possible. The range of communication is of course , dependent on the transmission power used by the transmitter. The frequency range is 300MHz- 400MHz.

Typically, RF transmitters and receivers must agree on a specific frequency in order to send and receive data. Using, FREQUENCY HOPPING it is possible for the transmitter and the receiver to communicate while constantly changing the transmission frequency. Of course, both devices must have a common understanding of the sequence for the frequency hops. Frequency hopping allows more devices to share a fixed set of frequencies and is commonly used in wireless communication protocols designed for networks electronic devices.

LED's are the light emitting diodes. These are the semiconductor diodes which are usually the best light source used in robot management. The light is used as a reference to maintain the slave in the area of vicinity.

E. SENSOR MANAGEMENT

LED's are the light emitting diodes. These are the semiconductor diodes which are usually the best light source used in robot management. The light is used as a reference to maintain the slave in the area of vicinity. The sensor is a combination of a LED (light emitting diode) and LDR (light dependent resistor). The reflected light from the LED is detected by the resistor. Whenever the light is incident on the LDR the voltage is detected across the LDR which serves as the input to the operational amplifier. The sensor input may serve as either inverting input or non inverting input. The above circuit is a non-inverting comparator. As the name indicates it compares the values of two inputs. A comparator is commonly available in IC form. The LM339 IC is a typical example.

Distance sensors are used to calculate the distance between the two robots. The voltage received indicates the distance between the robots. The distance and the voltage are inversely proportional to each other. Whenever the slave comes in the vicinity of the distance sensor, the slave movements will be reversed to indicate that the slave is the vicinity of distance sensor.

$$\text{VOLTAGE} \propto 1/\text{DISTANCE}$$

The triangulation decides where exactly the sensor needs to be placed.

V. CONCLUSION

In this system of interactive master slave robots, the master is controlled manually and the slave is controlled by the master. The sensors and the coded system help in controlling the slave.

The sensors will be a combination of visible and invisible light sensors. A coded is used such that each sensor reacts to a specific signal and hence will be a fool proof. The cohesive behavior of the master and slave helps in

1. Material clearance
2. Cargo shifting
3. Earth removal etc

The following improvisations can be done

1. Vision capabilities for better control.
2. Co-ordinated behavior between individual works
3. Group control.

ACKNOWLEDGMENT

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