
Final Report

PIBot(Pill Informer roBot)

EEL 5666: Intelligent Machines Design Laboratory
Student Name: Duckki Lee

Instructor: Dr. A. Antonio Arroyo
Dr. Eric M. Schwartz

TA: Mike Pridgen
Thomas Vermeer

UNIVERSITY OF FLORIDA

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I. Abstract

This report includes technical details of design and operations of PIBot, which is named after “Pill Informer roBot”. PIBot is a robot that can remind people to take medication efficiently and effectively by following people until they take medication. PIBot uses a PVR board, IR sensors for collision detection, DC motors for moving, a force sensor for detecting picking up a pill, a CMUcam for tracking and following people and TTS(Text-To-Speech) for speaking.

II. Introduction

Healthcare is becoming more and more important these days as the number elderly people are growing. One of the big problems in healthcare is medication noncompliance among the elderly people who has some cognitive and physical problem. One of leading reasons for medication noncompliance is “Forgetfulness/Wasn’t reminded to take medication.” The effect of medication noncompliance can worsen the symptom and health. Therefore, just taking right medication on time is very important.

Now, PIBot can solve the problem effectively and efficiently. It reminds people to take medication by following people and reminding them to take medication until they take medication.

III. Integrated System

ATxMEGA128A1 on PVR Board will control PIBot. The PVR board interfaces with all sensors (IR, Force and CMUCam) and actuators (DC Motor, LCD and TTS)

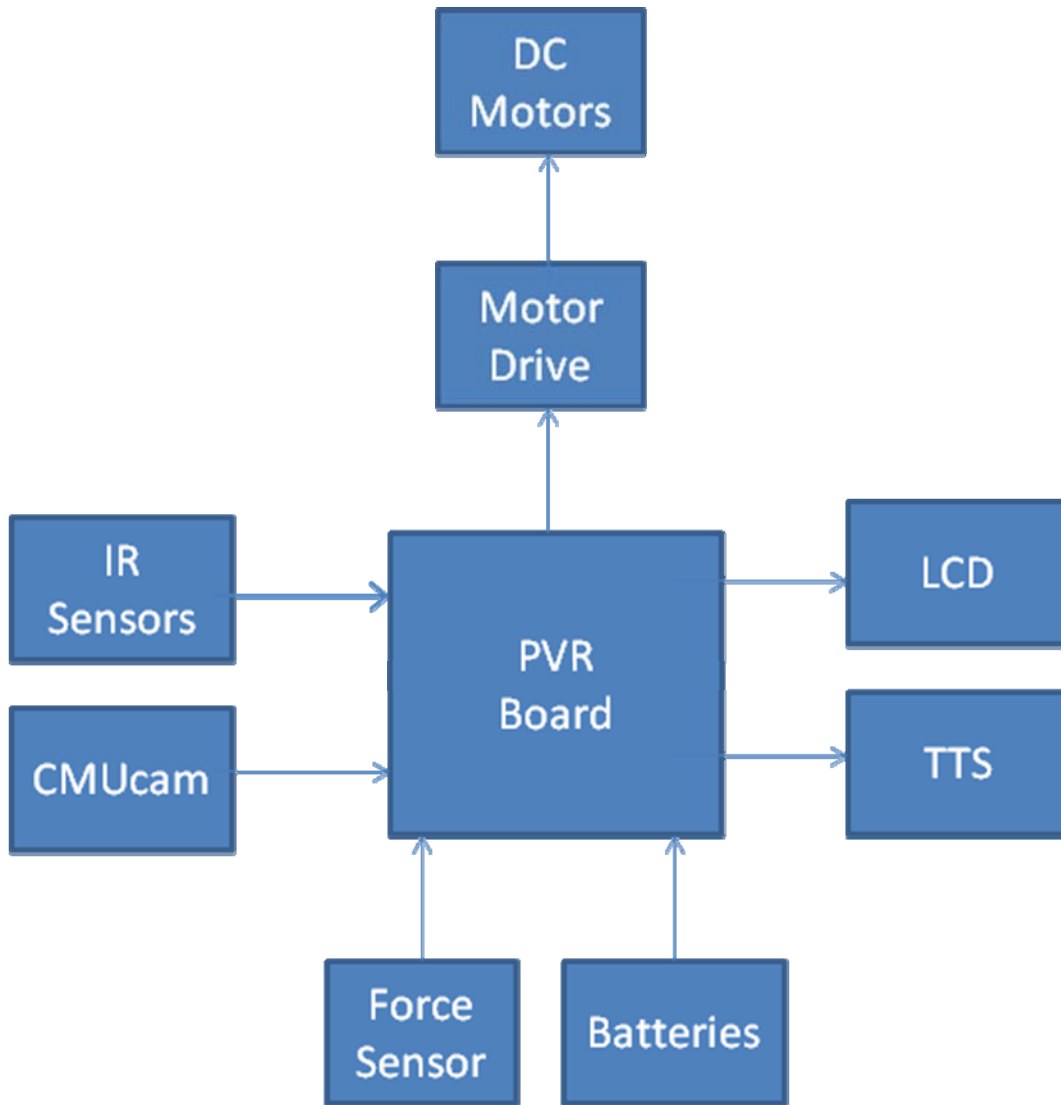


Figure 1. Block Diagram of Integrated System

IV. Mobile Platform

Below figures show different views of PIBot. PIBot has two layers. In the lower layer, PVR board, TTS chip, audio jack, two speakers, two motors and motor drive and IR sensors are attached. In the upper layer, CMUCam is mounted in the front to track and follow people and LCD panel is attached at a 45-degree angle so people easily see the instructions like what medication to take or any useful information for their health.

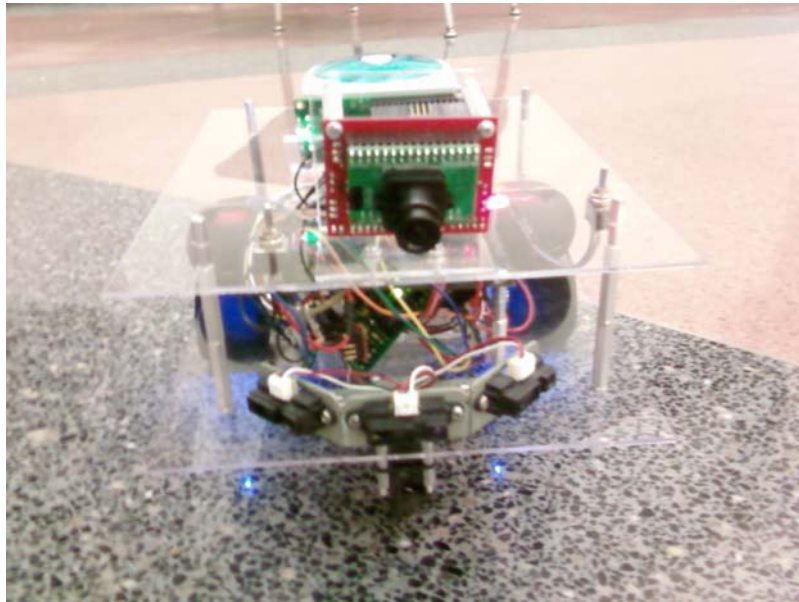


Figure 2. Front view of PIBot

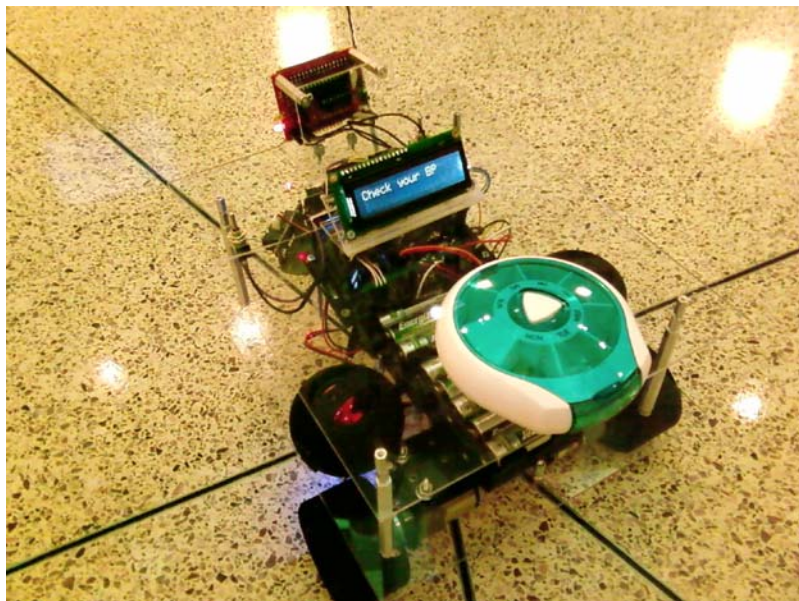


Figure 3. Side view of PIBot

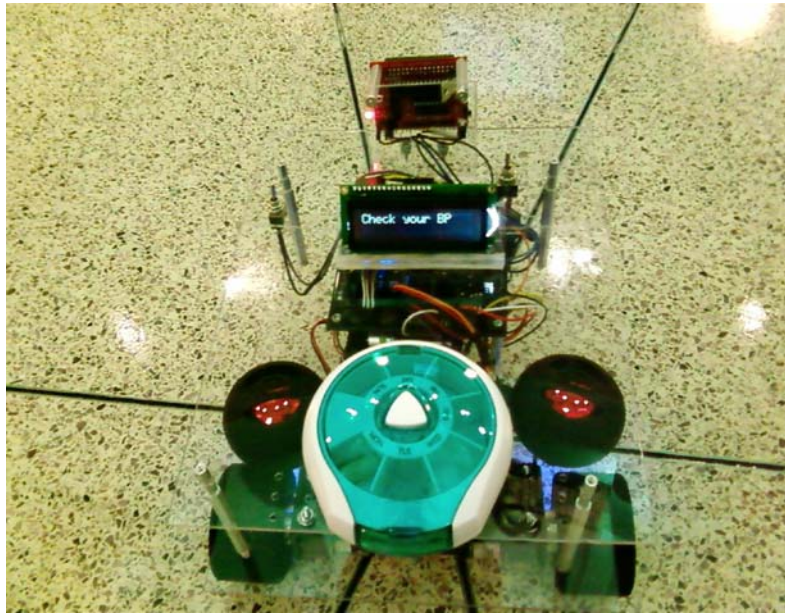


Figure 4. Upper view of PIBot

V. Actuation

Motor Drive and 2 DC Motors – for moving robot

TTS (Text-To-Speech) – for speaking

PVR board controls DC motors (12V-200RPM-3.6KG/CM torque DC gearhead motor; Figure5) through a dual channel motor drive (1A Dual TB6612FNG).

PVR board communicates with TTS chip through serial TTL serial interface to send texts to speak and control volume, speed and pitch.



Figure 5. DC Motor

VI. Sensors

3 IR Sensors – for collision avoidance

1 Force Sensor – for detecting if people grab a pill or not

CMUCam – for tracking and following people

- IR Sensor (Figure 8)

Below graph shows the IR sensor value according to the distance of object. 3 IR sensors are used for collision avoidance. One GP2D120 is for center and two GP2D12 is for left and right sides.

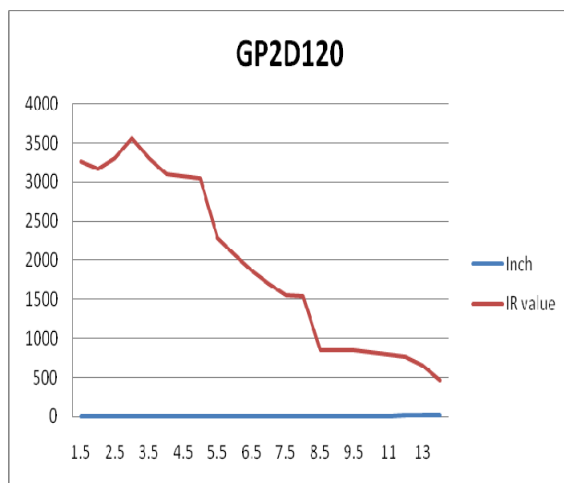


Figure 6. IR value of GP2D120

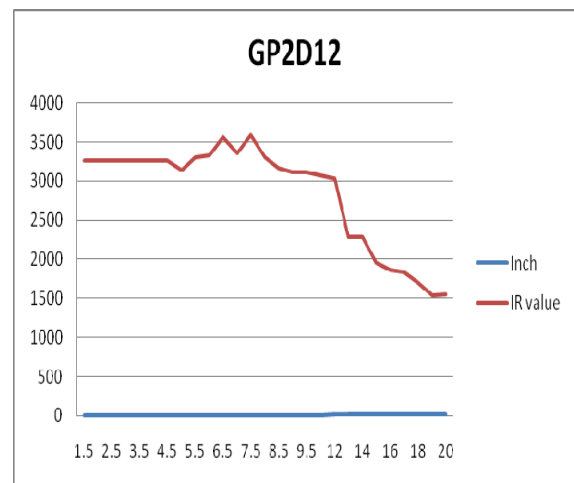


Figure 7. IR value of GP2D12

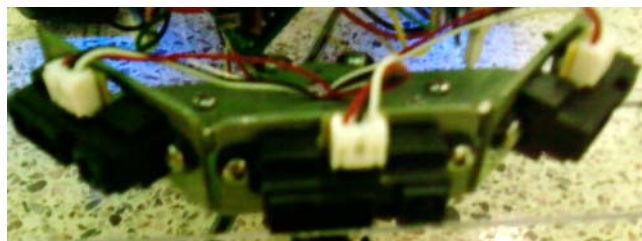


Figure 8. IR sensors

- Force Sensor (Figure 9)

The force sensor is used to detect if people take medication or not so when they push a pill box, it detects that



Figure 9. Force sensor

- CMUcam (Figure 10)

CMUcam1 is a color vision sensor so it can detect and track colors. CMUcam1 uses a fast low cost microcontroller interfaced with CMOS camera. The microcontroller handles the high speed processing of the camera data. Also, it allows using a servo which can be used for controlling the movement of CMUcam1. The board communicates via a RS-232 serial port. Although CMUcam1 does not support to detect and track a person but we can use color detection and tracking instead of that.

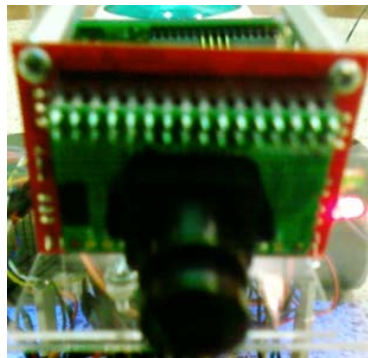


Figure 10. CMUcam

- CMUcam Block Diagram (Figure 11)

CMUcam1 and PVR board can communicate each other through RS-232 serial communication. CMUcam Vision board controls and collects data from CMOS Camera. The collected data can be passed to PVR board through RS-232.

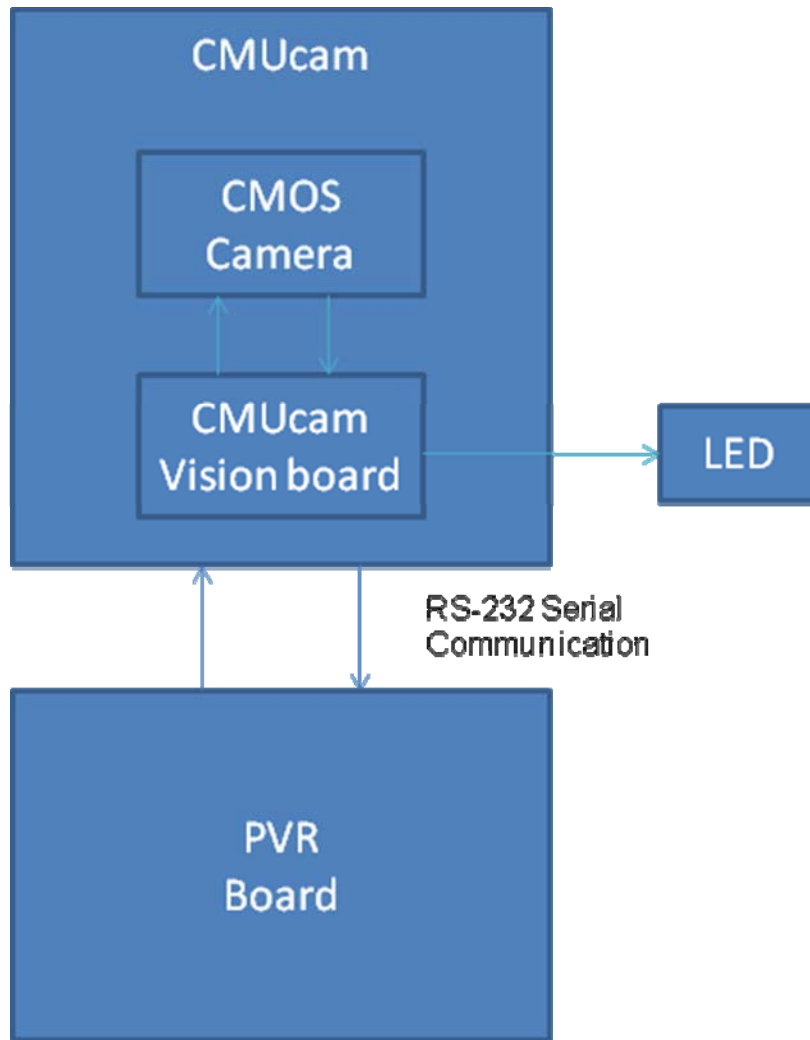


Figure 11. CMUcam Block Diagram

VII. Behaviors

- Collision Avoidance

3 IR sensors are used for collision avoidance. I used fuzzy logic to implement collision avoidance. Following is an algorithm for collision avoidance.

1. Get 3 IR values from left, center, right IR sensors
2. Do the distance mapping
 - 0 – very close
 - 20 – close
 - 40 – normal
 - 60 – far
 - 80 – very far
3. Convert fuzzy truth table for 3 IR sensors to each case
4. Depending on the case, send different commands with motor speed to motor drive
 - Commands(goFoward, goLeft, goRight, goBackward)
 - Speed(100-650)

- Tracking & Following

CMUcam is used to track and follow a person. By utilizing USART library, I initialized RS232C serial communication and set the baud rate. Following is an algorithm for tracking & following.

1. USART Init
 - Set port E to input/output port for RS232 serial communication
 - Set baud rate 115200bps
 - Enable TX,RX
2. Reset CMUcam
3. Set Raw serial transfer Mode 1 for no Ack/Nck confirmation
4. Send TC(Track Color) Command
5. Depending on the M packet(mx, my, x1, y1, x2, y2), send different commands with motor speed to motor drive to follow the person
 - Commands(goFoward, goLeft, goRight, goBackward)
 - Speed(100-650)

- Speaking

Emic TTS chip & audio jack are used to speak texts. In order to communicate with TTS chip, TTL serial communication is used. Following is an algorithm for speaking.

1. USART Init
 - Set port F to input/output port for TTL serial communication
 - Set baud rate 2400bps
 - Enable TX,RX
2. Reset TTS chip
3. Set volume
4. Set speech speed
5. Check if TTS chip is working, then wait
6. Otherwise, send texts to speak

- Detecting if taking pills

I attached a force sensor under a pill box to detect if a person takes pills or not.

VIII. Conclusions

PIBot (Pill Informer roBot) is a persuasive robotic companion that helps a patient take medication on time. With a mounted pill box, PIBot will track and follow patients and remind them when it is time to take their medication.