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A Localization Algorithm Using IR Receivers and LEDs for a Line Following Robot

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Abstract: **Designing a line follower robot, that decides its path autonomously. For localization, IR receivers and LEDs are used. The robot is simple but effective, having a straightforward design to perform line following and localization that is easily implementable and has less complexity.**

Keywords: **IR receiver, Light Dependent Resistors (LDRs), Light Emitting Diodes (LEDs)**

I. INTRODUCTION

Robot is a machine that is a combination of electronic circuitry and a computer program [1]. Robotics is a scientific discipline which needs a high level knowledge in the fields of computer science, as well as electrical and mechanical engineering and high-performance modular control systems [2]. For autonomous and semi-autonomous robots, localization is the necessary part, from which it knows “where it is” and “where it has to go next”.

A line follower is an autonomous robot that detects and follows a line. The robot follows the line with Light Dependent Resistors (LDRs) and white Light Emitting Diodes (LEDs) that are installed on it. The robot senses a line and stay on its course while correcting the wrong moves using feedback mechanism. For localization, the robot normally uses a pair of infra-red (IR) transmitter and receiver. This technique is known as Infra-red Active Badge System. But the same results are obtained by using IR receivers; and LEDs used for line following. Hence, the robot will be able to move in a virtual created environment using fuzzy logic. We used multi-sensor fusion technique to gather information from different sensors in providing a best estimate of the robot's position.

II. RELATED WORK

A lot of work has been done and new methods are still being proposed for localization. From [3], different color coded landmarks shall be used for self-localization on the field. The use of such color coded landmarks strongly relies on color classifiers, which are very sensitive to external light conditions. So to get a system which works under natural light condition one has to extract more shape oriented features from the images. In [4],use of active marker was demonstrated in outdoor environment which stated that the best results can be obtained with a series of high brightness LED’s, while for indoor use infra-red LED’s could be used with good results, even if the sensor of the webcam is not very sensitive in infrared region. The LED clusters are controlled by a microcontroller unit connected via a serial line to the robot PC that could run a suitable autonomous DCDT (Device Communities Development Toolkit) member. Another method used infrared targets and receivers to build an infra-red active badge system. The infra-red receivers were mounted on doors, walls and corridors. When one of the receivers received the active infrared signal which was broadcasted by the tags worn on the building’s occupants, the system could locate the occupants around the receiver [5]. Also, when an Access Point or a choke point (which can provide more accurate localization information with shorter signal transmitting distance) in a Cisco unified wireless network receives a Wi-Fi device signal, the system assumes that Wi-Fi device is close to this AP or chokepoint. This device’s location is estimated to the same as the location of AP or chokepoint. The highest location accuracy of CISCO Wi-Fi localization system is a few inches [6]. We combined a simple line following technique and infra-red active badge system to reduce the complexity of integrated design.

III. HARDWARE & SOFTWARE DESIGN

Multi-sensor fusion technique collects information in terms of voltages from different IR sensors in providing a best estimate of the robot's position. For localization, IR receivers and white LEDs (for line following technique) are used. Robot stays on the line by using LDR-LED circuitry and the current location is estimated when the light of an LED of the line following robot falls on IR receiver and is continuously updating its location till the robot is moving. Instead of using the pair of IR sensor, only IR receivers were used and alternatively for IR transmitter, the LEDs that were deployed for line following gives sufficient value to update the location.

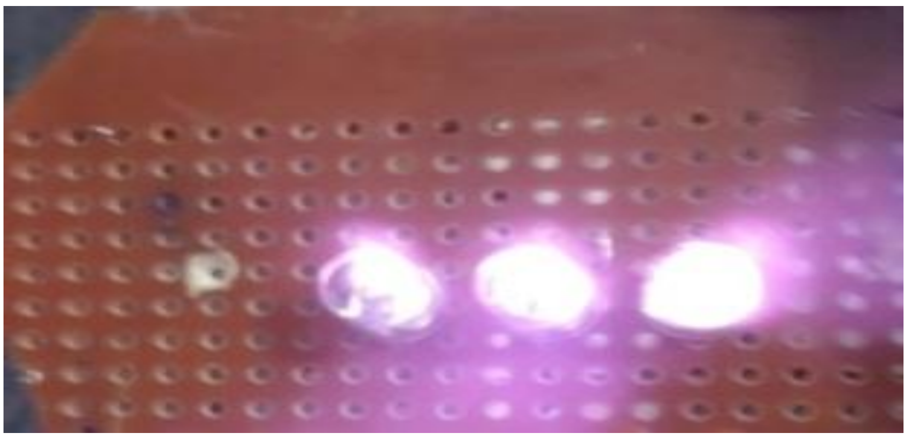

Figure 1: Powered up IR Transmitters

A unique address is defined for each IR receiver and that address can be sent to the robot via wireless or wired communication medium. After the location is updated, the next move of the robot is decided using fuzzy logic.

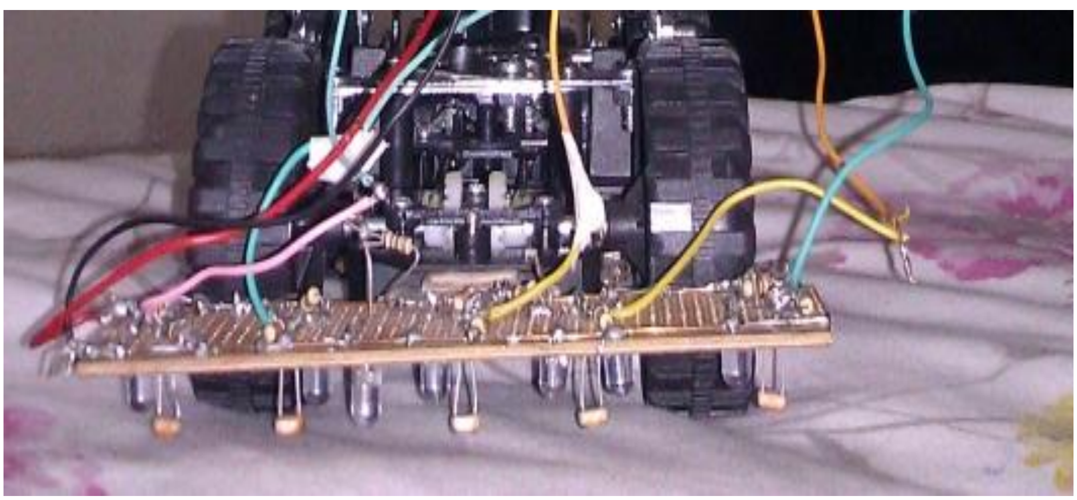

Figure 2. LED-LDR circuit for line following

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Figure 3. IR receiver placed in black line

IV. RESULT

The process of localization was successfully implemented and tested by using IR receivers and LEDs by setting the threshold value for which the system is sensitive enough to detect.

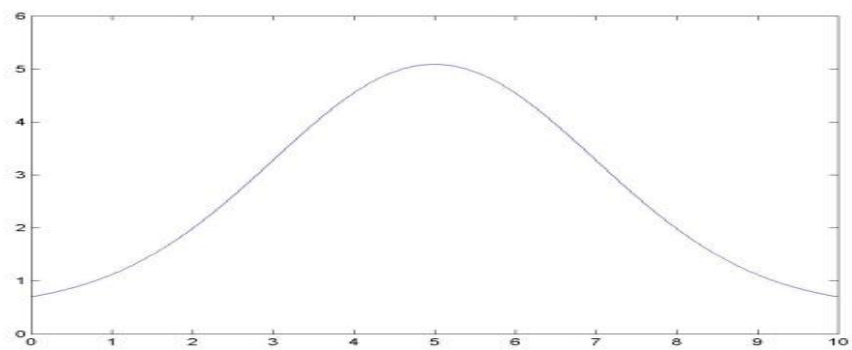

Figure 4. When IR Tx & Rx are in LOS

The unique address was sent from a micro-controller connected to the IR receivers by using micro-controller's analog pins and by using a comparator as well where the threshold is defined. Once, sufficient value is detected on any IR receiver, the address of that sensor is sent to the robot by using a wireless module and further action is planned the robot accordingly.

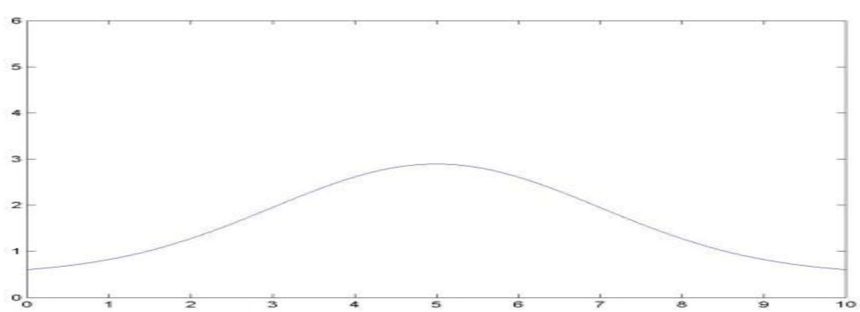

Figure 5. When IR Receiver is LOS of an LED

V. CONCLUSION

Instead of using a pair of IR sensor, IR receivers and LEDs (for line following) are used, where LEDs are exploited as transmitters. As the IR receiver gives sufficient value at the output when the LEDs come close to an IR receiver, we can effectively say that we obtain similar result if we use a pair of IR sensor.

By combing the two techniques, i.e. the line following technique and infra-red active badge system, line following and localization can be effectively performed by low cost and the system results in less complicated circuitry that results in accurate estimation of the robot.

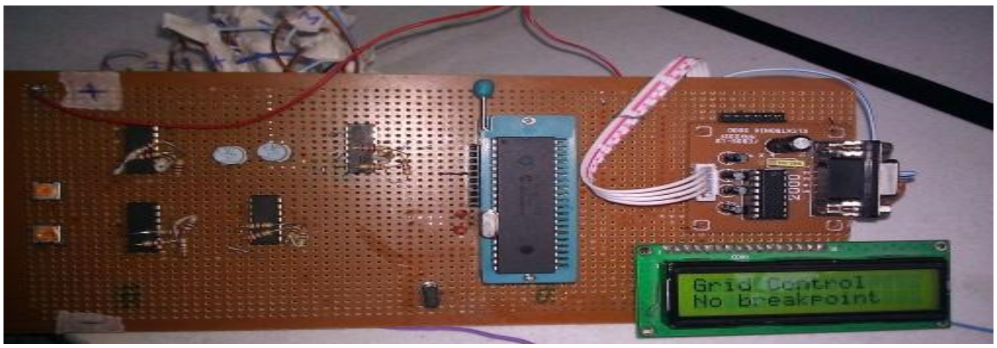

Figure 6. One micro-controller connected to several IR receivers by using comparators

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