



Original Article

AI-Augmented Time Theft Detection System

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Abstract - With the rise in time theft & payroll fraud especially, the shift to remote & also hybrid work has presented fresh challenges in evaluating more employee productivity. With strong AI, the AI-Augmented Time Theft Detection System (TDS) offers a more complete solution meant to address such issues. This method uses behavioral analysis to find more evidence of time theft by tracking little symptoms as idle periods, regular clock-ins & device use habits. In actual time, the TDS detects abnormalities & also anomalous activity using ML techniques & also anomaly detection tools. It uses a human-in-the-loop component to enable continuous feedback to improve its detection models and raise accuracy, hence lowering false alerts. This approach ensures a fair and responsible workplace as well as increases operational effectiveness. Industries include healthcare, consulting, aviation, retail, and manufacturing where accurate timekeeping is critical would benefit much from this strategy. Delivering a complete solution to stop time theft, the AI-driven architecture guarantees reliability and accuracy in staff production monitoring.

Keywords - AI, Time Theft, Behavioral Analytics, Payroll Fraud, Anomaly Detection, Remote Work, Task Verification, Micro-Behavioral Analytics, Timekeeping Systems, Machine Learning, Employee Monitoring, Compliance, Human-in-the-loop.

1. Introduction

Time theft has become a more major issue as companies implement more flexible work models especially remote & also hybrid configurations. Time theft results from people receiving pay for hours they did not really work, thereby causing more financial loss for companies and maybe ineffective work management. Especially in situations when employees are not physically present in an office setting, traditional timekeeping systems such as punch clocks and manual timesheets have grown increasingly inadequate in identifying more complex forms of time theft. Remote and hybrid working aggravates this problem as monitoring methods neglect to cover the total output of an individual.

In tackling these challenges, developments in artificial intelligence (AI) and machine learning provide a workable solution for improved & more proactive time theft detection. AI systems can analyze vast amounts of information & identify more behavioral trends absent from more traditional systems. AI may find more anomalies suggestive of time theft, even in remote work environments without any physical control, by means of the analysis of thorough indications including idle time, task-switching habits & gadget usage.

The design and deployment of an AI-Augmented Time Theft Detection System (TDS) meant to provide more companies a more reliable and effective way to identify time theft & payroll fraud is investigated in this article. This system's basis consists of a set of behavioral analytics tools that perform actual time analysis of employee activity. By regularly tracking tendencies like prolonged inactivity, repeated clock-ins without work participation & inconsistent device usage, the system may spot dubious behaviors for further investigation. Since the system links employee actions with assigned tasks to guarantee that work hours match productivity, task verification is very crucial.

Underlying the system is an AI framework that combines many ML models for anomaly detection, which constantly learns & adapts to evolving more work patterns. Human-in-the-loop (HITL) techniques increase system accuracy by letting human

participation assess highlighted behaviors or update detection models as needed. By merging AI with human oversight, this approach ensures more exact detection of potential time theft and lowers faulty positives' probability. We will look at the many other data inputs required for the system keystroke monitoring & device logs among many other things as well as how these inputs are processed to provide insightful analysis. By use of contextual verification techniques, one ensures that found anomalies are more comprehended within the framework of every employee's particular work environment and also obligations.

Industries like healthcare, retail, consulting, aerospace & also manufacturing rely on their precise time tracking & also responsibility, so the adoption of an AI-Augmented Time Distribution System has major consequences. Better transparency, reduced fraud & more operational efficiency will help these sectors. Furthermore, as technology develops there are exciting chances to maximize staff management & time tracking by including more complex AI features as predictive analytics & improved behavioral profiling. The functionality of the AI-Augmented TDS, the problems it solves & the possible benefits for businesses and also employees will be painstakingly examined in next chapters. We will also look at the developments in this fast growing field and the future of AI-driven work management.



Fig1: The functionality of the AI-Augmented TDS

2. Background and Importance of Time Theft Detection

Time theft is a more common issue that seriously affects their companies' finances, particularly in sectors depending on hourly employment. Simple tools like direct supervision, manual timekeeping, or staff attendance records may usually help to spot their time theft in traditional office environments. Conventional supervisory techniques become less effective when companies rapidly use remote & also mixed work schedules. Businesses have great difficulty confirming the accurate reporting of workers' working hours in the lack of physical presence in the office, which can result in more possible exploitation of paid time & also corresponding financial losses.

Using digital platforms & also remote communication tools as the workforce is more dispersed, companies have to find more creative ways to ensure responsibility & fair compensation. Punch clocks and manual timesheets are among the conventional timekeeping devices that fall short in spotting subtle forms of time theft including prolonged inactivity, multitasking, or faulty reporting. Deficiencies in monitoring might lead to discrepancies between reported hours & also actual work done, maybe going unnoticed until they cause significant financial losses over time.

The development of AI and ML provide an opportunity to bring about closure of these gaps. By using more sophisticated behavioral analytics, anomaly detection & actual time task verification, AI-driven systems might provide a more exact & more proactive means for identifying time theft. To find unusual behavior that could otherwise be overlooked, these systems might assess huge databases from multiple sources including device activity, work completion rates, and staff interaction patterns.

Remote monitoring & evaluation of employee performance helps companies to maintain their accountability while allowing more flexible working conditions.

3. Key Concepts in Time Theft Detection

3.1 Micro-Behavioral Analytics

Little, frequently overlooked acts called micro-behavioral might reveal more trends indicative of suspected time stealing when taken together. These behaviors must include unproductive periods, too many clock-ins empty of associated activities, repeated spells of inactivity & also unpredictable keyboard or mouse movement patterning. Although these actions may not seem like much on their own, taken together they give more valuable insight on an employee's degree of participation. Extended periods of inactivity, in which the computer runs but no inputs are logged, might point to an employee not actively participating in their task notwithstanding their time log seeming reasonable. Similarly, frequent clock-ins coupled by little or no activity might point to someone misrepresenting their work hours without completing any other tasks.

Time theft detection AI systems track these micro-behavior by closely examining device logs comprising keyboard inputs, mouse movements & also application usage. Subsequently, ML models may identify more patterns & also anomalies outside of expected work behavior. By using these micro-behaviors as markers, the system might detect when a person is not totally committed to their obligations & also generate an alert for further inspection. This kind of monitoring helps companies to quickly identify time theft & also inefficiencies, therefore reducing the financial effects of unnecessary hours and improving general employment responsibility.

3.2 Contextual Task Validation:

Contextual task validation shows that workers' reported hours match their actual job performance. It becomes more essential to make sure that an employee's time fits the work they are expected to do when companies monitor project development & also task allocation using digital task management systems. Sometimes conventional timekeeping systems rely only on human input, which is prone to manipulation or error. Workers' time logs are cross-referenced with digital activity records from project management systems including job completion statuses, milestones, and deadlines in order of context.

The system will flag an employee's eight hours of work on a project if there is no significant task progress recorded in the project management system. Similarly, the system may detect differences if an employee spends time on tasks different from the assigned activity, including browsing the internet or utilizing another programme package. Workers' efforts to claim unworked hours or whole tasks without any adequate engagement are more complicated by this verification layer. By matching time logs with task completion statistics, contextual task verification provides a more accurate & also reliable evaluation of production, therefore helping companies to maintain fair compensation policies & reduce time theft.

3.3 Peer Pattern Analysis

By comparing the temporal activities of an individual employee with those of their peers or team members, peer pattern modelling is a method used to spot more deviations in their work practices. This comparative analysis finds more anomalies that is, workers that habitually log hours while their colleagues do not or follow different work schedules from team standards. Because they provide a benchmark for what constitutes "typical" work conduct within a certain group, function, or department, peer comparisons are helpful. While most team members keep regular daytime hours, one individual sometimes works late into the night or shows notable differences between clock-ins & also task completion, suggesting erroneous or illegal time reporting.

Through their analysis of previous data of time logs & also task completion throughout the workforce, ML algorithms drive the peer pattern modelling process. The system creates models with common behavioral characteristics for more different teams or jobs. It then uses this method to examine how certain employees behave. When an employee's behavior deviates from more accepted standards such as irregular clock-ins, unproductive intervals, or aberrant activity within allocated hours—these deviations are noted for further investigation. In environments where direct control is challenging, including remote or hybrid teams, peer pattern modelling is often more successful for spotting time theft or fraud.

Using data from a huge range of colleagues helps the system to spot more discrepancies that could go unnoticed if individual employees are watched in isolation. It also helps companies find potential structural issues such as ineffective team dynamics or regions needing training to increase output. Over time, the machine learning models used for peer pattern modelling constantly improve their comparisons. Fresh data helps the system to recognize anomalies & adjust to changes in team dynamics or work habits. This ongoing schooling ensures that the system will be efficient in spotting time theft independent of changes in working practices.

4. System Architecture

4.1 Data Inputs

Effective monitoring & identification of time theft in the AI-Augmented Time Theft Detection System relies on their various fundamental data inputs. Working hours are based on timekeeping systems that track employee clock-ins & clock-outs, therefore providing the major source of information. These technologies help to create a schedule showing when employees should start their activities and when they are allocated to work. Understanding employee participation with their devices depends on time records as well as information on keystrokes and mouse activity. Monitoring the frequency & features of user inputs helps the system to spot signs of inactivity or disengagement, including gaps without keystrokes or mouse movements, which would suggest that the employee is not actively working.

Including actual time data on staff assignments & also project completion statuses, job management tools are very vital to the system. Cross-referencing employee time records with the progress shown in task management systems helps the system to determine if workers are doing their assigned tasks during the logged hours. In certain fields, particularly where physical presence is more vital, additional inputs like geolocation data & CCTV information might greatly increase the accuracy of the system. While CCTV information (where appropriate) may visually confirm presence, especially in security-sensitive or more regulated environments, geolocation data can confirm if staff members are in the right place.

4.2 Detection Framework Artificial Intelligence

The AI-Augmented Time Theft Detection System's base is its detection stack, which combines more anomaly detection techniques with ML models meant to identify their suspicious conduct. One basic component is isolation forests, a ML method skilled at spotting more anomalies in huge datasets. Seclusion Forests show likely examples of time theft if an employee's behavior differs from that of their colleagues or established norms by pointing out facts that significantly deviate from usual patterns. Using Autoencoders a kind of neural network designed to recognize workers' normal behavior is a fundamental part of the detection system. Trained on historical information, autoencoders find the parameters of "normal" work behavior for individuals; when deviations from this baseline are found, they may indicate likely timescale theft.

Since autoencoders adapt to shifting work patterns & also continually improve their capacity to identify more anomalies as employee behavior changes, they are quite successful. At last, the algorithm chooses highly confident signals requiring further investigation using logic rules. An employee will begin a review procedure if they are put into the system without active tasks or neglect to accomplish any meaningful work throughout their allotted hours. These logical ideas provide an additional degree of filtering & ensure that the method detects precisely those actions most likely to indicate time stealing. These AI-driven approaches taken together provide a strong & also versatile detection system suited for more precisely identifying suspicious activity while lowering faulty positives.

4.3 Human-in- the Loop Evaluation

While AI algorithms are great at spotting anomalies, accuracy & also reliability rely on human supervision. The Human-in- the Loop (HITL) review system guarantees that only actual time theft events are escalated for further action, therefore preventing faulty positives. When the AI detection system detects a potential issue, HR or compliance staff are notified so they may investigate the situation more fully. This assessment process helps one to better understand the found conduct. An employee could have been absent for a while, sometimes for good reason such as a break or attendance at meetings. The HITL assessment lets

human assessors take more contextual factors into account, therefore providing a definitive answer on whether the observed behavior counts as time theft.

Integration of AI-driven detection with human supervision assures that the system is fair & also accurate. Including human involvement in the review process improves the capacity of the system to control edge conditions, clarify any uncertainty & finally over time hone its detection methods. Maintaining the efficiency of the system & guaranteeing that only actual cases of time theft are handled depend on the recurring feedback loop between artificial intelligence and human assessors.

5. Outputs and Dashboards

The main outcome of the AI-Augmented Time Theft Detection System is a greater probability score for time theft for every employee that supports their supervisors to evaluate the occurrence of time theft. This score offers a more quantifiable representation of the system's confidence that an employee's behaviour deviates from established standards, therefore implying suspected time stealing. A higher score suggests more possibility that the employee's actions including inconsistent work participation or idle time need more further investigation. For managers, this probability score provides a timely & also sensible viewpoint that helps them to focus on events that could call for investigation.

Apart from the probability score, the dashboard of the system presents a comprehensive overview of data on time theft. Designed to be user-centric, the dashboard shows information in a logical & easily understandable manner. Managers may spot anomalies by user, therefore emphasizing employees whose activity deviates from usual patterns. This helps to quickly identify those maybe engaged in time theft or showing productivity issues. The dashboard shows team-based anomalies that let managers identify general trends that could affect whole departments or groups. Should a team show a consistent trend of excessive hours or time theft, this might point to issues with work distribution or team management.

The dashboard helps managers to look at more anomalies by time period, therefore providing information on the probability of time theft events. This ability might find patterns, like workers consistently failing at certain times of the day or week, which would point to dishonesty or also disinterest. Examining more anomalies within certain time ranges helps managers understand the factors behind time theft & apply preventative measures to minimize it. Apart from simple anomaly identification, the dashboard provides more comprehensive information that helps managers probe the underlying causes of observed activities. This covers studies of more specific activities that affected the probability score, like periods of idleness, incomplete tasks, or too frequent clock-ins. These revelations help one to have a more thorough awareness of the problem & also enable the identification of areas needing development, like staff engagement, process simplification, or also investigation of suspected fraudulent activity.

The information shown on the dashboard might be easily included in existing compliance protocols to ensure that any suspected time stealing events are quickly reported for review. The system may provide reports that clarify findings for HR or more compliance staff, therefore arming them with a wealth of data to support investigations & also decision-making. The solution automates time theft detection and reporting, therefore improving employee responsibility management and reducing the obligations of HR departments and managers. Moreover, the real-time features of the dashboard ensure that managers have current knowledge on staff output. This continuous monitoring helps companies to react quickly when they find potential time theft thereby allowing them to apply corrective actions.

The outputs of the dashboard help managers to provide employee comments, change work plans, and carry out further training, thus promoting responsibility and guaranteeing fair compensation policies all around the workforce. The outputs and dashboard of the system provide a clear, sensible, and all-encompassing view of the risk of employee time theft. Easily integrating into compliance and workforce management systems, the dashboard combines probability ratings with insights into user behaviour, team dynamics, and temporal patterns to provide managers the tools they need to identify, stop, and minimise time theft.

6. Case Study: Implementation of the AI-Augmented Time Theft Detection System in a Healthcare Provider

The pragmatic benefits of the AI-Augmented Time Theft Detection System (TDS) are shown by this case study from a huge healthcare provider utilizing a hybrid workforce. This company struggled greatly with payroll errors linked to time fraud. The company found increasing difficulty maintaining more accurate timekeeping & also job performance given a huge number of staff members working remotely. Many times, workers clock in for work without showing more commensurate job participation, which causes inflated payroll costs & huge financial expenses. Responding to these difficulties, the healthcare provider decided to use the AI-Augmented TDS to fight time theft, reduce payroll fraud & also improve their general work efficiency. The system was meant to find micro-behavioral and aberrant trends suggestive of probable misuse of working hours as well as to actively find more discrepancies between clock-in times and actual task accomplishment. After six months of TDS usage, payroll fraud dropped by forty percent. The effectiveness of the system could be traced to three key elements that directly addressed the basic issues of time theft:

6.1 Confirming Real-Time Activities

One prominent feature of the TDS was its ability for actual time task verification. Managers cross-referenced recorded hours with the progress on specified tasks to track employee activity all throughout the workday. This helped to identify more abnormalities, including cases where employees entered hours without significantly advancing their work. The system linked with the task management system of the company thus let managers track individual contributions & link them with the recorded time. The technology would flag an employee's prospective issue, for instance, if they claimed to have worked eight hours without any other documented completed tasks entered into the task management system. Managers could then interact with staff members to understand the discrepancy and, if necessary, apply more corrective actions. This degree of transparency assured that employees understood the careful monitoring of their time, therefore encouraging better working practices & also discouraging time stealing.

6.2 Peer Pattern Analysis

Detecting notable trends of time theft among many other teams required the peer pattern modelling feature. The TDS examined the temporal performance of more individual employees against their peers to find outliers that routinely logged hours without equivalent task progress or had unusual work habits. Several times it was found that certain teams were more prone to time theft, most likely due to unclear output targets or inadequate monitoring. By use of team behavior analysis, the system identified groups requiring certain interventions. One department showing a notable incidence of claimed time theft was found to have team leaders disengaged from supervising their subordinates, therefore reducing collective accountability.

By means of improved management & also team relationship restructuring, the healthcare provider successfully reduced departmental time theft. This capacity also let management see when time theft was turning into a more major issue inside the company. For example, management may quickly identify the problem & take remedial action before it spreads to many other teams if numerous members of a team consistently reported work hours that did not fit their productivity. Peer pattern modelling helped to identify more individual time theft as well as systemic problems perhaps fixable at the departmental or organizational level.

6.3 Anomaly Detection for Outward Behavior

The success of the system was much dependent on its more anomaly detection capacity. Using ML methods, this component identified unusual behavior more patterns like extended idle intervals, repeated clock-ins free of meaningful job participation & also irregular work habits at different times of the day. By means of ongoing data analysis, the system improved its ability to detect more anomalies suggestive of time theft. The system found an employee who regularly checked in but showed protracted periods of inactivity without doing any work.

Later investigation found that the staff member neglected assigned tasks while engaged in more personal interests during working hours. This realization helped management to react more quickly, have conversations with the staff, and correct conduct before it became a more serious problem. Furthermore, anomaly detection helped to identify more general trends such as certain

times of day or week when employees were more likely to engage in time stealing. This knowledge helped managers to carry out focused campaigns such changing work hours or offering extra training to improve involvement during ordinarily low productivity.

6.4 Organizational and Cultural Influence

Beyond simple fraud protection, the AI-Augmented Time Theft Detection System influences something more. One of the most obvious results was the system's ability to foster within the company an accountable and transparent culture. Workers realized their work behaviors could be tracked using more sophisticated analytics, which would lead to more responsibility and more diligence. Staff performance improved and overall idle time dropped as staff members knew that inefficiencies would be identified and corrected. Moreover, the company saw a growing confidence amongst staff members and managers.

The system was considered as a measure to ensure equality and openness in the recording and compensation of work hours, not as a tool for micromanagement. The approach, according to staff members, efficiently protected corporate resources and their time, therefore promoting a more pleasant and cooperative workplace. Staff morale improved with the TDS installed. Reducing time theft guarantees best use of resources and helps the company to provide fair compensation for hardworking employees. Higher retention rates and more output followed from this improved overall job satisfaction and morale.

7. Conclusion

Offering companies a more proactive, data-driven method to find & also reduce time theft, the AI-Augmented Time Theft Detection System marks a more significant development in employment management. Although more effective in certain situations, conventional timekeeping systems have struggled to fit the more complexity of modern workplaces, particularly in remote & also hybrid situations. Using advanced approaches like micro-behavioral analytics, contextual task validation & also peer pattern modelling, this system reduces current shortcomings to provide a more complete solution that is both scalable & also efficient. By constantly watching minute behavioral signals & also cross-referencing job actions with recorded hours, the system enhances time tracking with more accuracy & also guarantees fair remuneration for employees depending on their actual performance.

The system's ability to readily link with existing timekeeping, task management & also compliance procedures yields mostly benefits. In fields such as healthcare, retail, consulting, aerospace & also manufacturing where careful time management is more crucial—this integration ensures that the system fits more current practices exactly. It is particularly helpful in sectors with a significant, usually scattered workforce as it eliminates the need for human monitoring & also provides a complete mechanism for spotting time theft across many other operational systems. Moreover, the hybrid approach of the system ensures precise & contextually aware time theft detection by combining AI-driven automation with human monitoring.

While AI systems are great at spotting trends & more abnormalities in behavior, human reviewers are more essential for rendering decisions especially in more complex situations. By means of this cooperation between technology & also human understanding, faulty positives are less likely to be detected & only actual cases of time theft are found for further action, therefore preserving fairness in the usage of the system throughout the workforce. As companies grow, there is great possibility to improve the AI-Augmented Time Theft Detection System's features. Layers of audio & also video verification might be part of future developments, providing improved & also different ways to confirm staff operations. Mechanisms for biometric authentication might be included to confirm that the relevant staff members are using their positions to carry out the tasks relevant to them. These improvements would greatly increase the system's ability to address time theft in a more thorough & also more sophisticated way.

Moreover, if hybrid & remote work environments grow, the system might be adjusted to meet the particular needs of these flexible work models. Including geolocation tracking or mobile integrations might help to monitor their employee activity from a distance, thereby guaranteeing that staff members stay involved in more creative projects away from a physical office. In fields like healthcare, where staff members may function across many other locations or from patients' homes, this would be very helpful. Maintaining justice, responsibility & also financial integrity in the workplace will depend on AI-driven solutions such as the AI-Augmented Time Theft Detection System going forward.

These solutions are very essential for effectively managing employee time as businesses face a growing need to maximize their operations, save expenses & maintain their high production. Holding employees accountable for their work hours helps companies create an equitable, transparent culture that benefits employers as well as staff members. The AI-Augmented Time Theft Detection System helps companies to spot & reduce time theft while also giving them the opportunity to choose their technology that improves operational effectiveness & also employee satisfaction. Using advanced technology like these will be very essential to ensure appropriate resource use and preserving worker integrity as businesses negotiate the evolving work environment.

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