Programmable System on Chip Based Gesture Controlled Robot

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***Abstract*—The paperdiscusses design and implementation of an accelerometer based hand gesture controlled car-robot using Programmable System on Chip .The main aim of this paper is to highlight the need and use of gesture controlled robots with minimum hardware use. This system was implemented using PSOC3 devices , RF transceiver and a motor driver. The analog values from an on board accelerometer were processed digitally at the transmitting end and data in the form of characters was sent to the receiver which guided the car-robot accordingly.**

Keywords*—*Programmable System on Chip,Accelerometer,RF transceiver,motor driver.

I Introduction

Automation is the basis of development of Humanity and is a general trend in the technical progress. This has encouraged use of robots in almost every fields. However there are certain applications which require human involvement in controlling the robot.This paper presents an Accelerometer based hand gesture controlled car-robot using Programmable System on Chip.This approach using accelerometer is more intuitive. Using this system a newcomer can control the robot easily and in a natural way. It also offers wireless control which enhance its possibilities even more. Besides less Hardware and flexibility in designing and programming due to the nascent technology of Programmable System on Chip, adds to its advantages. Cypress Semiconductors developed PSOC in the year 2002.It has an advanced 8051[1] or ARM Cortex[2] CPU and an array of configurable blocks with programmable routing. This makes the PSOC platform very versatile and flexible. The PSOC has an Integrated Development Environment called PSOC Creator which removes the complications in C coding and focuses more on programming using block diagrams. This gives the PSOC platform great potential for fast prototyping and experimenting.This hand gesture controlled car-robot uses minimum hardware because of the use of the highly effective PSOC platform. The PSOC platform provide advantage of less hardware use and very high configurability of that hardware over most microcontrollers . PSOC optimizes design as per the required functionality and thus energy optimized compared to a typical microcontroller. Also PSOC provide high flexibility in programming and prototyping than FPGAs or CPLDs. The CC2500 RF transceiver and the motor driver L298 are very easily interfaced with PSOC3. The highly configurable ADC on the PSOC3 board convert the digital data into analog and the UART module transmit it serially, thus avoiding the use of external ADC and UART module.

A. PSOCProgramming

PSOC is a System on Chip which has programmable components, programmable input output pins and programmable routing. The components are analog or digital blocks which can be configured according to the required applications. This components are represented by icons that users can drag and drop into a design. These blocks are created using Universal Digital Blocks[3].Thus the number of these configurable blocks are limited by the number of UDBs available to the particular PSOC.The input output pins are also used in design which can be configured as analog or digital input or output. These pins are called as design pins. The routing is obtained as per the connections made in the design between the components. After creating the design, the design pins need to mapped to the physical pins on the PSOC board. The components in the design include a set of dynamically generatedAPI[4] libraries. After the configuration Firmware is written and compiled within the PSOC Creator.

B. Hardware Used

2 PSOC3 BOARDS

PSOC3 has a 8051 central processing unit(CPU).The PSOC3 board consists of an onboard accelerometer. It provides high accuracy and flexibility . It has an onboard analog accelerometer with 3 analog outputs in x, y and z directions. Each measured axis represents a separate Degree of Freedom.

Fig.1. PSOC3 board.

RF transceiver CC2500

CC2500[5] is a low cost transceiver working at 2.4GHz.It is used for wireless communication .

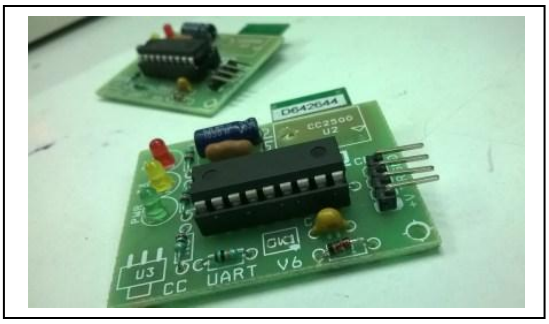

Fig.2. CC2500 RF transceiver.

C. Motor Driver L298

The L298 motor driver[6] consists of a dual H-bridge chipand can drive 2 DC motors at a given time. Besides it has a 5V voltage regulator, switches which can holdupto 2amps of current and other features.

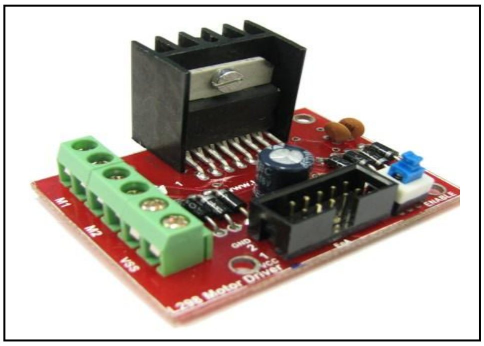

Fig.3. L298 motor driver.

D. Plastic DC motors.

E. Chasis.

II AT THE TRANSMITTING END

A. Design Specifications

The Transmitter consists of a PSOC3 boardand the transmitter of the RF module CC2500,working at a frequency 2.4Ghz.The Accelerometer values(analog) from the PSOCboard are digitalized through ADC and all the necessary processing is done on this end and only single characters are sent through UART to the RF transmitter instead of sending the accelerometer values to the board at the receiver end .

B. Components and Pins selection

The components and pins used at the transmitter end are:

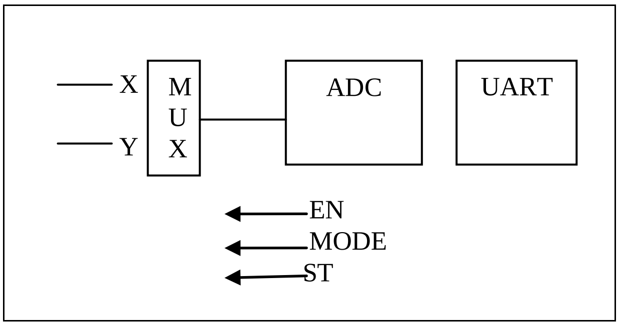

FIG 4:SCHEMATIC OF THE TRANSMITTING END.

- Analog Multiplexer
- 2 Analog design pins
- ADC
- 3 Digital output design pins
- UART

C. Components and Pins configuration

- The Analog Mux used is a 2:1 Mux. Taking x and y values from the accelerometer as the 2 inputs to the mux whereas the output goes to ADC where the data is digitalized for further processing.
- ADC is set with following configuration
  mode :multisample
  Resolution : 12 bits
  Sampling rate : 10000
  Single ended output
  Input range : 0 to 2*Vref(2.048V)

D. Mapping

The Design pins defined in earlier sections have to be mapped to the Physical pins on the PSOC3 board. The mapping is as per the data sheet of the PSOC3 kit used.

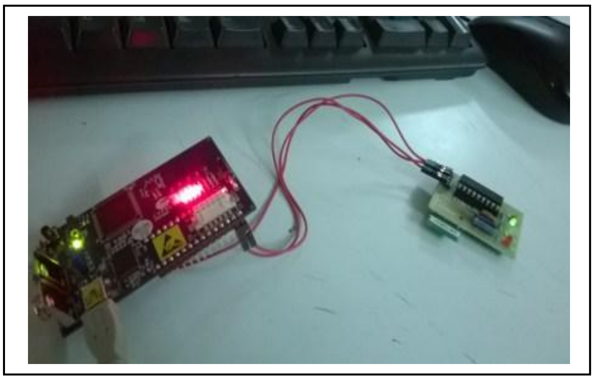

Fig 5:Transmitting end(PSOC3 and CC2500).

E. Algorithm

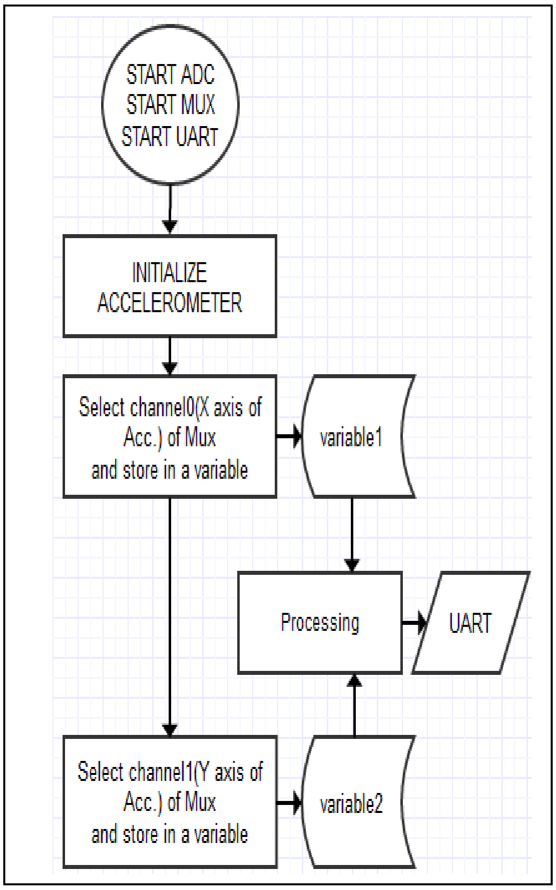

Fig 6:Transmission algorithm.

III DEBUGGING

In order to verify that intentional data was sent to the receiver and not some garbage data, PSOC3 was connected to PC.Since PSOC3 is a TTL[7] device, to interface with PC ,USB to TTL convertor was required . However PSOC3 does not have an onboard USB to TTL convertor(level shifter) ,hence PSOC5[8] board with an onboard level shifter, MAX232[9],was used. On PC the TERMINAL showed data received from the transmitter.

Care had to be taken to plug the right PSOC board while programming to avoid ending up programming the wrong board.

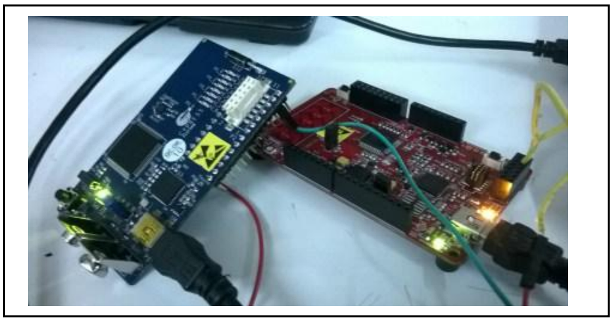

Fig 7:Debugging the transmitter end using PSOC5.

IV AT THE RECEIVING END

A. Design Specification

The Receiver consists of a PSOC3 board and the receiver of the RF module,CC2500,working at a frequency 2.4Ghz.The data received from the transmitter is sent by the RF receiver to the PSOC3 board through UART which drives the motors on the bots as per required conditions.

B. Components and Pins selection

The components and pins used at the receiver end are

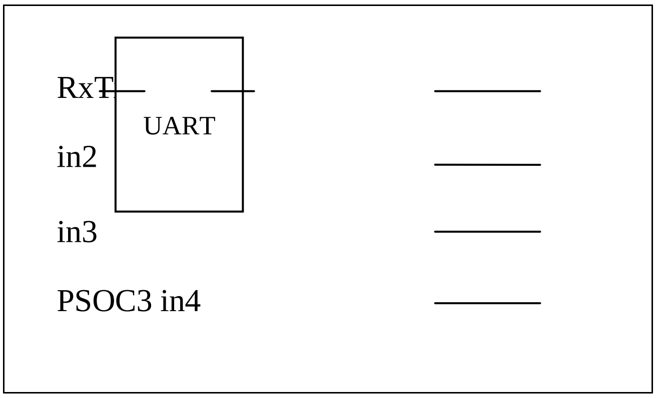

Fig 8:Schematic of the receiving end.

- UART
- 4 Digital output Design pins

C. Components and Pins configuration

- The UART is configured similar to that at the transmitting end(the number of bits per second)
- The 4 digital output pins are configured without hardware connection

D. Mapping

The Design pins are mapped to the Physical pins on the PSOC3 board.

F. Algorithm

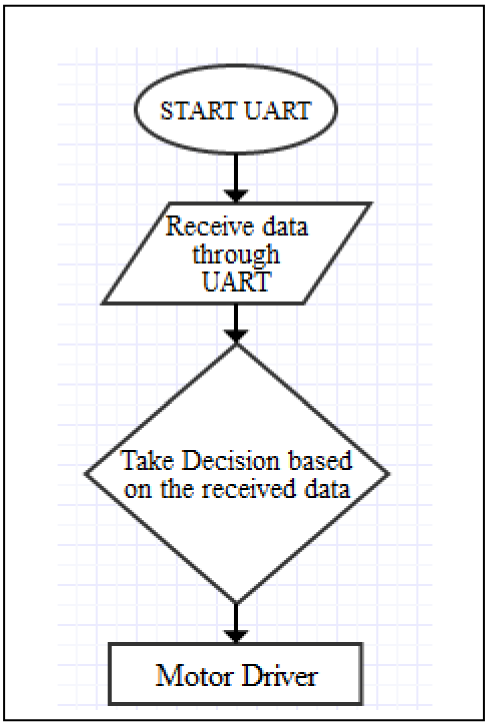

Fig 9:Reception algorithm.

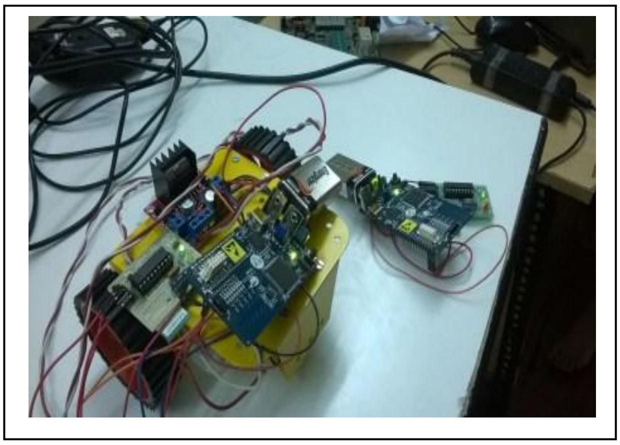

Fig 10:Final assembly of the car- robot.

V CONCLUSION AND FUTURE SCOPE

This paper presents an Accelerometer based hand gesture controlled car-robot using Programmable System on Chip.PSOC is a good solution for applications which require great flexibility in hardware configuration and programming as compared to microcontrollers and FPGAs .

However the reliability of the system proves to be a limitation. Data sent wirelessly is limited to characters in this system which hinders the smooth and continuous motion of the car-robot. Also the range of the RF transceiver is limited and any other noise in that frequency range would cause unintentional results .

Further efforts will be made to implement certain algorithms at the transmitter and receiver end of the system to smoothen the car-robot movement . This concept can be extended to applications related to Military ,Construction sites ,Medical surgery where natural control of the robot is essential as complicated robot controlling might result in fatal accidents..

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