Design and Implementation of IR based Line Follower Robot for Cooperative Task Sharing

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ABSTACT- In this paper we introduce a task sharing demonstrate by relay race of robots. This race is analogous to relay race of human being. Each robot is designed using microcontroller P89V51RD2 which have distinguished addresses.

These robots are line follower also and capable to interact with each other using IR sensor. Present mechanism is important in various industrial applications where a task is divided into various modules or subtasks which is performed by separate robots.

KEYWORDS- Microcontroller, Sensor, PWM, Line Follower Robot, Task sharing, RTOS
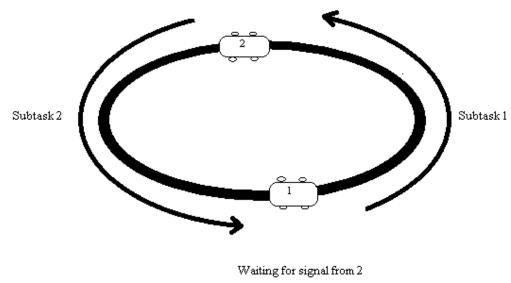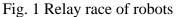
I.INRODUCTION

Task sharing plays very effective role in any sophisticated system. A complicated task can be converted into subtasks.

Each subtask can be performing by related module individually without any dependency on another module after receiving the signal from first module. In the present paper we perform a multi sharing task by two robotic modules tantamount of relay race performed by human being. This race completed using multiple persons. Fig 1 depicts the basic scheme of relay race. First robot runs on the path from start point, after some distance it gives a token or code to another or second robot using IR sensors. Second robot runs for remaining distance after receives signal. This process repeated again and again and tracks a complete path.

In the present system two robotic modules complete a task in two parts (subtasks). The whole working of robots is control by real time operating system RTX-51.

Waiting for signal from 1

Waiting for signal from 2

Fig. 1 Relay race of robots

Present task is perform in following three steps

- Implementation of Line Follower.
- Interaction between Line Follower using static addressing technique.
- Implementation of master and slave model.

A. *LINE FOLLOWER*

Line follower robots are mobile robots having ability to follow a line very accurately having an onboard hardware control circuit. As mechanical ways of performing various tasks have been discovered and the development of mechanics and complex mechanisms still going on in full swing, the necessity of automatic machines is ever increasing. This line or path may be as a physical as a simple line black line on the white surface or white line on the black surface or may be magnetic line on the floor. These schemes may be depend on the sensors [1]. These types of robots can be design using microcontroller. Fig 2 shows the photograph of line follower robot developed for present task.
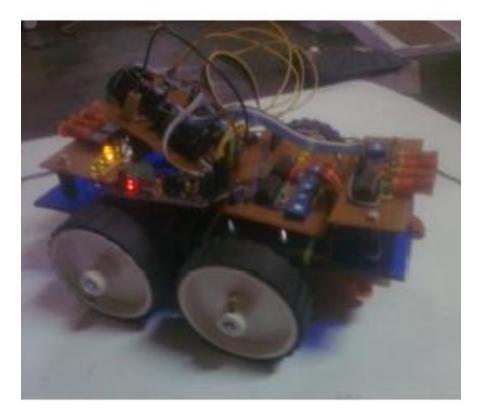

Fig. 2 Line Follower

II. HARDWARE DESIGN

We construct a system of 2 line follower modules for experimental purpose. This section presents our hardware design. Fig 3 depicts the basic block diagram of present system.

A. Sensor Array

In the present Line follower we use IR sensor to sense the line, Sensor array consist of five IR sensor pairs. IR sensor pair consist of two diodes that one of them sends IR ray and another one must receive it. IR LED emits infrared radiation. This radiation

illuminates the surface in front of receiver LED. Surface reflects the infrared light, Depending on reflectivity of the surface, amount of light reflected varies. This reflected light is made incident on reverse biased IR sensor. When photons are incident on reverse biased junction of this diode, electron-hole pairs are generated, which results in reverse leakage current. Amount of electron-hole pairs generated depends on intensity of incident IR radiation. More intense radiation results in more reverse leakage current. This current can be passed through a resistor so as to get proportional voltage. Thus as intensity of incident rays varies, voltage across resistor will vary accordingly. If the receiver receives the reflection ray, it means that the robot is on white and if it cannot receive it, so the robot is on black [2].
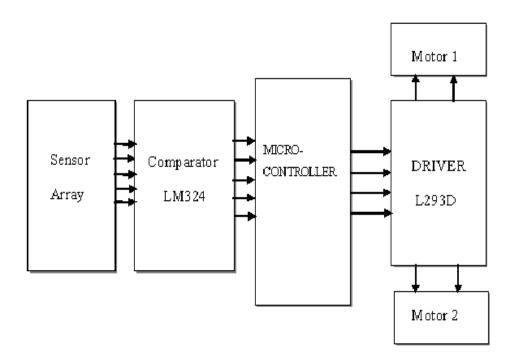
Fig. 3 Block diagram of Line Follower

B. Comparator

The Sensors Received signal must be converted to the digital form; comparator is a circuit that converts to signal and generates outputs accordingly. Comparator converts nature analog voltage into binary form. A good comparator IC is LM324, which consists of four independent, high gains and internally frequency compensated operational amplifiers. They operates from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage [2], [3]. Fig 4 shows the circuit diagram of comparator with IR sensor.
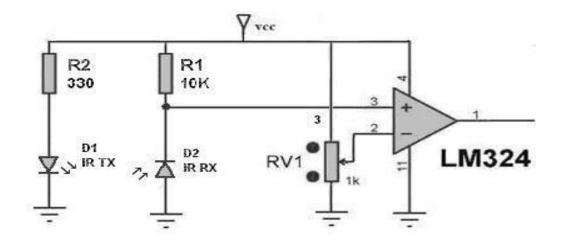
Fig.4 IR Sensor and Comparator circuit

C. Microcontroller

A microcontroller is an on chip computer like system on chip which contains a processor core, programmable input/output and memory peripherals [4]. Microcontroller 8051 is capable of doing all the required in this project. The P89V51RD2 is an 8051 family microcontroller with 64 kB Flash and 1024 bytes of data RAM. A key feature of the P89V51RD2 is its X2 mode option. In this microcontroller we can choose to run the application with the conventional 80C51 clock rate (12 clocks per machine cycle) or select the X2 mode (6 clocks per machine cycle) to achieve twice the throughput at the same clock frequency. Another way to benefit from this feature is to keep the same performance by reducing the clock frequency by half, thus reducing the EMI.

The Flash program memory supports both parallel programming and in serial In-System Programming (ISP). This microcontroller is also supported by ZRTX -51 real time operating system which is essential in present work for Inter Process/Task Communication. [5].

D. DRIVER

A driver IC used to control the motors. The microcontroller sends a signal to the driver that acts as a switch. If the signal received by the driver is high, it will rotate the motor or else it won't do so. Note that the microcontroller only sends a signal to a switch which gives the voltage required by the motor to rotate. Fig.5 shows the driver circuit for DC motor [2].
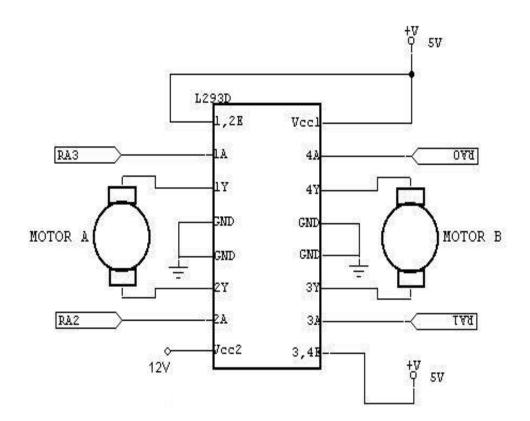
Fig.5 Driver circuit

The microcontroller sends instruction to driver after processing status of sensor array. Driver rotates motors according to input on it from microcontroller.

E. Motor

Movement is very important part in this. For this purpose motor and wheels are used. There are many kinds of motor. Selection of motor depends on the robot function, power, speed and precision.

DC gear motor is used in this project, Geared DC motors can be defined as an extension of DC motor. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable DC geared motors are widely used in robotics because of their small size and high energy output. They are excellent for powering the drive wheels of a mobile robot as well as powering other mechanical assemblies [7]. Fig. 6 shows the hardware of present system.
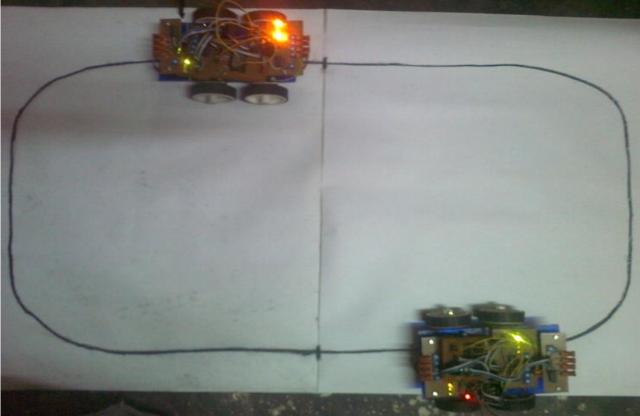
Fig.6 Relay Race Line Follower Robots

III. WORK FLOW

Present system is a model which shows cooperative task sharing in the form of relay race of robot. There each robot has separate address ID stored in it via programming. When module has got proper information on their ID detector which is basically a group of IR receiver, Whenever ID detector receive the signal its execute it release an semaphore to execute identification and validation process if ID is verified than it start to detect the sensor module of line follower and as per sensors reading module start its movement towards follow the line.

Sensor array consist of five IR sensor pair, each sensor has its own position and working. Output of sensors is analog voltage and little varies. Microcontroller only understands binary values because of this cause analog voltage needs to convert in binary form that is 1 or 0. Comparator is a device that compares two values and gives output accordingly. Comparator is also used here to compares sensor's output with reference voltage and gives output to microcontroller. Microcontroller sets commands and gives to motor driver. If right sensor activate then microcontroller generate PWM and controls speed of motor. Similarly act with left sensor. If center sensor activates then line moves forward. If left, right and center sensor activate at same time then all motors stop and microcontroller transmits a signal. It waits till appropriate signal then again run.

IV. SOFTWARE CONSIDERATION

A. Simulator

Fig. 7 shows the design on simulator. PWM is generating according to sensors activation which is shown in oscilloscope. There are five switches connected the place of IR sensors. That means close switch act as activate sensor and open switch act as deactivate sensor. There are four LEDs are connected at transmitter unit. This shows

some signal address in form of on and off condition. Similarly there are four switches connected at receiver unit. Microcontroller receives appropriate signal from these switches then it ready for all process.
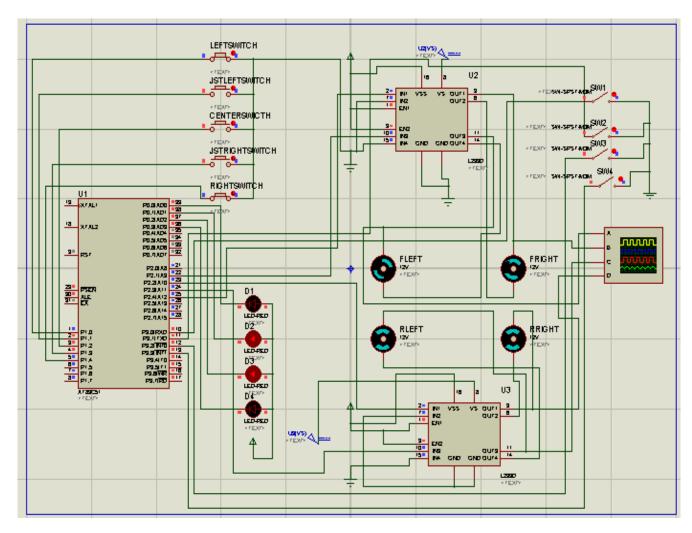

Fig. 7 Design on simulator

B. Algorithm

In start microcontroller check the sensor unit or receiver unit. Then verifies this address if it is correct then it continue process else it waits for appropriate address. If address is correct then it moves towards sensor array. If center sensor activate then all motors rotates and line follower move forward. Else if right sensor activates then motors rotates in manner that line follower move toward right. Else if left sensor activate then line follower move towards left. Else if left, right and center sensor activate at same time then all motors stop and transmit signal. It stops till not received appropriate address signal.

C. Flowchart

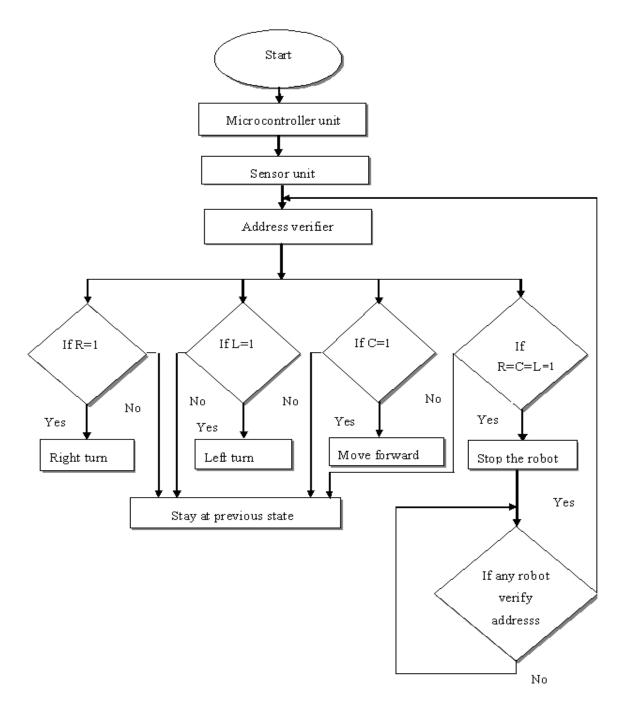Fig. 8 shows the flowchart of the present system.

Fig.8 Work flow

V. RESULTS AND CONCLUSION

In the present system we have got the desired operation of task sharing in the form of relay race done by robot. We use their IR sensor as wireless communication media but for safety pointof view another secure media is desire and in future we could implement this task using zigbee module. This model is very important inside any industrial applications where a complete task could be subdivided into subtasks and execute sequentially as per inter process communication tools

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