OPTICAL SENSOR SYSTEM FOR OBJECT DETECTION

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Abstract: *In this paper optical system for object detection is presented. Hardware realization is explained in details. Different approach for object detection is described in this paper, advantages of our system are discussed and hardware realization is explained in details.* **The** MCU decodes received data and only if code is correct, MCU is responsible for generating of coded data which are sending to IR transmitter, and for decoding signal from IR receiver. it send information that object is detected. *System is realized and used in robotic competition.*

Key Words: ***optical, detection, sensor***

1. INTRODUCTION

Motivation for the sensor system shown in this paper comes from years of participation of authors in EUROBOT [1] competition. For autonomous robots which must operate without human interfering. The autonomous robot has information about obstacles on the playing field during the whole duration of the match. There are many systems used for detecting of objects, depending on the type of the robot and location, where it will be used indoors or outdoors, etc. Most of these sensors are developed for industry; usually these sensors are large in dimension because of rugged enclosures needed for industry [10], [15]. Robotic Sensor system presented in this paper is similar to optical sensor used in industry, hobby electronics and other fields where detection of object is needed, but with use of microcontroller its features is significantly increased. In this paper, we first describe some of the existing and frequently used sensors for object detection in EUROBOT competition, and then we describe our sensor system.

2. SENSORS FOR OBJECT DETECTION

There are many sensors which can be used for object detection, we will describe some commonly used in robotics Mechanical switches-very reliable, but with very small detection range, up to couple of centimeters Ultrasonic sensors[2]- They are simple and low-cost. They can be used for detecting distance of the object but are not very useful for robotic competition, because many robots used similar system, so often this kind of sensors make wrong measurement. Optical sensors- there are many types of these sensors, usually used in industry, some of them can detect distance of the object. These sensors are also unreliable in robotic competition because of use of system with light transmitters on similar wavelength, mainly for robot localization [3], [8] Camera systems with image processing [4] are most sophisticated. These types of systems suffer from problem of variations in environmental illumination, complex algorithms and quality hardware must be used to operate in these conditions.

OPTICAL SENSOR SYSTEM FOR OBJECT DETECTION

A. Block diagram

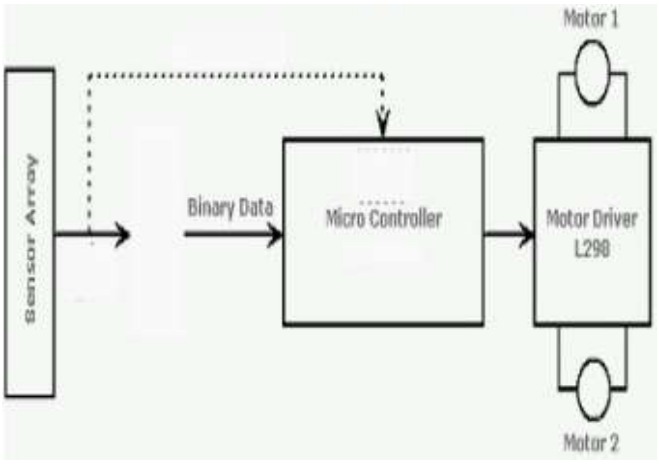

Fig 1. Block diagram of MHR

The Basic Block Diagram of the MHR consists of 3 blocks as showing in the figure, namely, 1. Photo Logic Optical Sensor Module. 2. Microcontroller Module. 3. Motor Control Module. PATH FOLLOWING BY SENSOR SIGNALS. The sensors are aligned so that if the MHR is centered on the track, then all the three sensors can see track-the output from all detectors will be high and the robot will continue in the previous direction. Sensor system is based on simple detection of infrared light, send by IR transmitter, to IR receiver by reflecting from detecting objects. Transmitter and receiver are parallel and as close as possible to each other, pointed at the same direction. To make our sensor system unsusceptible to other sources of infrared signals, microcontroller (MCU) sends coded data to IR transmitter. To receive this signals we use TSOP7000 infrared (IR) receiver[14], which receives the signal modulated on 455 kHz (signal period of 2.2 us), Fig 2.

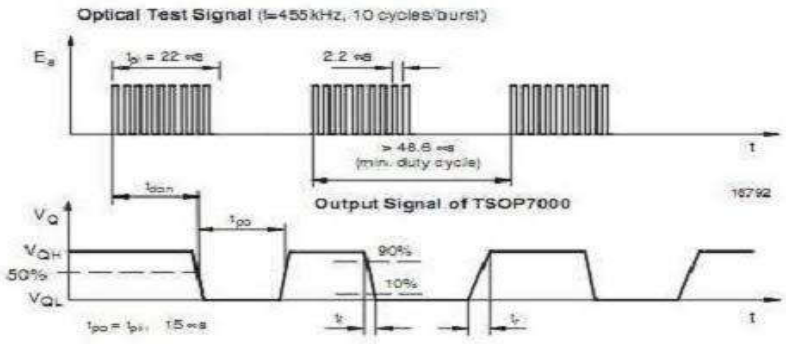

Fig. 2. Coded transmitter signal and output signal from TSOP7000

To further ensure that no other source of infrared light can influence our system, TSOP7000 IR receiver is placed into in a casing with two parallel slits (Fig. 3.), so only infrared signals directly in front of casing can reach IR sensor.By changing current send to transmitter diodes, this system can be used for distance detection. With different currents values in transmitting diodes, different amount of light is emitted to detecting objects. If reflected signal is too weak, TSOP7000 will not receive correct data pattern. Reflected light is proportional to emitted light and distance from the sensor, so receiver detects correct data pattern on different distances for different transmitting current.

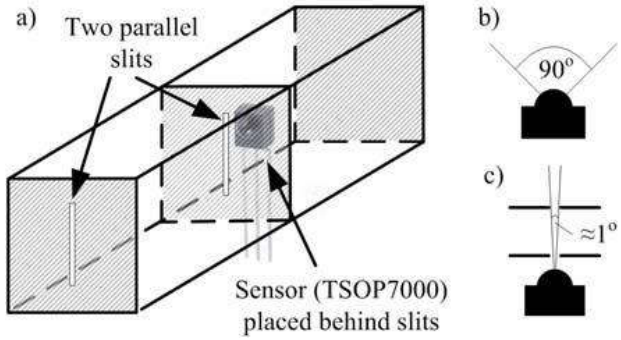

Fig. 3. Sensor packaged in a casing with two parallel slits

B. Power supply and RS-485 interface

Schematic of power supply and RS-485 interface is shown on Figure 4.

Power supply is realized with simple high-efficiency step-down (Buck) regulator LM2575 [11], requiring a minimum number of external components. Using of switching regulator enables this system have wide range of input DC voltages ,from 7V to 35V, with small losses, so there is no need for heat sink.

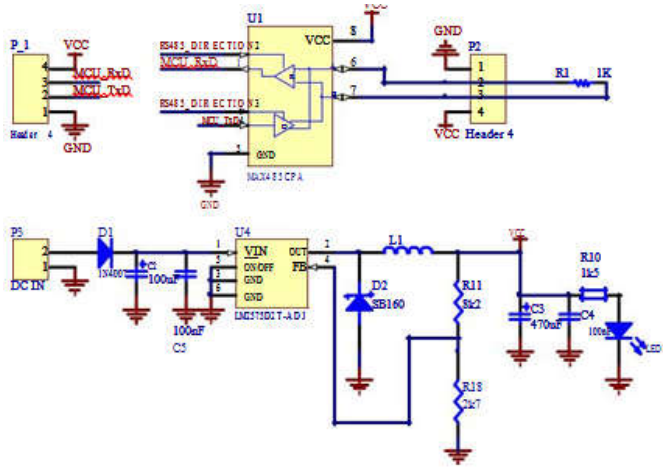

Fig. 4. Schematic of power supply and communication

Fig. 4. Schematic of power supply and communication RS-485 interface is realized with MAX485, low power transmitter with maximum transmitting rate of 2.5 Mbps [5].RS-485 interface is used because of its simple implementation, enabling connection of large number of devices over same line. Since it uses a differential balanced line, it resists electromagnetic interference from motors and other actuators, which is very important in robotics.MAX 485 is connected to serial interface of MCU, and in addition it needs only one digital signal for direction of current communication, so this interface can be easily implanted on almost all microcontrollers, all modules on robot use this interface

C. MCU block

As microcontroller for this system low-cost Atmega128 is used, this controller was selected because of its RISC Architecture, which enables maximum of 16 MIPS [6]. This controller can work with almost no external components. Also, this controlled has 53 I/O lines, which enables large number of sensors to be implemented on same MCU, which is very useful for systems with limited space. This system can work with eight IR transmitter/receiver pairs.

Modbus is used as communication protocol [12] in this system, this communication protocol is selected because is simple and robust, and since it is widely used, especially in industrial application, implementation of this sensor on other systems is very simple. Its implementation is easily achieved even on slower MCU, since it is openly published and royalty-free, main restriction is need for maximum priority of serial interrupt routine.

MCU is in-control for generating of coded data which are transfer to IR transmitter, and for decoding signal from IR receiver. When command for detecting of object on selected sensor is received from communication interface, MCU continually decodes signal from sensor, until command for reading is issued over Modbus protocol, when MCU sends information if object is detected or not , depending if correct data pattern was received or not[13].

D. Current control

Current control is realized with ULN2803 [7],[9] which consist of eight NPN Darlington connected transistors, so depending of the input signals on ULN2803, any of four resistors, R1 to R4, can be connected to ground, so by combining these resistors wide range of current on transmitter diodes can be selected. Since coded patterns needs to be send with IR transmitter, shown on Fig.2, which is realized by switching current on and off, switching of the selected resistors must be synchronized. Used MCU is 16MHz RISC controller, and ULN2803 can work with frequencies above 1MHz, so switching delays between resistors are negligible.

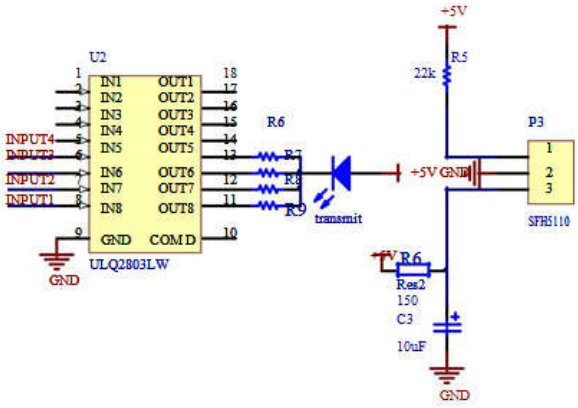

Fig. 5. Schematic of current control block

In this system one ULN 2803 is used for current control of two transmitters, in total four ULN2803 is used in this system.

4. MEASUREMENT RESULTS

Optical system was tested in laboratory conditions and during robotic contest “Eurobot”.After calibration on known object, this system vas very reliable on detecting of objects of same kind. By using current control detected range can be changed, but the system was most reliable on ranges from 1cm to 40 cm, where system was completely unsusceptible to external influences.

Only known object can be detected since dimension, shape and color of detecting object changes quantity of light reflected from its surface. Similar objects with small variations in these characteristics can be detected with proper calibration, but this system cannot simultaneously detect two different objects. This system can be also used for detecting distance of known object. If system receives command to detect distance, it will start to change IR current in several steps, starting from smaller to higher values. When correct data pattern is found, distance will be determined from IR current needed for correct decoding. Maximum accuracy of distance which was achieved with this system was 5 cm. Higher accuracy could not be achieved, since it would require more resistors for higher resolution of IR transmitter current, but significantly better results would probably be impossible with this system, since even small variations in reflected light would make errors in measurements.

5. CONCLUSION

In this paper simple and cost effective object detection system is presented. This system is designed primarily for use in robotic competitions, but with small alterations it can be used in other application where reliable detection of the objects is needed. By implementation of Modbus protocol, it is prepared to be used with wide variety of equipment. When object for detections have known characteristic, their distance can be roughly found

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