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“Applications in determining whether a point located by the Global Positioning System (GPS) lies inside a polygon using Ray casting algorithm Amidst Digital Transformation in Saudi Arabia 2030”

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ISSN:2045-2322

SCIENTIFIC REPORTS
INTERNATIONAL

Abstract

This study presents the design and implementation of a GPS-based attendance verification system that utilizes the Ray Casting Algorithm to determine whether an employee's device location lies within predefined workplace boundaries. The proposed solution aligns with the Kingdom of Saudi Arabia's Vision 2030 goals for digital transformation by replacing outdated biometric systems with an efficient, cost-effective, and mobile-based approach. The Ray Casting Algorithm was applied to identify if the coordinates collected from a smartphone's GPS fall within authorized polygons representing buildings boundaries. The system was integrated with Human Resource (HR) management databases to automatically record attendance. The results of the pilot implementation, conducted across 50 facilities at University of Jeddah and involving over 1,300 employees, showed high accuracy, improved operational efficiency, and significant cost reduction saving approximately 400,000 SAR annually by eliminating the need for biometric hardware. Furthermore, the system demonstrated enhanced flexibility for remote and field workers while maintaining strict data security through encryption and two-step authentication. Overall, this research demonstrates the potential of computational geometry and geospatial algorithms in optimizing administrative functions and advancing smart governance in line with Saudi Arabia's digital government framework.

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المستخلص

تقدم هذه الدراسة تصميم وتنفيذ نظام تحقق من الحضور يعتمد على نظام تحديد المواقع العالمي(GPS) ، ويستخدم خوارزمية Ray Castingلتحديد ما إذا كان موقع جهاز الموظف يقع ضمن حدود مكان العمل المحددة مسبقًا. تتماشى الحلول المقترحة مع أهداف رؤية المملكة العربية السعودية 2030 في التحول الرقمي، من خلال استبدال أنظمة البصمة القديمة بنظام فعال وذو تكلفة منخفضة يعتمد على الأجهزة المحمولة. تم تطبيق خوارزمية Ray Casting للتحقق مما إذا كانت الإحداثيات المأخوذة من نظام الـ GPS في الهاتف الذكي تقع داخل مضلعات مرخصة تمثل حدود المباني. تم دمج النظام مع قواعد بيانات إدارة الموارد البشرية (HR) لتسجيل الحضور تلقائيًا. وأظهرت نتائج التطبيق التجريبي، الذي نُفِّذ في 50 منشأة بجامعة جدة وشارك فيه أكثر من 1300 موظف، دقة عالية وكفاءة تشغيلية محسّنة، مع تحقيق تخفيض كبير في التكاليف بلغ نحو 400,000 ريال سعودي سنويًا نتيجة إلغاء الحاجة إلى أجهزة البصمة. علاوة على ذلك، أظهر النظام مرونة أكبر للموظفين العاملين عن بُعد أو في الميدان، مع الحفاظ على أعلى معايير أمان البيانات من خلال التشفير والمصادقة الثنائية. وبشكل عام، تُبرز هذه الدراسة إمكانات الهندسة الحسابية والخوارزميات الجغرافية المكانية في تحسين الوظائف الإدارية وتعزيز مفهوم الحوكمة الذكية بما يتوافق مع إطار الحكومة الرقمية في المملكة العربية السعودية.

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Introduction:

The Kingdom of Saudi Arabia has been on an ambitious path toward full digital transformation in recent years, following the strategic goals of Vision 2030. This national vision focuses on making public institutions work better, making digital services better, and making the experience better for both citizens and staff. The Digital Government Authority (DGA) is a key player in this change since it sets up frameworks and standards that make sure all parts of the government work efficiently, come up with new ideas, and create value. In this situation, it is more important than ever to have clever and cost-effective digital solutions to keep operations running smoothly and help the economy flourish. (Alshahrani, 2025)

Biometric attendance solutions that used to be thought of as modern are no longer able to meet the needs of digital governance. These systems usually have significant expenses for buying and keeping up with, are not very flexible, and rely on fixed hardware installations. Additionally, they do not completely fit with the ideas of efficiency and accessibility that Saudi Arabia's digital transformation strategy has in mind. As government agencies grow in size and number of sites and adopt more flexible work models like remote work and field operations, there is a rising need for an attendance system that is precise, safe, and works with mobile devices. (Alajmi, 2022)

This study presents a novel methodology employing the Ray Casting Algorithm, a computational geometry technique, to ascertain whether a GPS point indicating an employee's mobile device location is situated within specified geographic boundaries associated with authorized workplace buildings. (Khazen, 2022) The suggested approach replaces old biometric systems with a smartphone-based attendance system that works perfectly with HR management systems. This system lets employees check in or out using their own devices, making sure that the recorded location is within the official building perimeter.

The solution fits well with various key parts of Saudi Arabia's Digital Transformation Framework, including those that deal with digital systems and infrastructure, digital service delivery, digital channels, user experience, institutional innovation, and new digital solutions. By using mobile technologies and geographic algorithms that are already in place, the system improves operational efficiency, lowers costs, and makes users happier while removing the need for expensive biometric devices.

The ultimate goal of this research is to create and show off a clever, cheap, and dependable attendance verification system that follows the rules of digital transformation. The proposed model uses smartphones, GPS data, and the Ray Casting Algorithm to help Saudi Arabia's government operations become more modern and technologically advanced. It offers a safe, scalable, and innovative alternative to traditional attendance systems.

Problem Statement:

Even though Vision 2030 has helped the Kingdom of Saudi Arabia make a lot of progress in digital transformation, many government agencies still use old biometric attendance systems that are becoming less and less useful for the country's digital goals. Hardware-dependent systems like fingerprint and card-based devices need a lot of money to set up, keep running, and get technical help at different locations. Their restricted scalability and reliance on physical infrastructure lead to inefficiencies, especially for firms with geographically dispersed branches or workers working remotely or on field assignments. (Golightly et al. 2022)

Also, the fact that current attendance systems don't operate well with the bigger digital transformation framework makes it harder to achieve operational efficiency and wise governance. Current solutions don't take advantage of new technologies like mobile computing, geographical data, and cloud-based verification to make attendance management more accurate, secure, and flexible. Because of this, public institutions have trouble lowering costs, making the work experience better for employees, and making sure that administrative tasks follow the rules of digital governance. (Balaji, 2025)

To solve these problems, we need a smart, safe, and cheap way to check attendance that uses the digital infrastructure we already have and smart devices that employees already own. The proposed research aims to address the shortcomings of conventional systems by utilizing the Ray Casting Algorithm a computational geometry technique to ascertain whether a GPS-detected point (representing an employee's mobile device) is situated within specified geographic boundaries that delineate official workplace premises. This computational method allows for accurate, real-time verification of attendance without the need for physical biometric devices.

The main problem this study looks at is that present attendance methods are inefficient, expensive, and don't use technology well, which goes against Saudi Arabia's digital transformation ambitions. The study seeks to illustrate how the use of the Ray Casting Algorithm in a GPS-based attendance model can offer an innovative, precise, and scalable solution that improves operational efficiency and aligns with the strategic goals of digital governance.

Research Questions:

1. How can the Ray Casting Algorithm be applied to verify employee presence within authorized geographic boundaries?
2. To what extent does the proposed solution improve efficiency, flexibility, and cost-effectiveness compared to traditional attendance systems?
3. How does the integration with HR systems enhance data accuracy and administrative processes?
4. What challenges and security considerations emerge when applying GPS-based attendance systems?

Study Objectives:

1. To apply the Ray Casting Algorithm to determine whether a GPS-located point lies within predefined geographic boundaries for employee attendance verification.
2. To assess the system's effectiveness in improving efficiency, flexibility, and cost-effectiveness compared to traditional biometric attendance systems.
3. To integrate the proposed solution with Human Resource (HR) systems to enhance data accuracy and streamline attendance management.
4. To examine the key challenges and security considerations involved in implementing GPS-based attendance verification systems.

Study Significance:

This study is very important for Saudi Arabia's continuing digital transformation efforts under Vision 2030, both in terms of strategy and practice. It immediately helps the national goal of improving government digital performance by bringing in a new model that makes operations more efficient, cuts costs, and improves the quality of public services. The proposed approach shows how digital innovation may be used in public administration by replacing standard biometric attendance systems with a smart, GPS-based verification mechanism. The suggested concept gives government agencies a scalable and flexible way to keep track of attendance, allowing employees to do so safely on their own smart devices. This method gets rid of the need for expensive biometric gear, cuts down on maintenance and operational costs, and meets the Digital Government Authority's standards for efficiency, security, and service quality.

This study illustrates the actual implementation of computational geometry, particularly the Ray Casting Algorithm, in the realm of digital government. It shows how geospatial computing may be used well to check if a person is present and help with real-time administrative decision-making. This adds to the larger scholarly conversation about the links between computer science, public administration, and digital transformation policy. The study ultimately emphasizes how innovative algorithmic solutions can revolutionize conventional administrative processes into intelligent, data-driven systems that improve user experience, bolster institutional performance, and solidify Saudi Arabia's position as a leader in digital government innovation.

Limitations of the study:

This study is confined to a particular governmental organization in Saudi Arabia, perhaps limiting the applicability of its findings to other sectors or institutions with distinct operating frameworks. The suggested model's usefulness is contingent upon the precision of GPS data and the accessibility of stable internet connectivity, both of which may be influenced by environmental or technical variables. Also, differences in the geometric complexity of building boundaries can affect how accurately the Ray Casting Algorithm can tell if a point is inside a polygon. Lastly, because the system needs constant geolocation tracking, it might be a security and privacy risk that needs constant policy updates, data encryption, and compliance with digital governance standards.

Literature Review:

1. **Ray Casting Algorithm and Computational Geometry**

The Ray Casting Algorithm is one of the most basic methods in computational geometry for solving the point-in-polygon problem, which is figuring out whether a point is within or outside a polygon. The algorithm works by drawing an imaginary ray from the point in question and counting how many times it crosses the edges of the polygon. If the number of crossings is odd, the point is within; if it is even, the point is outside. (Kambhampati, et al. 2024) This method gives a mathematically sound and computationally efficient way to check boundaries. This makes it especially useful for applications that need geographic accuracy, such Geographic Information Systems (GIS), computer graphics, and spatial modeling. In this study, the Ray Casting Algorithm serves as the theoretical basis for creating a GPS-based verification system that checks if an employee's smart device is within the specified geographic borders of their workplace. The system uses this algorithm to make sure that attendance records are only kept when the employee is actually at the right place. This makes attendance management more accurate, clear, and efficient. This strategy is in line with the goals of Saudi Arabia's Digital Government Authority, which are to use new, data-driven technologies to make services better, help with digital transformation, and achieve the goals of Vision 2030 for institutional efficiency and digital maturity. (Bendary & Rajadurai, 2024)

2. Location-Based Verification and Geo-Fencing Systems

Location-based verification and geo-fencing systems have become important tools for modern digital management and smart governance. These systems use Global Positioning System (GPS) data to build virtual geographic boundaries called geo-fences. When a device enters or leaves a certain area, these barriers activate automated actions. These kinds of systems are used a lot in logistics, security, mobile marketing, and workforce management since they let businesses keep an eye on, verify, and record user activity in real time in certain areas. (Vishnoi et al. 2023) The theoretical basis of geo-fencing resides in its ability to convert spatial coordinates into dynamic control systems that improve operational efficiency and accountability. This study employs the concept of geo-fencing to validate employee attendance by assessing whether a GPS-designated point, symbolizing an employee's mobile device, resides within the sanctioned perimeters of the workplace. This is a more flexible, less expensive, and automated solution that takes the place of traditional biometric or hardware-based attendance systems. The study also makes sure that location validation is accurate by combining geo-fencing with the Ray Casting Algorithm. This supports accuracy and reliability. This method not only makes the experience of employees better and the organization more efficient, but it also fits with the strategic goals of Saudi Arabia's Digital Government transformation, which focuses on smart solutions, innovation, and efficiency in public sector operations. (Pecorari et al. 2023)

3. Integration with Human Resource (HR) Systems

The combination of digital attendance verification systems with Human Resource (HR) management platforms is an important part of digital transformation in public administration. Modern HR systems are increasingly built to interact with external digital tools through secure Application Programming Interfaces (APIs), providing easy data interchange and real-time synchronization. (Abdullah, 2024) This study proposes a GPS-based attendance verification system that is directly connected to the HR database. This means that attendance records may be instantly checked and updated as soon as an employee's location is confirmed inside the approved geographic bounds. This integration does away with the necessity for manual entry or verification, which cuts down on administrative effort, mistakes, and improves data accuracy. It also lets managers see accurate and up-to-date attendance data that they may use to plan resources and evaluate performance. Integrating the Ray Casting Algorithm with HR systems also helps to achieve the larger

goals of operational efficiency and transparency by creating a single digital ecosystem where spatial data and personnel information may interact safely and quickly. (Park, et al. 2021) This is in line with the Saudi Digital Government Authority's criteria for interoperability and data governance. It makes sure that digital solutions used by institutions help achieve the goals of automation, accuracy, and better service delivery set out in Vision 2030.

4. Security, Privacy, and Ethical Considerations

Installing GPS-based attendance verification systems raises important issues about data security, privacy, and following the rules. Because these systems rely on constantly collecting and analyzing geolocation data, it is very important to protect the privacy and accuracy of this data. Unauthorized access, data breaches, or the abuse of personal location data could break privacy laws and damage confidence. So, strong encryption protocols, safe authentication methods, and limited access rights are all important parts of the system's design. (Nwakamma, et al. 2024) This study ensures data security using multi-layered methods, including encryption of sent coordinates, restricted database access, and integration with trustworthy HR systems under governmental monitoring. From an ethical point of view, transparency and user permission are very important. This means that employees should know how their location data is gathered, utilized, and safeguarded. These steps are in line with the guidelines set by Saudi Arabia's Digital Government Authority, which stress the responsible and legal use of digital technologies in public services. Also, policies need to be updated all the time to keep up with new cybersecurity threats and data protection rules. (Murali, et al. 2024) By including these ethical and security considerations, the study makes sure that technical innovation in attendance verification works within a context of trust, accountability, and conformity with national digital governance goals.

5. Digital Transformation and Smart Governance

The suggested GPS-based attendance verification system is a big part of Saudi Arabia's digital transformation and smart governance efforts. The Saudi Vision 2030 and the Digital Government Authority both say that the country's main goal is to improve the efficiency of government operations, the quality of services, and the use of data to make decisions. (Bendary & Rajadurai, 2024) The goal of digital transformation in public administration is to replace old,

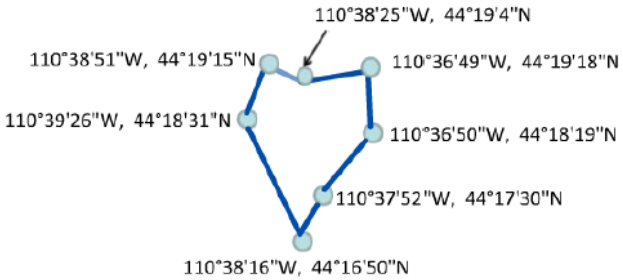
manual, and hardware-dependent ways of doing things with smart, automated, and cheap digital alternatives. In this context, the use of the Ray Casting Algorithm provides a new way to promote smart governance by making attendance tracking precise, automatic, and clear. It gets rid of the need for physical biometric equipment, which lowers costs, makes things more flexible, and makes the user experience better. Also, it fits with the national requirements for digital governance, which stress interoperability, security, and innovation across all government platforms. This study advances the development of e-government models that leverage emerging technology to optimize operations, ensure accountability, and improve public sector productivity through the integration of geospatial computing with human resource management systems. So, the proposed approach is not just a technological improvement; it is also a strategic way to help Saudi Arabia reach its bigger goal of creating a sustainable and smart digital government ecosystem.

Methodology:

This work utilizes an applied and descriptive research technique to build and execute a digital solution that ascertains whether a point identified by the Global Positioning System (GPS) is situated within a polygon through the Ray Casting Algorithm. The suggested solution helps Saudi government agencies with their digital transformation efforts by replacing old biometric attendance systems with a more efficient, location-based digital attendance system.

- **Data Collection**

We got geographic information for all the all the university buildings that were part of the project. We used Google Earth to get the latitude and longitude coordinates and then turned them into polygons that showed the exact geographic boundaries of each building. These polygons were kept in a central database that was connected to the Human Resources (HR) system. This made sure that employees were correctly linked to the borders of their workplaces.



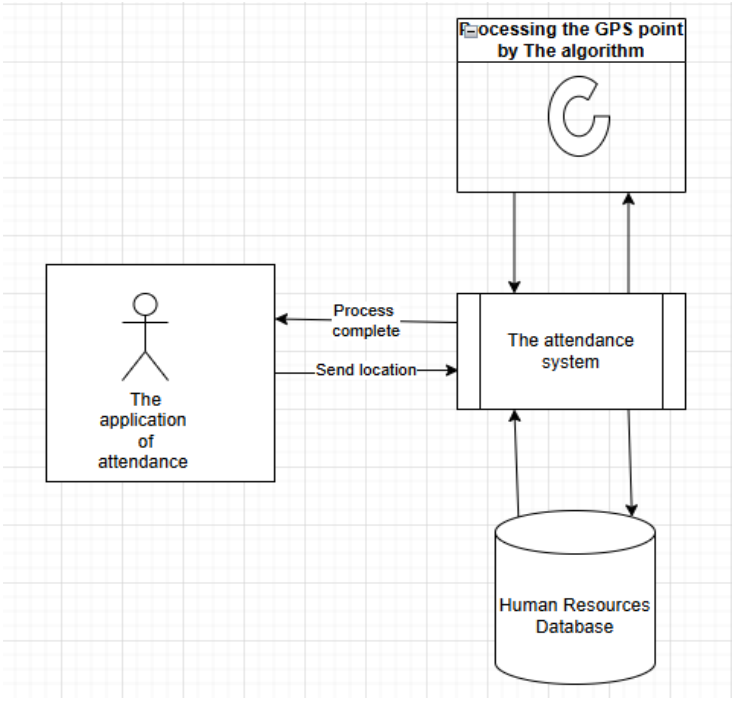


Figure 1. System Architecture of the GPS-based Attendance Verification Model.System Development and Integration

A mobile app interface was made so that employees could check in and out directly from their smartphones. The system was made to work with the HR management system through Application Programming Interfaces (APIs) to check employee credentials, keep attendance records in sync, and make sure that data flows safely across systems.

Figure 2. Ray Casting Algorithm Concept for Point-in-Polygon Determination.

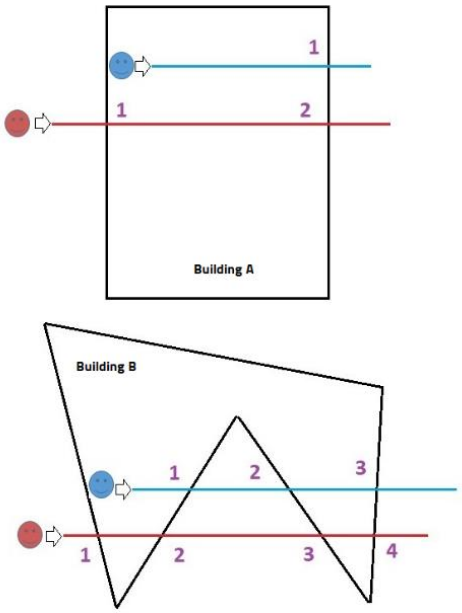
The algorithm was put into the backend to check if the GPS coordinates that were recorded when the person logged in were inside the building's approved borders. The Ray Casting Algorithm was used to do the Point-in-Polygon check. It casts a ray from the point in question and counts how many times it hits the edges of the polygon.

Figure 3. Mobile Application Interface for Attendance Check-in/Check-out.

- If there is an odd number of crossings, it means that the point (where the employee is) is inside the polygon (the building).
- If there are an even number of intersections, the point is outside the polygon.

The implementation logic is as follows:

```
public bool IsPointInPolygon(Polygon polygon, Coordinate point)
{
    bool isInside = false;
    int count = polygon.Coordinates!.Count;
    for (int i = 0, j = count - 1; i <                                    count; j = i++)
    {
        if
```



```
(((polygon.Coordinates[i].Longitude > point.Longitude) != (polygon.Coordinates[j].Longitude > point.Longitude))
&&
        (point.Latitude < (polygon.Coordinates[j].Latitude - polygon.Coordinates[i].Latitude) *
        (point.Longitude - polygon.Coordinates[i].Longitude) /
        (polygon.Coordinates[j].Longitude - polygon.Coordinates[i].Longitude) + polygon.Coordinates[i].Latitude))
      {
        isInside = !isInside;
      }
   }
   return isInside;
}
```

- **Technologies Used**

Technology	Application
Ray Casting Algorithm (Point-in-Polygon)	Determines whether the GPS coordinates of an employee's device fall within the authorized building polygon.
GPS	Provides accurate real-time geolocation data during attendance recording.
Smart Devices	Serve as the user interface for performing check-in/check-out without the need for physical biometric devices.
API Integration with HR Systems	Ensures seamless data exchange for validation, synchronization, and automated attendance logging.

- **Implementation and Testing**

More than 50 buildings and 1,300 employees tried out the technology. During testing, we kept an eye on how accurate the GPS data was, how reliable the boundary recognition was, and how well the users liked it. The system did the following:

- More than 248,000 successful attendance transactions.
- The average time it takes to check in went down to less than five seconds.
- Getting rid of about 200 biometric devices will save about 400,000 SAR a year on hardware and maintenance expenditures.

BuildingID	BuildingName	Latitude	Longitude
23	كلية العلوم (13)	21.891530500000000	39.256177100000000
23	كلية العلوم (13)	21.891033700000000	39.256889500000000
23	كلية العلوم (13)	21.890349100000000	39.256354100000000
23	كلية العلوم (13)	21.890867600000000	39.255641900000000
24	كلية علوم الرياضة (14)	21.890682200000000	39.255609700000000
24	كلية علوم الرياضة (14)	21.890214700000000	39.256257400000000
24	كلية علوم الرياضة (14)	21.889693400000000	39.255807200000000
24	كلية علوم الرياضة (14)	21.890069900000000	39.255203100000000
25	كلية الطب (15)	21.892593900000000	39.256877000000000
25	كلية الطب (15)	21.891792900000000	39.257986000000000
25	كلية الطب (15)	21.891004200000000	39.257336900000000
25	كلية الطب (15)	21.891779200000000	39.256156200000000
26	كلية الهندسة (16)	21.892593900000000	39.256877000000000
26	كلية الهندسة (16)	21.891792900000000	39.257986000000000
26	كلية الهندسة (16)	21.891004200000000	39.257336900000000
26	كلية الهندسة (16)	21.891779200000000	39.256156200000000
27	معهد اللغة الإنجليزية (17)	21.892633600000000	39.256880700000000

Figure 4. Integration Workflow between GPS System and HR Database.

- **Security and Data Integrity**

There are several security measures in the solution, such as

  - Two ways to check the identity of a gadget and its GPS position.
  - Encrypting data while it is being sent.
  - User access restrictions and permission management are built into the mobile app.
- **Evaluation Metrics**

We looked at the system's performance based on:

  - How accurate is the detection of geographical boundaries.
  - Compared to biometric systems, this saves money.
  - User happiness and better service efficiency.
  - Flexibility in operations for working from home, going to training, and accessing several sites.

Results:

- **Implementation Overview**

The suggested approach, which used the Ray Casting Algorithm to figure out if a GPS-located point was inside a polygonal boundary, was successfully put into action and tested by multiple University of jeddah Sectors in Saudi

Arabia. There were about 1,300 personnel in the pilot phase, spread out over more than 50 buildings. This made it possible to test how well the system worked in real-world settings.

The technology worked perfectly with the Human Resources (HR) management system and ran on employees' smart devices. Before letting the attendance or departure record go through, the algorithm quickly checked to see if the device's GPS coordinates were inside the allowed building perimeter. This validation procedure took less than five seconds, which shows that the technology is quite responsive and can be used in real time.

- **Quantitative Results**

The system kept track of more than 248,581 attendance transactions by 1,380 active users during the implementation period. Data analysis indicated that the Ray Casting Algorithm always gave correct answers when figuring out if points were inside or outside the designated polygons. There were no major delays in computing or errors in detection.

There were clear financial and operational benefits:

  - About 200 traditional biometric devices were no longer needed, each costing about 2,000 SAR. This saved almost 400,000 SAR a year.
  - Hardware-based systems were removed, which cut maintenance and technical support costs by 90%.
  - The software-based solution was very flexible, could grow with the business, and had very little expense for future integration or expansion.

- **Operational Efficiency**

The use of this approach made it much easier to keep track of attendance. Employees could check in or exit right away with their own smart devices, without having to wait in line or use traditional attendance terminals.

The process took less than five seconds, which made daily tasks easier and cut down on time lost.

The solution also worked for many types of tasks, such as:

  - Working from home and doing tasks online
  - Business travel and field work
  - Moving about the office and doing training sessions

This flexibility made the organization more productive while still keeping track of attendance no matter where the employee was.

- **User Experience and Acceptance**

Feedback from users showed that things were easier and more satisfying. Employees liked being able to safely and promptly record attendance from their own devices. This made things easier than with previous biometric systems. The easier approach made the entire experience better for employees, increased their use of digital platforms, and cut down on the work that HR teams had to do. The system's easy-to-use interface and ability to be used on mobile devices also helped it spread quickly with little training or technical help needed.

- **Reliability and Security**

The system was very accurate and dependable for the whole testing time. There were many layers of protection to make sure security, such as:

  - Two-step verification that uses both GPS location and device authentication.
  - Encrypting the data that is sent between the mobile app and the HR system.
  - Access control and permission management in the app to stop anyone from using it without permission.

There were no reports of fake attendance logging or data breaches, which shows that the system was a strong and reliable way to keep track of attendance.

- **Cost Reduction and Performance Gains**

The switch from hardware-based biometric systems to a software-driven, GPS-integrated architecture led to clear financial and operational benefits:

  - By getting rid of hardware and lowering maintenance costs, you can save about 400,000 SAR a year.
  - Costs for system support go down by 90%.
  - Less than 5 seconds to log attendance.

These results show that the system is good at lowering operational expenses, boosting productivity, and helping with long-term digital transformation.

The results show that adding the Ray Casting Algorithm to a GPS-enabled mobile platform is a good and long-term option for modern attendance management systems. The method does away with the need for expensive biometric gear while yet guaranteeing accuracy, adaptability, and safety.

The study also shows how algorithmic geolocation validation may be used in real-world administrative tasks to make them more efficient, keep data safe, and make users happier. The system's success shows that digital innovation in workforce management can operate on a large scale in both the public and private sectors.

Conclusion:

This work effectively illustrated the utilization of the Ray Casting Algorithm as a proficient computational instrument for ascertaining whether GPS-derived coordinates reside inside specified parameters, providing a viable answer for digital attendance verification. The new system fixed the problems with old biometric systems by giving users a digital option that is more flexible, safe, and cost-effective. Its connection to HR systems made attendance tracking more accurate, automated, and in real time. Strong security mechanisms kept data safe and protected user privacy. The results of the implementation showed that the model could be used at many sites and was reliable, which proved that it was suitable for use by the government on a wide scale. The results show that geospatial algorithms and mobile technology can help with digital transformation projects in more ways than just checking attendance. This study advances smart governance in Saudi Arabia by illustrating how computational geometry can improve operational efficiency, decrease expenses, and stimulate innovation in university of Jeddah systems.

References:

1. Abdullah, A. S. (2024). The impact of digital transformation on employee attendance management in university. International Journal of Economic Integration and Regional Competitiveness, 1(3), 22-29.
2. Alajmi, M. (2022). Using a multi-framework to investigate the determinants of smart government systems adoption in public service organizations in Saudi Arabia (Doctoral dissertation, University of Canberra).
3. Alshahrani, A. (2025). Adopting Emerging Technologies in Digital Government: A Multi-Case Analysis of Drivers, Enablers, and Challenges in Saudi Arabia. Digital Government: Research and Practice.
4. Balaji, K. (2025). E-Government and E-Governance: Driving Digital Transformation in Public Administration. Public Governance Practices in the Age of AI, 23-44.
5. Bendary, M. G., & Rajadurai, J. (2024). Emerging Technologies and Public Innovation in the Saudi Public Sector: an analysis of Adoption and challenges amidst Vision 2030. The Innovation Journal, 29(1), 1-42.
6. Gabel, J., Schmidt, S., Ariza, O., & Steinicke, F. (2023, October). Redirecting rays: Evaluation of assistive raycasting techniques in virtual reality. In Proceedings of the 29th ACM Symposium on Virtual Reality Software and Technology (pp. 1-11).
7. Golightly, L., Chang, V., Xu, Q. A., Gao, X., & Liu, B. S. (2022). Adoption of cloud computing as innovation in the organization. International Journal of Engineering Business Management, 14, 18479790221093992.
8. Kambhampati, A., MANDARAPU, D., & KULKARNI, M. (2024) Analyzing the Performance of GPU-Based Point-in-Polygon Algorithms.
9. Khazen, M. (2022). Monitoring Workers on Construction Sites using Data Fusion of Real-Time Worker's Location, Body Orientation, and Productivity State (Doctoral dissertation, Concordia University Montreal, Québec, Canada).
10. Murali, N., Rajesh, R., Sridharan, S., Mariadas, A. E. P., Murugan, S. P., & Manikandan, S. (2024, February). A GPS-based face attendance register system using Android applications stored in the cloud. In 2024 11th International Conference on Computing for Sustainable Global Development (INDIACom) (pp. 17-22). IEEE.
11. Nwakamma, M. N., Ndinechi, M. C., & Agubor, C. K. (2024). Examining the Integration of a GPS-based Staff Performance Monitoring and Assessment System within Academic Settings.
12. Park, H., Ahn, D., Hosanagar, K., & Lee, J. (2021, May). Human-AI interaction in human resource management: Understanding why employees resist algorithmic evaluation at workplaces and how to mitigate burdens. In Proceedings of the 2021 CHI conference on human factors in computing systems (pp. 1-15).
13. Pecorari, N., Rinaldi, M., & Hoogendoorn, S. (2023, June). Dynamic Geo-Fencing for Polycentric Congestion Management: A Simulation-Based Analysis. In 2023 8th International Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS) (pp. 1-6). IEEE.
14. Vishnoi, A., Choudhury, T., Patni, J. C., Sar, A., & Mahdi, H. F. (2023, November). A Proposed Framework for Smart Geo-Fencing For Religious Places. In 2023 7th International Symposium on Innovative Approaches in Smart Technologies (ISAS) (pp. 1-6). IEEE.