Acres Design Competition

RFID Time and Task Management

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1 Introduction

The primary issue that we seek to amend is time management on job sites, particularly in the realms of time theft and small-scale task management. Time theft is not a new problem – a 1985 study found that the average worker stole over four hours a week from their employer – but, due to the increasing prevalence of cell phones and small devices in the workplace, it is likely increasing [1]. It can occur in a wide range of ways, including fabricated time sheets, excessively long breaks, use of a phone on the job, and so-called “buddy punching.” Task management is a similarly complex issue. At many workplaces, particularly one as complex as a construction site, many workers are presented with a variety of new tasks throughout the day, and receiving individual instruction from site supervision can be needlessly inefficient.

Our solution to these issues is an integrated system that informs management of employee location and task completion, informs employees of expected tasks, and stores gathered data for future analysis and consideration. The three primary components to this system are a website for management to add tasks and view employee information, a web server sending requests and storing relevant data, and a small wearable device for employees to clock in/out and view their expected tasks on the go.

2 Design Problem

2.1 Problem Definition

Acres management lacks information about the location and behavior of employees, potentially resulting in billing errors, time theft, and a general disconnect between management and the on-site situation. Additionally, current systems of informing employees about their currently expected tasks is inefficient and needlessly time-consuming.

2.2 Design Requirements

2.2.1 Functions

- Detecting and logging employee location and task data

- Allowing management to add employee tasks and easily view task completion and location data
- Enabling employees to easily and safely check in to the job site, check tasks, and log task completion

2.2.2 Objectives

- Closer knowledge of employee location and task completion to better inform supervision on time management issues
- Safety and efficiency for workers
- Consistent and clean data storage for efficient future analysis

2.2.3 Constraints

- Cost effectiveness: are the costs incurred by our solution worth the capital gains?
- Practical feasibility at scale: can our solution be realistically scaled for use by Acres as a whole?
- Institutional acceptance: will the people affected by our solution embrace and utilize it?

3 Solution

3.1 Solution 1

Our initial solution was essentially a smaller-scale version of Acres's Serca software; a web-based task manager in which workers can view and 'check-off' tasks on their cell phones. We shifted away from this solution because of safety concerns and similar applications already existing. It was concluded that incorporating cell phones was 'out-of-the-question' for our final design, however we retained the idea of small-scale task management.

3.2 Solution 2

A small, simple device, either wearable like a smartwatch or equipable to a tool belt, with which employees could view, scroll through, and check off tasks from a large list (~50 items). The task list would need to be updated only once every several days. We moved on from this idea

because, after a discussion with our TRU faculty mentor, we elected to lean more into employee location monitoring.

3.3 Final Solution

Our final solution is an integrated system consisting of small, wearable devices for workers, a backend web server and database, and a frontend website for Acres management. The device contains a list of tasks for employees and communicates via RFID with the server to log employee presence on site and task completion. Tasks can be quickly loaded onto the device via a separate RFID unit. The server stores data about tasks assigned to employees and their completion status, employee location, and employee time-on-site. The server communicates this information to the frontend website, where management can view data, assign new tasks, and initialize new employees.

	Solution 1	Solution 2	Solution 3
Task Management	Yes	Yes	Yes
Time Management	Yes	No	Yes
Location Tracking	No	No	Yes
Cell Phone Use	Yes	No	No

Fig. 1. Features of our different solutions

3.3.1 Components

Our design uses two RFID units, two Arduinos, and a laptop for hosting a web server. The RFID units are meant to imitate the larger, commercial quality RFID system that our final product would utilize. One RFID unit allows registration of new employees and clocking in, and the other allows updating of the task list and clocking out.

3.3.2 Features

- Employees clocking in/out and “picking up” tasks onto RFID chips at set locations on site.
- Remote task addition and data viewing by management
- Storage of various datapoints, including times clocked in/out, time-on-site, and task completion data.

3.3.3 Environmental, Societal, Safety, and Economic Considerations

Environmental Considerations

- **Sustainability of Materials:** Emphasize the use of eco-friendly materials for the RFID devices and other hardware components to minimize environmental impact.
- **Energy Efficiency:** Highlight the energy-efficient design of the wearable devices and the server infrastructure, focusing on low power consumption to reduce the carbon footprint.

Societal Considerations

- **Worker Empowerment:** The system empowers workers by providing them with clear task lists and expectations, thereby improving job satisfaction and reducing stress associated with unclear job roles.
- **Privacy and Ethics:** Address the ethical considerations of tracking employee locations, ensuring that data collection practices respect worker privacy and are transparently communicated.

Safety Considerations

- **On-site Safety:** By tracking the location of employees, the system can enhance on-site safety, allowing for quick response in case of accidents or emergencies.
- **Health Monitoring Potential:** Discuss the potential for integrating health monitoring features into the wearable devices in future versions, such as alerts for overheating or abnormal heart rates, contributing to overall worker safety.

Economic Considerations

- **Cost-Benefit Analysis:** Provide an analysis of the initial costs versus the long-term savings achieved through reduced time theft, increased efficiency, and potential reductions in workplace accidents.
- **Scalability and Adaptability:** Highlight the economic advantages of the system's scalability, showing how it can be cost-effectively implemented across various scales of operation.

3.3.4 Limitations

- The system heavily depends on RFID technology for employee clocking in/out and task management. While RFID technology can be effective, it may have limitations in certain environments, such as interference from metal or other materials, which could affect its accuracy and reliability.
- The system requires a web server for data storage and management, which could introduce vulnerabilities such as server downtime or connectivity issues
- It may face scalability issues if the number of tasks or employees increases significantly.
- While the prototype includes location tracking capabilities, it may not provide real-time or precise location data.Depending on the accuracy of RFID technology and the frequency of updates, the system may not be suitable for applications requiring highly accurate location monitoring, such as emergency response or safety-critical scenarios.
- There may be challenges in training employees to use the new system effectively and gaining their acceptance, especially if it significantly alters their workflow or routines.

4 Team Work

Listed below are a series of the most major working meetings our group has had over the work period. The project was divided into the following tasks:

1. Discussion/organization
2. Backend creation & design
3. Frontend design
4. Hardware design/experimentation
5. RFID tag reading/writing code
6. Report writing

4.1 Meeting 1

Time: February 14th, 2024, 2:30-3:30 PM

Agenda: Discussion of project goals and early software experimentation

Team Member	Previous Task	Completion State	Next Task
Paul Richter	1	30%	4
Kenneth Kouadio	1	30%	2

Shubham Jangra	1	30%	1, 3
Connor Cross	1	30%	1

4.2 Meeting 2

Time: February 16, 2024, 6:00-8:00 PM

Agenda: First discussion with TRU mentor, begin backend and programming

Team Member	Previous Task	Completion State	Next Task
Paul Richter	1, 4	50%	4
Kenneth Kouadio	2	40%	2
Shubham Jangra	1, 3	55%	2
Connor Cross	1, 4	60%	1, 4

4.3 Meeting 3

Time: March 2, 2024, 1:00-3:30 PM

Agenda: Working on communications between arduino and RFID tags, and backend web server development.

Team Member	Previous Task	Completion State	Next Task
Paul Richter	4	80%	5
Kenneth Kouadio	2	70%	2, 3
Shubham Jangra	2	60%	3
Connor Cross	1, 4	80%	4, 5

4.4 Meeting 4

Time: March 16, 2024, 1:00 - 3:00 PM

Agenda: More work on RFID communications and backend development

Team Member	Previous Task	Completion State	Next Task
Paul Richter	5	80%	4, 5
Kenneth Kouadio	2, 3	80%	2, 3

Shubham Jangra	3	80%	3
Connor Cross	4, 5	80%	4, 5

4.5 Meeting 5

Time: March 27, 2024, 2:30 - 3:30 PM

Agenda: Finalization of report and frontend

Team Member	Previous Task	Completion State	Next Task
Paul Richter	6	80%	6
Kenneth Kouadio	2	90%	6
Shubham Jangra	6	95%	6
Connor Cross	2	90%	6

5 Project Management

Fig. 2. Gantt Chart of group progress throughout the work period.

6 Conclusion and Future Work

We developed a simple prototype of our initial design concept, which satisfies most of our intended functionality and all of our objectives. The only function that we could not incorporate at this time was employees being able to check on currently assigned tasks due to the complexity associated with LCD displays. We did achieve, however, the functions of clocking in/out, employee data collection, and easy viewing of data by management. Our initial objectives of better knowledge of job site situations, efficiency, safety, and clean data storage were all met.

More extensive testing and research is necessary to decisively determine whether or not our constraints were met. However, it is the opinion of this group that our design does satisfy our constraints, namely cost-effectiveness, institutional acceptance, and feasibility at scale.

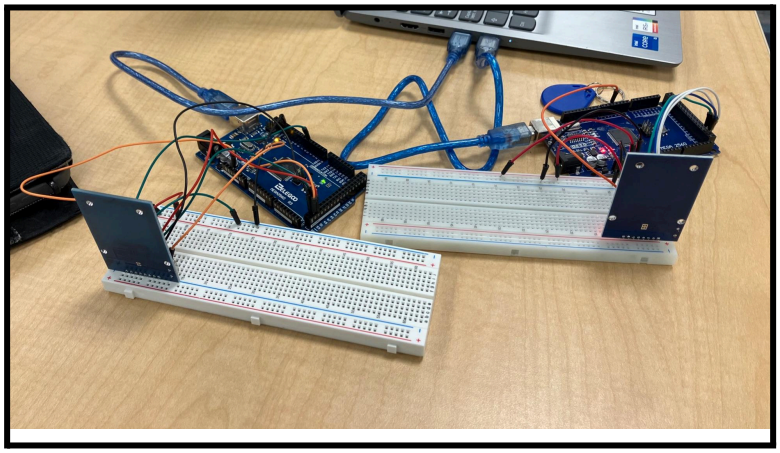

Fig. 3. The two Arduinos and RFID units used in the final prototype.

As mentioned in the introduction, time theft and general inefficiency is a major issue in construction. Reducing the friction between management and on-site situations is a simple way of tackling both of these problems, and the data gathered would only improve the situation more over time. For this reason, our design is not only a cost-effective solution to major problems, but a major source of yet-untapped capital.

A similar argument applies to feasibility at scale. The costs of servers and RFID scanners do not exactly scale with their size and quality, so our design can easily scale to a company-wide solution.

Institutional acceptance, particularly acceptance from the workers using the devices, is certainly the most complex constraint on our design. As discussed in the social considerations section, it is important that the employees being monitored don't feel antagonized, pandered to, or micromanaged. Because of this, much of the success of our device in this area will depend on how it is rolled out; it should be abundantly clear that the tasks displayed on the device are

more a checklist than a pandering reminder system, and that the purpose of the location monitoring is to make the process of workers arriving and leaving site more efficient, rather than constantly monitor them to increase productivity.

As for future developments, there are three primary ways in which our design can be readily improved: RFID range, task viewing/remote checking, and improved access to data.

Ideally, a commercial-quality, long-range RFID system would eliminate the need for employees to sign in/out of worksites, and provide consistent, reliable data about employee location for safety and efficiency purposes. At present, employees still need to stop by an RFID checkpoint to clock in/out.

Our current prototype doesn't incorporate the task viewing/checking system due to time constraints, but this is an area that could be quickly improved with minimal future work. Gathering additional data about the wearer such as heart-rate, temperature, etc. could also be implemented for safety purposes at some point in the future.

Finally, improved access to/analysis of data could also be quickly improved. Our present prototype only provides a histogram of time spent clocked in, but this could be expanded to include longer-term data such as task completion times, start times, job progress, and situations associated with accidents or injuries.

7 References

[1] "Time is Money, and Time Theft is Costing Companies Billions," *Chicago Tribune*, December 9, 1985. [Online]. Available: Chicago Tribune, https://www.chicagotribune.com/1985/12/09/time-is-money-and-time-theft-is-costing-companies-billions/. [Accessed March 16, 2024].