RFID in the Construction Industry

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Outline

Review of RFID in the construction industry
  Supply chain
  Real-time controls on job sites

Example of current RFID research project
  Automating the location of engineered components on large industrial projects

Conclusions and Recommendations
Review of RFID applications in the construction industry
1. RFID in the construction supply chain

4 years – 225 projects (South Korea)

Coordination between contractors and suppliers

Management of long lead items
Coordination between contractors and suppliers for a ready mix concrete activity

RFID stores invoice data and is scanned at the site

Benefits

Contractor: concrete within regulation or not
Supplier: notice of concrete poured, truck returning time

Chin et al. (2007)
Management of long lead items

Re-engineering the supply chain process: 25% fewer activities

Sharing of information: manufacturing, quality control, delivery, receipt, and installation

Time savings: 17% on management and 43% on stockyard

Navon and Berkovich (2006); Chin et al. (2007)
2. Real-time control of construction resources

Improved visibility of construction resources; i.e. materials, equipment, and labor

Reactive controls vs. proactive controls

For instance, when deviations occur from planned conditions an automated message is triggered to management
Daily labor controls

Check in and check out of laborers

90% maintenance reduction relative to barcode technology

80% labor waiting time reduction

Improved productivity data

Chin et al. (2007)
Tools Tracking

Tools individually tagged

Accurate inventory - multiple tools

Check in/check out real-time tools control

Kang (2005); Goodrum (2006)
Tracking concrete components on a storage yard

Combination of short-ranged RFID technology and a crane-mounted GPS

Automated collection of new positioning data

Ergen et al. (2006)
Automated delivery & receipt of construction components

Tags were attached to spools lying on a flat-bed truck

The truck passed through a portal equipped with fixed antennas

All components were detected with truck speeds < 2mph
Current study on automating the location of engineered components on large industrial projects

Construction Industry Institute RT240 Team
The University of at Texas at Austin
University of Waterloo
University of Kentucky
The localization problem

Manual collection of site data is error-prone, inefficient, and expensive (Sacks 2003; Ergen 2007)

Workers spend large amounts of their time either searching or waiting for components (Rojas 2003; Caldas 2006)

The inability to locate needed items negatively affects installation productivity (CII 1986; Thomas 1989; CII 1999)

Construction activities require constant visibility for proper control (Stone 1995; Kim and Haas 2002; Hwang 2004)

CII determined that sensors have a great potential to improve site tracking of components (Vorster and Lucko 2002)
Objectives

The objectives of this study are:
(1) automating the localization of construction components on large industrial projects, and
(2) assessing the automation impact on construction productivity
This study focuses on the automated location of engineered components on industrial sites.
Scope (ii)

Large industrial projects

Extensive lay down yards far from installation areas

Thousands of engineered components

Installation and Staging Area

Lay Down Yard
Overview of the localization approach

Uncertainty of tags location is reduced from (a) the RFID read area to (b) much smaller areas by localization mechanisms.

(a) RFID uncertainty area ≈ 30,000m²  
(b) Reduced uncertainty area ≈ 40m²
Localization Framework (i)

GPS and RFID receivers installed on a Bobcat identifies and locates tagged components while moving around the site.

These receivers could be installed on equipment (e.g. cranes).
Localization Framework (ii)

Framework Schema

Data Collection
1. Set up GPS/RFID receivers
2. Synchronize data collection
3. Store collected data

Location Estimation
1. Estimate tag locations
2. Determine location errors
3. Store processed data

Navigation
1. Enable navigation functions
2. Generate and print maps
Data Collection Module

Senses, collects, and stores the worker’s GPS positions and the RFID identification signals

Data fusion and synchronization of sensors

Lack of tags location information
Location Estimation Module

Proximity Mechanism
It assumes an square RFID signal pattern of side $\rho$

For a given tag, the four GPS positions situated at axis extremes (maximum and minimum X and Y) determine the smallest uncertainty area

Localization error

- Estimated Tag Location
- GPS positions where a given RFID was identified
Navigation Module

Mapping and navigation functions

GIS, GPS, and real-time differential correction

Alternatively, printed maps can support navigation
Field Tests – Localization and Productivity

CII RT240 “Leveraging Technology to Improve Construction Productivity”

$900 million power plant project located in Rockdale, TX

25 acres lay down yard
Localization Tests

Average localization error: \(~3.2\)m

Median localization error: \(~3.7\)m
Productivity Tests

2 identical steel boilers
  Boiler A untagged
  Boiler B tagged

A subset of 450 tagged components are being tracked from receiving to installation (Boiler B)

The tracking process is divided in two different areas:
  Lay down yard
  Staging area
Productivity assessment
Lay down yard

Average time spent locating construction components

Number of lost components

TOTAL OF 39 COMPONENTS

MWR: 627
DATE: 
EMPLOYEE(S) NAME(S): 

START TIME: 
END TIME: 
NUMBER OF COMPONENTS NOT FOUND: ___
Productivity assessment
Lay down yard
Productivity Assessment
Staging Area

Tons of installed components per day

09/19/2007 4:00 PM
Observations

Zero lost tagged components

Reduced labor times on lay down yard

Labor/managers positive comments

Confidence on location results
Recommendations for implementation

- Change resistance
- Corporate and site management support
- Labor orientation and training
- Main actors – craft laborers
- Components tagged at manufacturing facilities
Conclusions

Early RFID implementation / research within the construction industry

High expectations and interest from lead owners and contractors

A clear and positive benefit to cost ratio required

Feedback between academy and industry
Thank you!