**Introduction**

According to the US Centers for Disease Control there were 123.8 million emergency room (ER) visits in the US in 2010, many involving potentially life-threatening injuries or conditions where swift triage and treatment is often required. Medical professionals must quickly ascertain any medications a patient may be taking. Patients may be unresponsive, unaware of the names of their medications, or fail to carry their medications in the original prescription containers, making identification of the drugs difficult and potentially time consuming. Further, with the large number of drugs on the market, medical personnel may not be immediately familiar with a drug’s side effects and contraindications.

**Solution**

The PDI device identifies a wide variety of prescription medications and provides timely information about the drug from on-line or built-in databases. Drugs can be identified via a camera or by scanning a barcode from a prescription. When the system is unable to automatically identify the drug, the user can assist by manually entering any markings on the drug.

- For the pill’s images, the input is passed through the image processing stage to recognize shape (12 categories), color (10 categories), size, and imprint.
- For the barcode on the pill’s container, system implements a barcode module to decode the barcode.
- Upon successful identification of the drug, pertinent information about the drug is displayed on the LCD screen.

**Intel Atom development board**

The Intel Atom board is our core system for controlling hardware devices, image processing, database management, internet connectivity and display.

**Image capturing hardware**

- CMOS camera & mechanical housing: captures pill images, ensures image quality and prevents interferences from outside environment.
- Lighting system: includes four upper LEDs supporting capture of pill color, four lower LEDs supporting capture of pills imprints and shape. The system is controlled by PWM signal.
- Barcode decoder: reads UPC or EAN barcode formats from pills containers.
- Motion sensor: an ADXL345 accelerometer detects tray motion.
- Microcontroller: ATmega644PA with 64 KB flash memory controls the lighting subsystem, barcode reader and motion sensor.

**User interface**

Using MIMO UM-710S 7” LCD Display and Logitech N305 wireless numeric keyboard to display all of recognized-drug information and user-interface controls.

**Wireless module**

Intel Wireless 4965AGN PCI-Express Mini card is used for querying the online database and system updates.

**Database**

Includes two offline databases: Pillbox and Daily Med, and one online database: Medline Plus. They have all of drugs information such as shapes, colors, sizes, imprints and also instructions for using drugs properly.

**Recognition**

Information of shape, color, size and numerical imprint is used to query database for a specific pill:
- Shape and color are recognized by using machine learning technique. In details, 13 features are used to identify shape and 7 features are used to identify color.
- Stroke Width Transformation and Tesseract OCR engine are implemented to detect and recognize numerical imprints.
- Size conversion ratio is defined with tolerance of 1 millimeter by experiment.

**Performance**

Samples of 39 different drugs obtained from the Center for Student Health and Counseling are used for testing the recognition performance and accuracy. Indentifying samples using the PDI device and evaluating the drugs information, we achieve an accuracy rate of 96.5%.

Using stopwatch to measure the execution time for every sample and making calculation based on the statistic data, we get the average execution time of 12.87s.

**Conclusions**

The PDI device satisfies requirements for accuracy rate and timing stated in the Product Design Specifications. Performance could be improved by:
- Using a better camera to capture improved images.
- Providing more samples for training stage in recognition shape and color.
- Implementing an advanced OCR (Optical Character Recognition) algorithm to detect rotated imprints.
- Integrating IPP (Integrated Performance Primitives) with OpenCV to boost the speed of image processing task.