DUAL COORDINATION ROBOTS USING ZIGBEE MODULE

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***Abstract*— In this present work, interaction between the master slave robots is established which aims to use their correspondence to pick cotton and to manage the ones picked. A tricolor sensor (TCS3200) is mounted on the robotic arm to detect the presence of cotton. This tricolor sensor can differentiate and guess the contrasting colors (RGB). Also it reduces the complexity in image processing when a camera is used and is half the cost of an optimal resolution camera. Dexter ER2 robotic arm, a 5 axis robotic arm and a servo gripper is used as a slave robot to pick up the cotton from the plant. It used a 7 metal gear servo motors with a degree of freedom 5.ZigBee module with a higher range of 10 to 20 meters is used for robot communication, which is also cost effective. This paper demonstrates that the higher range of communication can be achieved via Zigbee than the Bluetooth module. In this paper, the proposed master slave technology reduces the complexity in computing hardware and software implementation. The entire setup is robust and requires only a one time investment.**

***Index Terms*— Tricolor sensor (TCS3200), image processing, robotic arm, servo motors, ZigBee module**

I. INTRODUCTION

Though the Right To Education (RTE) Act has been enforced by the government, its implementation is still a mirage in the countryside. Children as young as five years old are recruited and sometimes forced to work in cotton fields as they have nimble fingers and are of the same height as the cotton plant. The grueling labour attacks a child's physical and psychological development and locks them in poverty. The work presented in this paper aimed in replacing the fatiguing child labour in cotton fields and curb financial ruin. The idea was enacted by means of a master and two slave robots. The hardware requirements of the entire setup are the TCS3200 (tricolor sensor), Firebird 5 (IR sharp sensor, proximity sensor, DC geared motors), Servo motors, ZigBee module, Robotic Arm materials. The software requirements are AVR bootloader, ATMEL studio 6, Microsoft Visual Studio, DraftSight.

A sensor is used to identify the color of an object. It can be used to identify the colors which are RED, BLUE, GREEN and BLACK. This color sensor generates a square waveform. The frequency of the sensor varies when the sensor is exposed to different colors. Thus on the basis of different frequencies we can identify the color using this color sensor. There are three types of photodiodes in the color sensor (RED, BLUE, GREEN). To detect a given color we need to take the readings after selecting each photodiode separately. For example, if the given color is RED, you will get very high reading when you select RED photodiode and low reading when BLUE or GREEN photodiode is chosen. Output pin of the tricolor sensor (TCS3200) is connected to the PD0(INTO) of Atmega 2560.

Dexter ER2 Robotic Arm uses 7 metal gear servo motors with 15Kg/cm torque and two servo motors with 7Kg/cm torque. Robot Arm has 5 degrees of freedom which includes: Base rotation, Shoulder rotation, Elbow rotation, Wrist pitch and roll. Robotic Arm is powered by SMPS. It provides 5V DC for powering up the servo motors and 12V DC for powering electronics. Control card for the Robotic Arm is based on ATMEGA640 microcontroller. It has connections for 9 servo motors.

ZigBee USB wireless adaptor board is used for interacting any of the series 1 ZigBee wireless modules with the PC. Using this USB adaptor board for ZigBee wireless modules we can communicate between PC to PC, PC to robot/ embedded board with case.

II. PATH DESIGN

A line follower robot is automated device programmed to follow a specific path. They have a vital role in industries and domestic applications. Some of the existing techniques used in controlling the line following robot are by using microcontroller, guided tape method etc. Machine vision is an image processing technique where in pre-programming algorithm are used to process the obtained image. A camera is used to obtain the image of the track and the obtained image is processed using suitable image processing software and depending on the results generated the robot tracks the path.

The camera that is placed in front of the robot captures the track to be followed by the robotic slaves. The RGB image obtained from the camera is first converted into a gray scale image. Then the gray scale image is converted into its binary image and the complement of the binary image is taken. Then the centroid of the image is calculated and is compared with the centre of the image. If the centroid of the image coincides with the centre of the image, the line following robot is programmed to go straight. If the centroid of the image is shifted to the right or left from the centre of the image, the robot is programmed to take a right or left turn. Thus the line following is guided along its track.

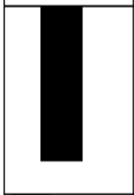
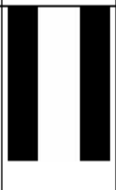
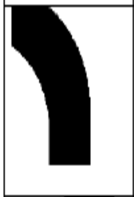
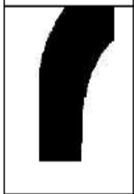
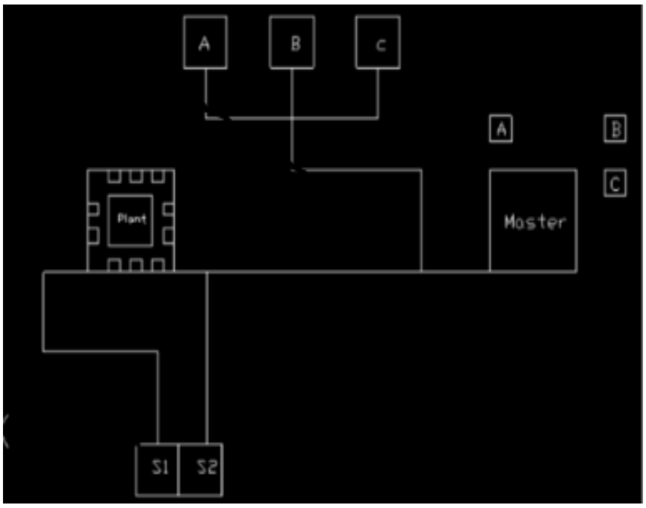
Captured image	Final processed image	Centroid (x, y)	Centre (x, y)	Programmed output
		(50.5000,51.000)		Goes straight
		(45.9599,48.824)	(50.50,50.50)	Turns left
		(59.1700,47.6294)		Turns right

Fig.1. figure showing the tabulation of the different values of the centroid and the motion of the line following robot as per centroid value.



Fig, 2. Example of a layout design.

III. WORKING ALGORITHM

The master is stationed at its appropriate position in the warehouse point. The two slave robots (s1 and s2) are stationed at the respective home points.

A. Sequence of Operation

The master signals the slave s1, to go to the cotton field set up by means of a line following mechanism. The slave s1, enters the field through a node which serves as a gateway. The slave uses white light sensors and traverses the path and reaches the next nodal point. A nodal point is where the white light sensors read black lines. The slave pauses here. Now the arm attached, actuates using a servo motor. The tricolor sensor mounted on the arm detects the presence of cotton. When the detection process renders a positive feedback, the arm moves up the required height and plucks the cotton by the combined action of all the pin constrained points. The process takes place until the required node is encountered and upon completion, an acknowledgment signal is delivered to the master by s1with the number of cotton plugs collected.

B. Operation of Slave s2

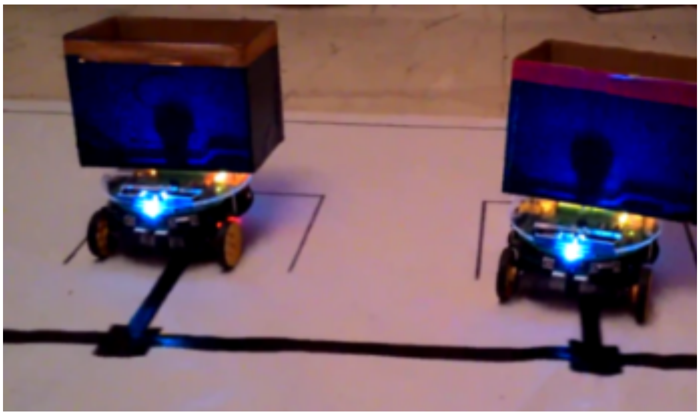
The master now signals the slave s2 at its home point to collect the cotton from s1. In the meantime, the master arranges the number of boxes required to keep the cotton. S2 navigates to the nodal point where s1 operation terminated and collects the cotton from s1and delivers it to the master. s2 delivers a 'task completed' signal to the master. Now master signals s1 to reach its home.

C. Master Operation

The master robot packs the cotton into the boxes and then signals s2 to deliver the package to the respective places in the warehouse. Upon completion of the task, another 'task completed' signal is corresponded by the slave s2 to the master. The master receives the acknowledgment and signals s2 to go its home. The communication between the robots is achieved by means of a ZigBee module.

IV. RESULTS

The master slave technique is implemented using the example layout shown in Fig. 2 is and the algorithm is tested. From the obtained result Fig. 3, it is observed that by using ZigBee provides a higher range of communication between the robots that are separated by a distance of 10 to 20 meters. Also the tricolor sensor used was able to differentiate and guess the presence of cotton with the help color sensing. Thus the proposed master slave technique reduced the complexity in hardware and software implementation.



Fig, 3. Screenshot of a video implementing the master slave technique using line following mechanism.

V. APPLICATIONS AND FUTURE WORKS

The proposed master slave technique via ZigBee module can be applied to military applications such that the loss to human life can be reduced to a greater extent. Also this work can be applicable in medical field where the human power can be replaced by these robots and the operations done by the robots can be achieved with a high degree of accuracy.

VI. CONCLUSION

In this study, a novel algorithm was developed to implement the master slave technique via ZigBee module and path tracking is done using the line following mechanism based on image processing. The 2D vision algorithm was implemented in a line following robot and was found to be an effective replacement for the existing sensor based image processing techniques.

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