“LibA”

The Library Assistant

Presented by:

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Intelligent Machine Design Lab EEL 5666, Spring 2016

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Abstract:

Sometimes it becomes very hectic and chaotic for library workers to go through the shelves all day long and get the books for that people want. It would very helpful to reduce the workload by providing automation and artificial intelligence for such trivial scenarios. So I came across the idea of LibA, the library assistant.

The idea is to design and construct an autonomous robot that can communicate with the user and bring the book that is requested. It will be able to perceive, identify, actuate, and complete the task in the environment provided to it. Here, perceive and identify means to recognize the specific book from all the books, actuate means to move around the grid of books following the path provided and to pick the book.

The robot will get a books name as input, and if the book is available, it will go around the grid will scanning the barcodes of the book. Once the book is found, the robotic arm grabs the book and brings it back to the user. If the user declines the book, it will keep the book back again. All the time, the robot will display the status such as ready, busy, and error (if there is one during the operation of the bot).

Introduction:

The robot that I wish to develop is a completely autonomous bot. It will be given a book name as an in input from the list of books that the shelf would have. I will start with 5 or 6 books, which will be available as a table with barcode inside the main CPU of the bot, i.e. the Raspberry pi. The CPU will manage the Input/Output, Image Processing and communication with the microcontroller board, TI MSP430F5529 Launchpad, using UART protocol. The robot will be a 4 wheeled robot controlled by 4 motors. The motors will be powered by four brushed DC motors with moderate speed. The bot is supposed to follow a predefined black track. The books will be placed on the sides of the track. This line following will be done by a set of 5 IR sensors in the front of the bot. On the platform of the bot, we will have a 3DOF robotic arm. The arm will rotate around the base, the link will rotate 90^o from X-Y plane to Z axis, and the end effector will be a 2 finger gripper. The microcontroller will be controlling the inputs from the IR pair and the motors to drive the bot and the robotic arm. There will be camera one side of the bot that will scan the barcodes in real time as the bot moves. The basic schematic can be seen form *Figure 1* below.

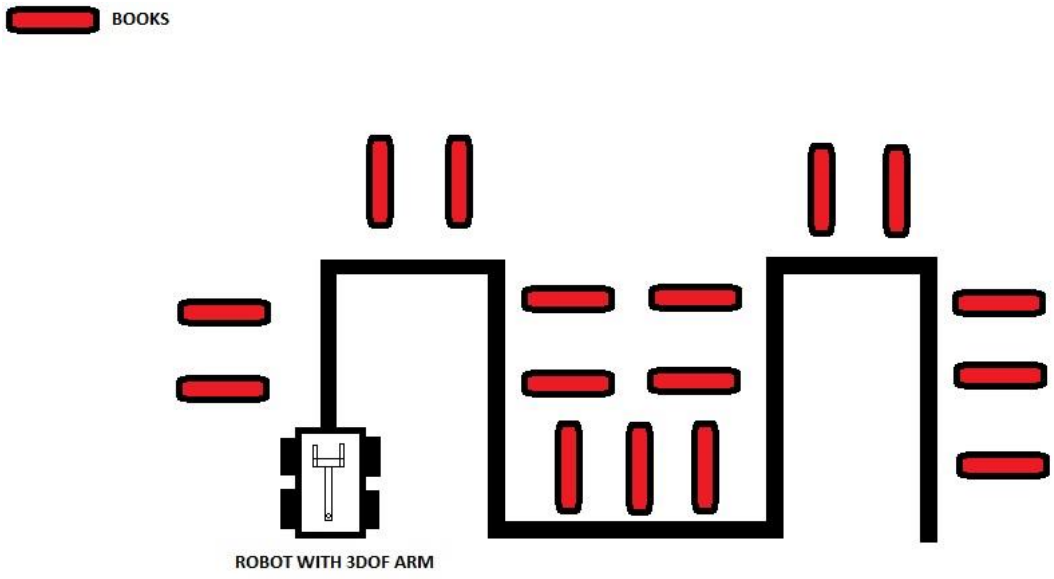


Figure 1.

Flowchart and algorithm:

You can find the flowchart of the robot in *Figure 2.*

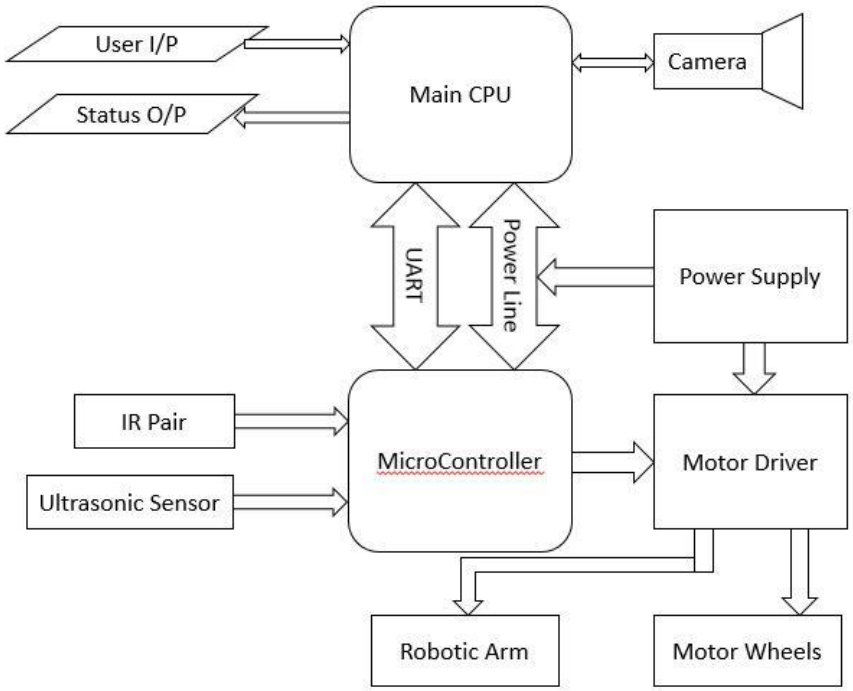


Figure 2.

The main CPU will take the input from the user which book they want. It will check for the book in the table. If the book is not available it outputs the status as not available. If available then it puts the status as busy and sends command to microcontroller to go forward. The microcontroller keeps on driving the robot by following the inputs of the IR sensors. Simultaneously, the camera is ON and it scans for the particular barcode of the book. Once the barcode for the particular book is found, the CPU sends an interrupt to the microcontroller to stop and start the book pick up routine. The microcontroller aligns with the book and starts the Robotic Arm routine to take the book. Once the book is taken, it rotates and starts moving towards the user following the line backwards. After the book is taken by the user, it gives the status as available and waits for the next input. When the robot moves along the line, it also tries to detect any obstacle, and if there is an obstacle, it stops and gives an error signal till the obstacle is cleared.

Integrated System:

The whole robot will can be divided into two sections. The first system which will be the master will be governed by a microprocessor board and the second system which is a slave will be consists of a microcontroller board. The two systems will communicate in real time using UART protocol.

The two microprocessor systems and their role are:

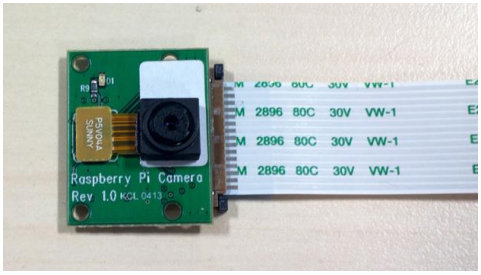
1. Raspberry Pi 2:
    - It is a 900 MHz Quad Core Arm Cortex A7 microprocessor board which is the main CPU of the robot.
    - 1 GB RAM, Camera and Display Interface.
    - 4 USB ports.
    - 40 GPIO pins.
    - Will communicate with the user and handle the input and output.
    - Run the barcode scanning algorithm.
    - Send instructions to the microcontroller board.
    - Make decisions during operation.
2. TI MSP430F5529 Launchpad:
    - It is a 25MHz microcontroller board with 16bit MSP 430 microcontroller that is responsible for the actuation of the robot.
    - 128kb Flash memory with 8Kb ram.
    - 16 ADC, 5 PWM, 40 I/O pins.
    - Run the obstruction avoidance algorithm and inform the microprocessor if any.
    - Move and control the bot forward and backward on the line.
    - Actuate the robotic arm when the book is found.
    - Interface and control all the sensors.

Mechanical Design and Actuation.

The robot is a four wheeled robot. All the four wheels of the bot are powered by Brushed DC motors. The chassis of the robot has a very simple one which have the wheels and various sensors mounted on the side. On the top, there is a 2DOF robotic manipulator with a two finger end effector. The base motor and elbow joint of the robotic arm is powered by High Torque Brushed DC motors with encoders to check revolution of the motors. Also there are limit switches to restrict it to certain angular motions only. The chassis is made up of wood and 3D printed materials. The designing is done in SolidWorks.

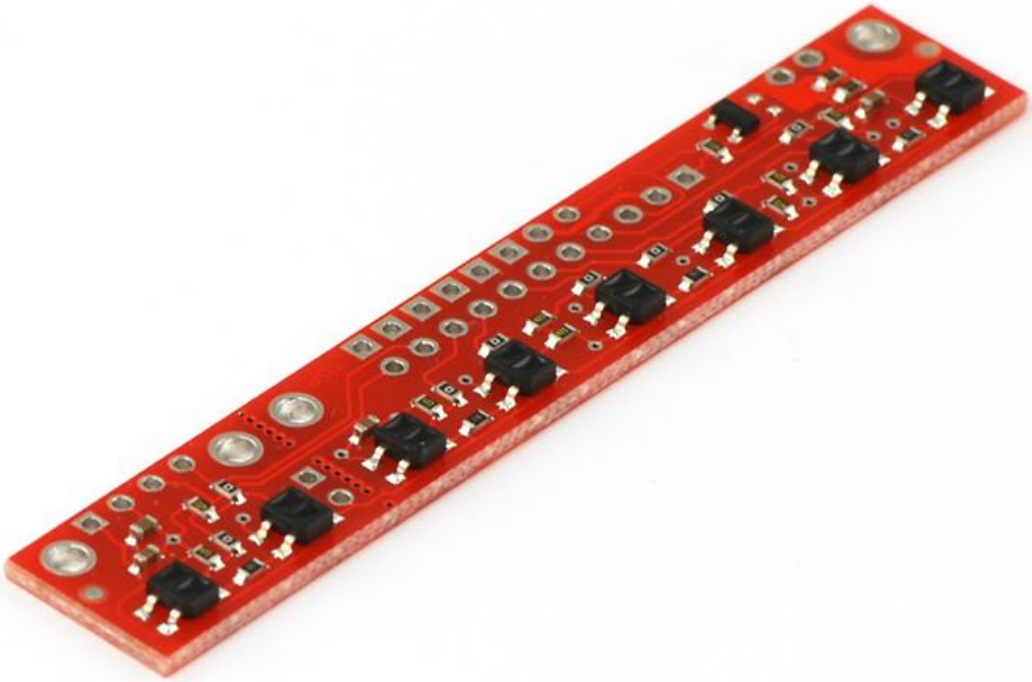
Sensors:

1. **Raspberry Pi Camera Small board size**:
   - 25mm x 20mm x 9mm A 5MP (2592×1944 pixels).
   - Omni vision 5647 sensor in a fixed focus module.
   - Support 1080p30, 720p60 and 640x480p60/90 video record



2. **Ultrasonic Sensors**
   - Provides precise, non-contact distance measurements within a 2 cm to 3 m range
   - Ultrasonic measurements work in any lighting condition, making this a good choice to supplement infrared object detectors
   - Simple pulse in/pulse out communication requires just one I/O pin
   - Burst indicator LED shows measurement in progress
   - 3-pin header makes it easy to connect to a development board, directly or with an extension cable, no soldering required

3. **IR-Sensor :**
    - Pololu reflectance sensor.
    - 8 IR led pairs.
    - 8 digital I/O-compatible signals that can be read as a timed high pulse.
    - Optimal sensing distance: 0.125" (3 mm)
    - Maximum recommended sensing distance: 0.375" (9.5 mm)



Conclusion:

The above is the proposed plan and draft of the bot. The robot has to be completed before 4th of April. So all the development stages have to be completed in the time frame of about 2 months. I am very excited for the project and hope to develop my robot with all the objectives it meant to complete.