

RFID-based Play Zone Access and Time Monitoring System using Smart Card/Watch with Alarm

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Abstract— Children’s play areas in commercial settings need supervision to ensure fair playing time and that zones remain operational. Manual supervision can cause human error, billing disputes, and disabilities in controlling numerous users at the same time. This paper explains the use of RFID wearables and a Raspberry Pi controller to automate the management of time and access for play sessions. When a child scans an RFID tag on entry, the system starts a countdown timer to that user’s ID and activates real-time alerts on the interface and play time indicators on the wearable. Direct Wi-Fi, with lightweight UDP, eliminates the need for a brokering messaging system while keeping delay to a minimum. This system digitally stores session data for billing and other analytic and accountability purposes. This design allows for reduced staff intervention, enhanced user experience, and shows promise for deferred use in entertainment venues and other services that require time management.

Keywords— RFID, Raspberry Pi, IoT, Wearable Devices, Time Tracking, Real-Time Notification.

I. INTRODUCTION

Utilizing RFID systems allows for safe recognition of identities and recording of data. For the areas in which children will be involved, RFID, as a wearable solution, is ideal because it is non-intrusive, user friendly, and allows for a decrease in the reliance of paper. RFID works best paired with IoT systems, such as Raspberry Pi and Wi-Fi enabled microcontrollers. It has the potential to revolutionize the way in which monitoring of playtime is done. With the integration of real time countdown timers and alerts, children can receive feedback directly from the device, which also eliminates the need for staff to give verbal reminders and make reminders to themselves.

This concept has entered into the proposed system complete workflow. Each child receives an RFID watch that is able to communicate with a Raspberry-Pi wirelessly. At the beginning of playtime, the child’s watch needs to be scanned, and the system will countdown from a predefined limit. When that time elapses, the system will issue a visual alert to both the management and the wearable from the child. This system will allow every child to receive the same playtime, and will decrease the workload of the staff. This will also be a playtime enhancement in the experience of the children. The system ensures that management has the ability to log timestamp. This log serves as a record in the rare instance of a lapse in accountability.

II. LITERATURE REVIEW

Radio Frequency Identification technology is used a lot for identification and automated data capture. It helps with communication in areas. [1]. At first Radio Frequency Identification was used mostly for access control systems. Radio Frequency Identification tags helped with authentication and secure entry management. [2]. Later people started using Radio Frequency Identification for attendance systems in schools and offices. These systems made it easier to record attendance and reduced mistakes. They also made it easier to manage people. Studies found that Radio Frequency Identification systems can handle people at the same time with minimal delay. This makes Radio Frequency Identification good for real-time monitoring. [3]. Then Radio Frequency Identification was used for safety and monitoring systems.

Radio Frequency Identification alarm systems were made to improve security. They send out alerts when something happens. The systems showed that Radio Frequency Identification can work for real-time response. [4]. These systems made it easy for people to interact with them. Wearable Radio Frequency Identification solutions were found to be easy to use. This makes them good for applications that involve children and public places. [5]. The Internet of Things technologies have also been used with Radio Frequency Identification. This has made Radio Frequency Identification more capable. Internet of Things enabled Radio Frequency Identification systems allow for real-time data transmission and remote monitoring. They also make the system more scalable.

These systems use microcontrollers, communication and cloud platforms to enable automation and analytics. [6]. Radio Frequency Identification has also been used for child safety and tracking systems. It is used to monitor movement and ensure security in controlled environments. Radio Frequency Identification based billing and access systems have been made to automate user tracking and financial transactions, in setups. These studies show that Radio Frequency Identification can be used for tracking, automated billing and operational efficiency. [7].

Despite all these advancements not many people have looked into using Radio Frequency Identification with real-time countdown timers and automated session expiry alerts in children's play zones. Most systems only focus on attendance tracking or access control. They do not address time-based activity management and user notification systems. Radio Frequency Identification technology is still not fully used in this area. Radio Frequency Identification can make many things easier and more efficient.

III. PROBLEM STATEMENT

Currently, employees at these facilities track how long each child has been playing using handwritten logbooks, verbal cues, and simple timers. This system is highly inefficient because there can be multiple children playing at once. Tracking each child, remembering their individual start times, and attempting to time their exit is impractical given how busy these facilities get. Staff at these venues are ineffective at keeping children within defined play time limits and this makes it even more difficult for facility operators to keep track of time and play fairly. Handwritten time tracking also poses several operational challenges. The largest issue of this system is the high risk of human error. Such as, unsupervised areas will have children playing for too long, and employees will not pie reasonable revenue for the company.

Launching a set of time limits for children is sure to please parents begging to set time limits for their kids, and it has great potential to generate revenue for the facility, as parents will want to pay for the ability to set time limits on their child's play. Tracking limits will also improve the revenue of the facility, as there will be no areas where children can play unmonitored. Current systems are also unable to manage the historical recording, user pattern analytics, and

capacity management. As users increase, manual systems tend to scale poorly and need an increased workforce which raises operational costs while continuing to provide low levels of reliability. Children often do not notice the passage of time and become absorbed in their activities. In the absence of automated time management systems and user notifications, most users unintentionally exceed their allocated time leading to staff having to pause play in order to address time-outs.

This intro- duces time management dissatisfaction for users, frustration for parents, and operational disruptions for staff. An time management system that is automated, real-time, and time management errorless is therefore required. The system must able to consistently identify users, time log, notify users of time-outs, and require little to no human intervention. The use of RFID-based wearables in conjunction with wire- less microcontroller technology will modernize management supervision to provide play zone management of the highest order.

IV. OBJECTIVES

- The main goal of this study is the automation of timing individual play sessions using RFID-based identification. Currently, each child has to be monitored manually which is inefficient. There is a possibility of errors or biases in session time management. In the proposed system, each child is given a unique RFID-enabled wearable device so the system will be able to automatically verify the child's entry, start the session timer, and link the session to the child's identity. This will minimize the need for manual checking and each session will start with a sufficient and accurate timer.
- The second objective discusses the construction of a complete system for real time counting and alerts. Instead of relying on staff for reminders or visually judging the time remaining, the proposed timer will be on a Raspberry Pi and will do all the calculations for the remaining time. When the time reaches zero, the system will send out alerts on the display to the operator and the child's watch to signal that the session is done. This is important for reliable communication of session expiries in busy locations where verbal communication is not effective.
- The third and main goal is to focus on establish control signal transmissions via direct Wi-Fi systems between the Raspberry Pi and the ESP-01 wearable modules. This goal guarantees the instant transfer of updates on the timers and alerts, devoid of the need for third-party servers or internet access, a necessity for indoor localized play environments.

Another goal of the research is to automate the processes to the greatest possible extent by minimizing human intervention, thereby eliminating errors related to manual operations. When staff is required to oversee time management, the precision of time recording is dependent on human concentration, leading to a potential increase in time recording errors. This goal also seeks to preclude disputes regarding billing by reducing the workloads of employees and increasing the level of transparency. In this way, the operational tension on the staff is also reduced.
- The system logs entry time, assigned time, and status of completion.
- In commercial play zones, many children join and leave activities at the same time. The proposed design should continue to work seamlessly while several RFID devices are active, without slowing down or dropping packets. This is why scalability is important. It means the system will still be useful, even when the size of the business or number of users grows. The last goal is to provide an easy and simple method of interaction for the staff and children.

The graphical interface should be straightforward enough to ensure that no one will need to have a technical background or training to assist staff in logging time for sessions, and for children to understand the visual cues that the system will be provided via LED that will be worn.

V. METHODOLOGY

A. Workflow

The user begins the application by tapping the display on the Raspberry Pi. This will launch App.exe, which the user can see as an app icon on the user interface. The first screen on the user interface says, "scan your watch." Each child has a paired watch with an RFID tag that allows them to authenticate at the RFID reader that the Raspberry Pi is connected to. After they successfully scan the RFID, the screen changes to the timer, which shows how much time is left for playing.

The timer will continue running until it reaches the end, at which point the screen changes to say, "count reaches 0." At the same time, an alert is sent to the watch through Wi-Fi using the UDP protocol, which allows the Raspberry Pi to communicate quickly and without a state with the ESP-01-based watch. Along with the simplicity of the design, the speed of the alert is prioritized over the design of the system when the timer is done, which is why they chose UDP over HTTP. This way, they can avoid session control and fixed IP address assigning.

B. Data Handling and Communication

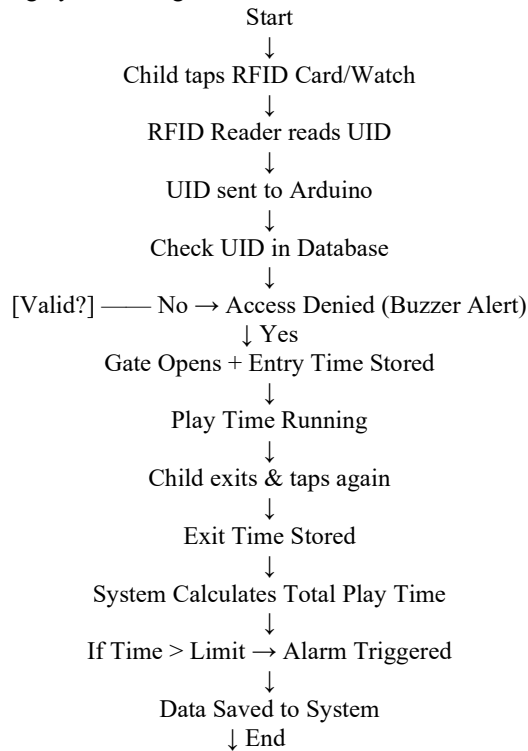
Operational and billing records are kept on Raspberry Pi in an Excel sheet (Log.xlsx), which includes session metadata such as watch id, start and end times, completion status and date. The Raspberry Pi and watch communicate via the Wi-Fi use of UDP packets, which makes IP management easier and overhead lower compared to persistent, connection-oriented protocols.

C. Technical Rationale

The system is designed for maximum ease-of-use, incorporating touch screen launch UI transitions, as well as providing real-time operator and child feedback. Using RFID to authenticate watches ensures that watches can't be used by those who don't have authorization to use them; therefore, all usage is tied to associated session records. The use of UDP for triggering devices, sending low-latency mobile notifications, and managing dynamic (non-static) IP address assignments to ESP-01 modules reduces overhead associated with maintaining the controller. The modular design of the software will allow for future expansions that support the possible introduction of analytical tools, additional services, or improved mobile notifications.

VI. RESULT AND ANALYSIS

The system managed to automate tracking of play sessions with RFID watches, and Raspberry Pi, reducing the need for human involvement and the errors that come with it. Real time notifications were displayed on the touch screen and the wearables with the countdown timers programmed, effective for both the operators and the kids. The communication for the Raspberry Pi and ESP-01 watches over Wi-Fi using the UDP protocol was efficient and fast, with immediate alerts for the end of sessions. Watch-ID, session start time, end time, and completion status were logged accurately in the Log.xlsx file for billing and analytical purposes. The studio management is now more efficient because we automated the time tracking and the notifications. This solved a lot of problems about how people played and it also made the employees jobs easier. The internet connection is really good. We get messages fast when a lot of people are using the internet connection at the same time. This helps us get things done in time. The studio management system is easy to use, for kids. The screens are simple to touch. The menus are easy to understand. Kids like the timer and the reminders the ones, with lights. The timer and the reminders help the kids keep track of time. We can see how people are using the studio management system and make the studio management system better because we keep track of what people do when they use the studio management system. This helps us make sure we have things for everyone. We can see what people like to do. The studio management system works well when a lot of people are using the studio management system at the time. The studio management system does not get slow when everyone is playing together. The studio management system and the time tracking system and the notifications system all work well together to make things easier for the employees and the children and the owners of the studio. Flow diagram of RFID-Based Play Zone Access and Time Monitoring System Using Smart Card/Watch with Alarm:



VII. CONCLUSION

This research introduced a system to track kids in play zones. The system uses RFID tags that kids wear a small computer called Raspberry Pi and Wi-Fi to communicate. It helps manage and monitor play zones so adults do not have to watch all the time. The system solves problems with timing methods like people making mistakes when collecting data. It also fixes issues with things not working well. The RFID system suggests a way to make things fair. This helps reduce the workload on staff and makes kids happier. The study showed that RFID and simple wireless communication can be very useful. The study results are good for use in applications. This research is helpful for creating play zones for kids. The new system is an improvement, over methods. Digital records provide transparent billing and support future analyses. Wearable feedback allows children to receive prompts that indicate the end of a session without the need for staff to verbally communicate the end of a session. While the solution works well in the given scenario, there is room for improvement. Usability in the long run would be improved by incorporating features such as cloud storage, mobile access, enhanced security, and mobile dashboards. Also, additional features such as biometric security and cloud storage would allow for expanded use in other industries with similar timed services. This research articulates for the first time the RFID-embedded wearable time management system solution as a valuable and innovative option for contemporary leisure facilities. It could lead to enhancing the automation, accuracy, and operational oversight of play zone systems and serves as a springboard for future technological advancement and research.

FUTURE SCOPE

There is a tremendous potential for this new RFID/Wi-Fi time management system to be used in many different ways, both now and in the future. A few examples of how the system might evolve over time include: The Internet of Things is being used to make things easier for people. People can now access the Internet of Things from anywhere in the world. This means people can look at session records from anywhere they want. The Internet of Things is also being used to send notifications to customers. These notifications are based on how customers use the product. The Internet of Things can figure out what customers want. They are making apps for owners and customers of the Internet of Things. These apps will help people manage sessions and get notifications on their smartphones. This will make it easy for people to use the Internet Of Things. They are also looking at security options like biometrics for the Internet Of Things. This will make it hard for hackers to get into the system of the Internet Of Things. Childrens smartwatches with the Internet of Things will be more comfortable and fun to wear. This is because of tags and materials used in the Internet Of Things. These tags and materials will make the smartwatches, with the Internet Of Things kid-friendly. New technology of the Internet of Things will also make wearable devices last longer. This means people will not have to recharge them. The Internet of Things will not just be used for gaming. The Internet Of Things will be used in health care and education. The Internet Of Things will also be used in business and transportation. Even people who organize events will use the Internet of Things. The Internet Of Things will be used in different areas because it is very useful.

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