Vehicular rental industrial automation

Automation using Internet of Things and Blockchain smart contract.

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***Abstract*—The current automotive renting services rely heavily on human resources which also makes room for human errors. Using Internet of Things, and Blockchain, the proposed business case is a take to increase efficiency by minimizing factors that are prone to human errors. By tracking impacts against the surface of the vehicle, sending an alert on anomaly detection, and automating and securing transactions using blockchain.**

Keywords- Application Programming Interface; consensus; univariate; array; microcontroller

I. INTRODUCTION

Currently the car renting system, even though integrated with the internet, unnecessarily relies heavily on human resources. Human intervention also makes this process susceptible to errors. For instance, if a car renting service lends a car to a customer, the car, after drop, need to be examined for any physical damage that it has taken, which requires human resources, needless to say that maximum cars that are dropped back are not damaged, meaning a lot of human resource is wasted to test for an event that has a low probability of occurrence. Similarly, the car inspector can neglect or purposely penalize customers based on their own discretion.

Automating this process can save excessive and extraneous use of human resources and reduce the amount of errors. An ideal model would include data collection, data processing, remote transfer, and tamper proof validation. These necessities can be satisfied using Internet of Things and Blockchain smart contract.

II. PROPOSED MODEL

Analyzing online vehicle rental businesses, the two kinds of business models companies often followed:
Ownership: The company owns the vehicles to be rented, and often provided cab services with chauffeur.
Platform: owners of vehicles can list their vehicles on the common online portal to be rented.

In each of these models, the car is needed to be checked for external physical damage after being returned to the drop point. The proposed model aims to automate the rental service with minimum human intervention in a tamper proof manner.

The automobile in question is installed with sensors and an Internet of Things (IOT) system, the sensors are used to track for any physical impact that the automobile experiences during the period of service. Physical impacts that are treated as anomaly are registered and the employee is notified by the automobile's IOT system. The transaction is secured by the help of a smart contract.

Physical impacts above set threshold are registered as an anomaly and a notification, by the selected mode of communication, is sent to the respected employee via the Application Program Interface (API) configured within the code. If there were no anomaly registered the condition for smart contract is satisfied and the payment is successfully processed. If there was any anomaly that was detected, the smart contract doesn't proceed to process the transaction, rather it enters another conditional statement, where the employee need to acknowledge the damage done and respected penalty is to be paid.

III. TECHNOLOGIES USED

A. Internet of Things

Internet of things is a network of everyday physical objects that are connected to the internet. The network is used to incorporate all kinds of physical objects and establish seamless communication between them to facilitate an environment of harmony for a specific task to be executed. This network enables data collection, processing of the collected data, and distribution of data and meaning to and fro 'things'.

B. Blockchain

Blockchain is a distributed decentralized public ledger following a set of rules based on consensus and validation. Blockchain is based on 3 golden aspects: Decentralization, Immutability and Transparency.

Decentralization: There is no central server, person, or organization to control the network.

Immutability: Any transaction, code, trade, once deployed to the blockchain network cannot be changed.

Transparency: Blockchain is an open ledger, thus validity of any transaction will be checked using consensus rules before it is released on the blockchain.

Types of Blockchain: Blockchain is an open ledger, thus validity of any transaction will be checked using consensus rules before it is released on the blockchain.

Public: Public blockchains are permissionless blockchains where any one can join the network and become a part of its core activities. Example: Ethereum, Monero.

Private: Private blockchains are built for private independent businesses. There is a central authority who can join the network, who can read the transactions, who has mining right etc. Example: Hyperledger Fabric.

Consortium: Consortium blockchain is a mixture of decentralization and centralization. Consortium blockchains are semi-public blockchains but controlled by a few master nodes. Master nodes are the ones which direct the validation process during a transaction. Example: Quorum.

C. Smart Contract

Smart Contracts are computer programs which are considered to be legally binding digital contracts used for transferring of digital assets across the blockchain network. A smart contract once deployed cannot be changed by any entity.

IV. PROJECT SET-UP

Multiple arrays of force sensitive resistors are made to sit on the front, back and all sides of the car. An inexpensive alternative to force sensitive resistors, which is recommended to cover such a large surface area would be pressure sensitive fabric velostat set up, though for the prototype we have used force resistive sensors. These arrays are connected to I/O ports of ESP 8266 microcontroller.

V. WORKING

The automobile is laced with pressure and vibration sensors along the doors, front and rear part of the car. The change in resistance due to any force in the sensors sitting on the surface of the vehicle, connected to ESP 8266, via logic mux, to microcontroller's Input/Output(I/O) pins, is sensed through analog read. Anomaly is detected using the moving average algorithm on the microprocessor. The serial readings from the sensors are stored in an array. As readings are registered after equal intervals of time/clock it is a univariate time series. The array is a window to a time series of sensor readings. A longer window is less susceptible to changes in values and may detect more outliers. Possibly some of them may be false positives. A shorter moving window adapts quickly to changing values, which in consequence may cause missed alarms. This series is decomposed, and the trend is obtained. Any reading 5 times higher than the standard deviation is considered as an anomaly. If an anomaly is detected, a flag is set high and is sent to the smart contract.

Smart Contract:
Entities involved in the smart contract are:
1.The user i.e. one who borrows the car at a fixed rate.
2.The higher official of the company which provides rental cars.

Variables involved in the smart contract are:
1.The user balance.
2.The company balance for that particular transaction
3.Public key of the user (64 byte).
4.Public key of the company (64 byte).
5.The anomaly-combination of both pressure and vibration sensor values.

The usual process in car renting businesses is to pay for the cost of the rented car as well deposit in case of damages. Sometimes the deposit surpasses the cost of rent as well. Refund of these damages depends on the inspection of the official. Many of the times the user is falsely accused, and the deposit is never returned. Sometimes the deposit takes several days to be returned.

Locking of money:
This problem is solved by locking the money by the smart contract between the user and the car-rent company. Car_rent is an object in the smart contract shown in fig. 1, which stores the address and initial deposit money. The variable balance refers to the deposit money which is locked between the user and Car_rent company which will be refunded as soon as the journey ends if no anomaly takes place.

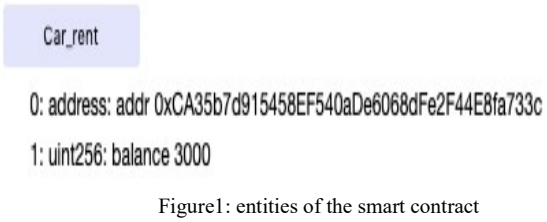


Figure1: entities of the smart contract

Sometimes the car damage is not the fault of the driver driving the rented car but some other car, thus leaving the final decision of whether to refund the deposit money in the hands of the official.

Anomaly:112 && Officialsword: false
In this case, as in fig. 2, the official decided to refund the deposit money even when the value of anomaly was 112

because the driver of the rented car may not be at fault in this case

Anomaly:112 && Officialsword: true

Here, as in fig. 3, numeric Value of anomaly is 112 thus confirming that the sensors on the rented car detected an unusual amount of force exerted against the surface of the vehicle and if the deposit money is cut it'll be completely legal. The Car_rent officials' word is important in this case.

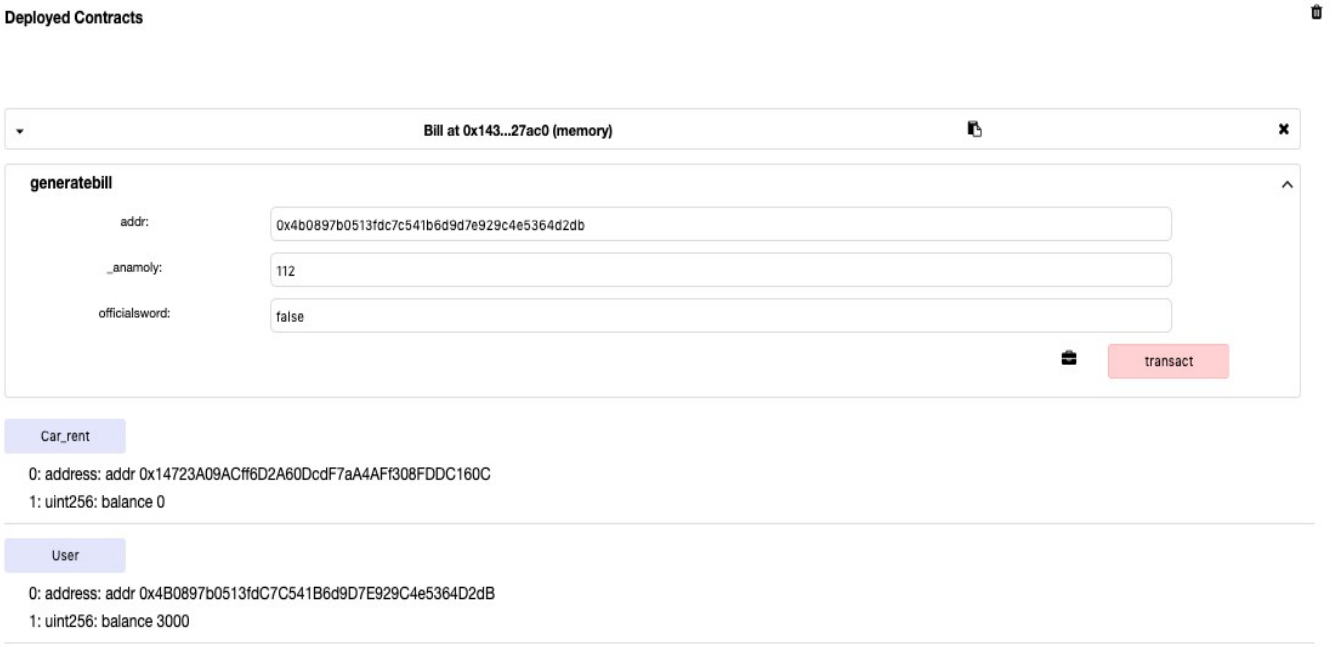


Figure 2: Anomaly detected and official's verdict is false

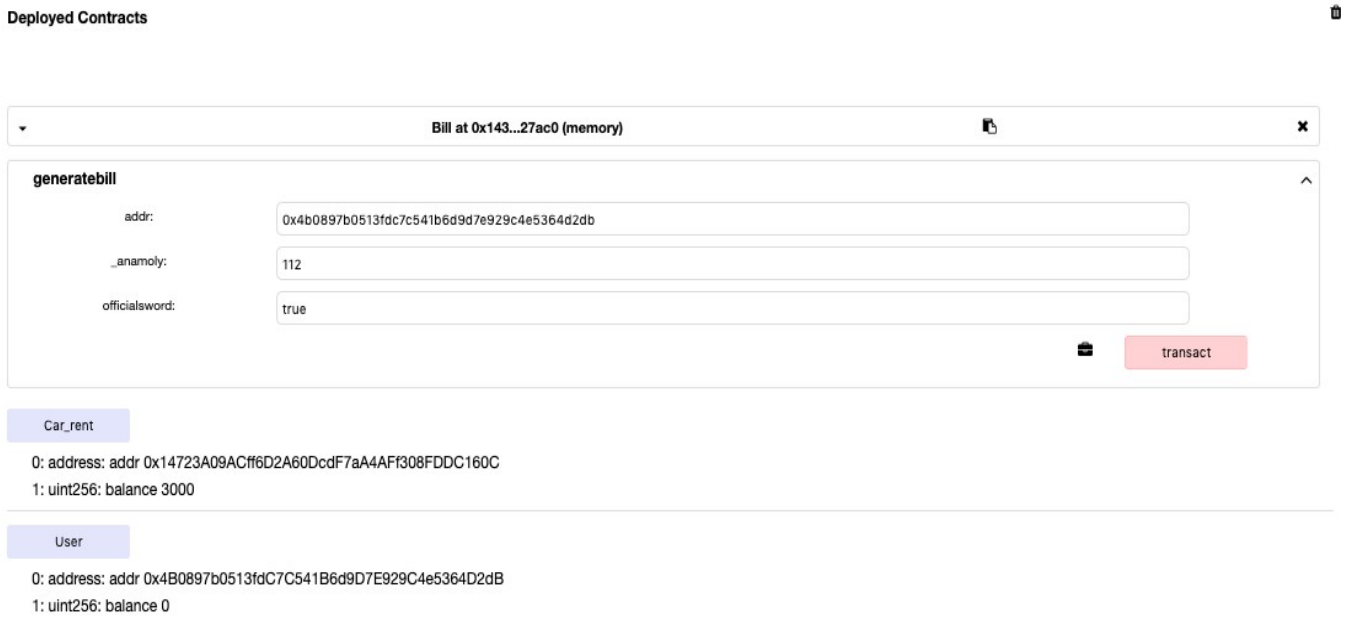
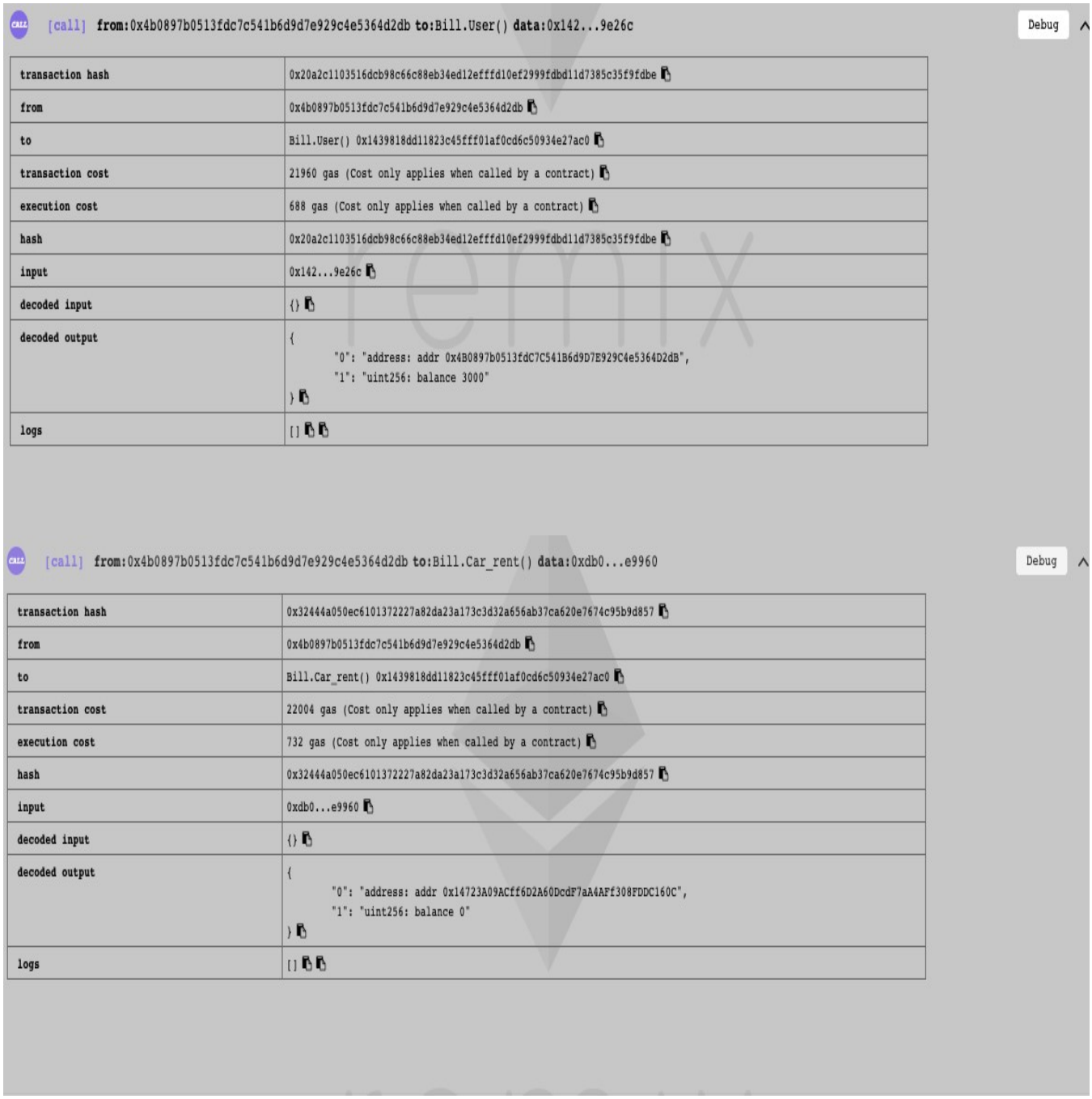


Figure 3: Anomaly detected and official's verdict is true

TAMPERPROOF BLOCKCHAIN

All the details of every transaction are recorded on the blockchain network.
None of the transactions can be tampered with thus making the blockchain network immutable.

Fig 4 prove the non-repudiation feature of the blockchain.



[call] **from:**0x4b0897b0513fdc7c541b6d9d7e929c4e5364d2db **to:**Bill.User() **data:**0x142...9e26c

Debug

transaction hash	0x20a2c1103516dcb98c66c88eb34ed12efffd10ef2999fdbd11d7385c35f9fdbe
from	0x4b0897b0513fdc7c541b6d9d7e929c4e5364d2db
to	Bill.User() 0x1439818dd11823c45fff01af0cd6c50934e27ac0
transaction cost	21960 gas (Cost only applies when called by a contract)
execution cost	688 gas (Cost only applies when called by a contract)
hash	0x20a2c1103516dcb98c66c88eb34ed12efffd10ef2999fdbd11d7385c35f9fdbe
input	0x142...9e26c
decoded input	{}
decoded output	{ "0": "address: addr 0x4B0897b0513fdC7C541B6d9D7E929C4e5364D2dB", "1": "uint256: balance 3000" }
logs	[]

[call] **from:**0x4b0897b0513fdc7c541b6d9d7e929c4e5364d2db **to:**Bill.Car_rent() **data:**0xdb0...e9960

Debug

transaction hash	0x32444a050ec6101372227a82da23a173c3d32a656ab37ca620e7674c95b9d857
from	0x4b0897b0513fdc7c541b6d9d7e929c4e5364d2db
to	Bill.Car_rent() 0x1439818dd11823c45fff01af0cd6c50934e27ac0
transaction cost	22004 gas (Cost only applies when called by a contract)
execution cost	732 gas (Cost only applies when called by a contract)
hash	0x32444a050ec6101372227a82da23a173c3d32a656ab37ca620e7674c95b9d857
input	0xdb0...e9960
decoded input	{}
decoded output	{ "0": "address: addr 0x14723A09ACff6D2A60DcdF7aA4AFf308FDDC160C", "1": "uint256: balance 0" }
logs	[]

VI. CONCLUSION

The proposed model and working prototype make the process of renting a car and checking for damage more seamless and less prone to errors utilizing less resources than most current models do. This model includes all necessary aspects to successfully automate the process in question. The project includes appropriate data collection modes, data processing models, data analysis and interpretation, remote data transfer facilities, and a tamper proof payment gateway solution.

This model coupled with the existing mode of remote monitoring can make the experience feel even more integrated for all concerned parties.

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