2nd Seminar – Structural Modeling

1 Background

We are engineers at the newly founded *Shopping Experience Ltd.* We provide a cloud-based *price matching service* ("who sells this cheaper?") free of charge, where users of our smartphone app may scan product barcodes (optionally entire price tags) while browsing the aisles of a shop or supermarket, and we retrieve real-time price matching for the same or similar product from other retailers.

We plan to continuously extend our network of retailer partners who accept and promote usage of this app as a *self-checkout* mechanism. Users may indicate via the app which scanned items they want to add to their cart; the app will provide a running total, as well as greatly expedite the checkout and payment phase. The device uses positioning services to identify the store where the purchase is made.

For customers who do not own smartphones, do not wish to install our app, or simply do not arrive to the store prepared, partner stores may offer to lend our *custom-made single-purpose devices* for the shopping process, with full support for self-checkout and price-matching.

A key engineering focus will be ensuring that barcodes and price tags may be captured quickly and accurately using both our custom-built "bespoke" devices (equipped with laser barcode scanners) and a wide array of consumer smartphones (equipped with various generic photo cameras).

2 Seminar tasks

- Design a high-level functional decomposition of one aspect of the problem, focusing specifically on the decomposition of the shopping app into a device-independent purchase process and a device-specific barcode acquisition module. Draw the defined blocks on a Block Definition Diagram and their interconnections on one or more Internal Block Diagrams.
- Assume that we opt to design the laser scanner hardware ourselves. Draw appropriate BDD / IBD diagrams that decompose the laser scanner into functional components, identifying the relevant flows between them, and how they relate to components identified in the previous task.
  The scanner contains a *beam source* that emits a laser beam, and an adjustable *beam deflector* (consisting of a mirror, a rotating motor and a controller) that redirects this beam in the selected direction. (The deflector works by having the motor continuously rotate the mirror, causing the redirected laser beam to scan a range of angles.) The redirected laser beam may hit a nearby *barcode* and reflect off it. In case there is a reflected light beam, it is picked up by a *light sensor* (calibrated to the wavelength of the laser) contained by the scanner. The sensor continuously measures brightness to distinguish between 0s and 1s in the bar code. The brightness information is processed by a *barcode recognizer*, which emits valid codes detected in the signal.
- Similarly to the previous task, decompose the barcode acquisition functionality on a consumer smartphone. Use your background knowledge on the architecture of smartphone cameras (fixed or variable focal length, sensors arrays, digital image stabilization and other filters, etc.).
- Discuss how we can reasonably expect to find these model artifacts packaged.