NATIONAL INSTITUTE OF TECHNOLOGY KARNTAKA

Software Engineering Project Report

Parking Lot Automation

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Submitted by

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Abstract

Automation or automatic control is the use of various control systems for operating equipment such as machinery,processes in factories, and other applications with minimal or reduced human intervention.Indias urban population is currently around 30% of its total population.The existing parking system seems to create much of a hassle to the public, especially in metropolitan cities. Malls and other public places provide limited parking space, which gets exhausted many a times and people have to search for parking space outside. This creates immense inconvenience and leads to frustration.The absence of a secured control system in multi-layered parking leads to a lot of time wastage in searching for the available parking spaces. Users will keep on circling the parking area until they find an empty parking spot. Parking is an ever-growing challenge in cities and towns across the world. To curb this problem, we propose an efficient online booking system for parking slots which saves users from the hassle of congestion, as well as saves their time and money.

Contents

List of Figures

Chapter 1

Problem Definition

There are various malls in urban cities, and they have multi-level parking systems. But the spaces are not being utilised to the fullest. Also, many a times, all the parking slots of a particular mall get occupied and there is no space for the incoming cars after that. Because of this, many people have to park their vehicles on the streets, and this leads to excessive crowding up of the already crowded streets and leads to immense congestion. It also leads to frustration among people. The problem that arises in this existing system is that people dont know about the number of parking spaces available before visiting a mall or any other public place. They are unaware of the parking conditions there. Thus they are not able to estimate the crowd as well as think of other parking options if all the mall parking spaces have already been allotted. This leads to hassle and they end up parking on the streets and this worsens the situation. Due to insufficient parking spaces which cannot meet the needs of huge amount of vehicles,many new technologies have been invented to use the available spaces optimally.

Chapter 2

Introduction

Parking is one of the major concerns in terms of spaceoccupation in urban cities. It can be broadly classified into 2 types: On-Street and Off-Street. Presently, demand for cars is going up at the rate of 15% per annum. Approximately 15lakh cars are being sold every year. Making roads are more expensive than parking infrastructure. Cars being parked on roads causing traffic causes traffic congestion and pollution. Land is valuable in urban areas. Parking places occupy large portions of such land. This fact should be recognised in determining the principles for allocation of parking space. Multi-level parking space should be made a mandatory requirement in city centres that have several high rise commercial complexes. But these spaces are not being utilised appropriately. The biggest benefit of automation is that it saves labour.However,current technology is unable to automate all the desired tasks. Nevertheless, through this paper, we try our best to propose a semi-automated parking system, so that the general public are benefited. Semi automated parking system is designed to reduce complete dependency on machines and sensors. This system is not fully automatic and needs human intervention. This software will facilitate people to book parking slots online and reserve their space. If the slots are full, that will be shown in the map and people can make arrangements of parking their vehicles beforehand. This will reduce congestion on the already crowded streets. In the domain of parking lot automation, quite a lot of useful research has been done in the previous few years. Numerous papers have been written andpublished on the same. Their inferences and conclusions have been mentioned in detail in the further sections. Multi-level car parking system is used for optimum utilization of parking space by utilizing vertical space rather than horizontal space. Smart parking, which is another technology developed over the years, uses sensors, wireless communication technology and data analytics to solve parking issues. The main components which are used are microcontroller, RFID

module GSM module. The microcontroller is generally interfaced with GSM and RFID module. The GSM technology uses the SMS service to locate the available parking space in a parking lot. Artificial Intelligence (AI) techniques were used to process images, which recognizes the parking occupied only by vehicles. Robotic garage (RG) was used along with Bluetooth which would be used to fully automate the placement of a car in the slot without the aid of the driver. There are a few limitations of all these methods which hasnt allowed it to bridge the gap between the crowd and technology. Various algorithms describing the workflow and implementation of the software have also been depicted through flowcharts and representative diagrams. Each user will have a separate login id and password for himself. He can book an available parking slot of his choice as shown to him on the map. The map will contain parking slots with 4 kinds of statuses. And they are Vacant, Booked, Booked Not Reported and Booked Reported. The biggest challenge that we predict in developing this project will be coming up with a good software design including an efficient and friendly user interface. A good design early on will make the development process easier by allowing team members to be assigned well defined areas of responsibility. The Idea is to build an application where people can book slots to park their vehicles for a particular period of time. We have proposed a system that facilitates the public to get acquainted with the parking conditions at a mall before they come there. We will show them a map of each floor of the multi-level parking system, which contains the empty slots and booked slots with the duration mentioned. This will facilitate people to book parking slots online and reserve their space. This application would be a perfect user choice because of its user friendliness, reduction of parking costs as well as its efficient software development life cycle model. An extension to this would be including sensors to detect vacant parking slots and the use of timers to calculate the time of entry and exit at the parking lot. This would be a fully automated system,something which we strive to achieve if this semi-automated system gets carved out successfully.

2.1   Existing System

There are various malls in urban cities, and they have multi-level parking systems. But the spaces are not being utilised to the fullest. Also, many a times, all the parking slots of a particular mall get occupied and there is no space for the incoming cars after that. Because of this, many people have to park their vehicles on the streets, and this leads to excessive crowding up of the already crowded streets and leads to immense congestion. It also leads to

frustration among people. The problem that arises in this existing system is that people dont know about the number of parking spaces available before visiting a mall or any other public place. They are unaware of the parking conditions there. Thus they are not able to estimate the crowd as well as think of other parking options if all the mall parking spaces have already been allotted. This leads to hassle and they end up parking on the streets and this worsens the situation. Due to insufficient parking spaces which cannot meet the needs of huge amount of vehicles,many new technologies have been invented to use the available spaces optimally.Multilevel car parking system has been one of the most successful systems so far.Automation is being brought into this system with new advances every time.It can be broadly categorised into:

1.Fully automated parking

2.Semi automated parking

Automation has been growing to a large extent these days. It has uplifted the level of technology in the present era, and revolutionised the automobile and other industries.

Semi automated parking system is designed to reduce complete dependency on machines and sensors. This system is not fully automatic and needs human intervention. It is less costly when compared to a fully automated system and easy to implement as too much construction is not needed and it depends mainly on software. It is economical and inexpensive as compared to fully automated parking. This system of parking is simple and can be implemented easily. As this system requires the combination of human and machine effort together, it reduces the complete dependence on either human or machine. The power requirement to run the system is less. Semi-automated car parking can be situated above or below ground or a combination of both. Construction cost is less. Parking fares are affordable in such parking system. Less use of sensors and robotic trolleys make the system more simple, and easy to maintain and use. However, this system is not safe as human interference is required. Time required to park and retrieval of vehicle is more. Ventilation facility is essential in this type of parking system.

2.2 Literature Survey

The problem of managing congested facilities is a long- standing one in economics, a problem usually analyzed taking the size of the facility as given and studying the effects of var- ious allocation systems. In the domain of parking automation, quite a lot of useful research has been done in the previous few

years. Numerous papers have been written and published on the same. The various conclusions and ideas drawn from all the elements of research have been presented here.

2.2.1 Multi-level Car Parking System

Multi-level car parking system (MLCPS) is one such technology which is implemented in India. It is used for optimum utilization of parking space by utilizing vertical space rather than horizontal space. Some of the benefits of MLCPS are optimum utilization of space, low construction cost, low working and maintenance cost to name a few. Although automated parking like multilevel parking has made the condition a little better than the earlier situation, there is still scope for improvement. This is because people still face problems of space availability, searching time and waiting time in public places like malls, multiplexes, railway stations, shopping streets etc. Some of the advantages of MLCPS are:

1. Best use of Space details etc. can be obtained which will help the drivers and will thus ease out parking vows. Using GSM, Short message service can also be used to provide drivers with relevant parking information. The main components which are used are micro- controller, RFID module GSM module. The microcontroller is generally interfaced with GSM and RFID module. The GSM technology uses the SMS service to locate the available parking space in a parking lot. The IR sensor which is placed at that parking slot, examines if it is vacant, and if it finds that there is availability, then it sends a confirmation. The SMS contains details like the Parking slot number, allowed Parking period, the tariff for parking which is proportional to the time duration and a security code. In another technology which uses QR code, the user can pre book the desired parking space which saves his searching time and also saves fuel.

2. It uses pallets and lifts for parking and retrieving cars. Therefore it eliminates the need of drive ways and ramps. This leads to optimum utilisation of space. 3. Low construction cost. Construction cost of MLCPS is very less. It is delivered and assembled on the site itself. The system is automatically operated hence the extra expense of parking such as structure building, security etc. are avoided. 4. Low working and maintenance cost. Since MLCPS are mechanical systems, it needs less energy for its operation. Ventilation systems which are used for underground parking is not needed in this case. Cladding is selected to match the buildings frontage. Smart Parking System using RFID Technology[3] The vehicles of MLCPS on surrounding residential blocks cause noise and air pollution. A pollutant such as motor oil leads to contamination of parking lots. The parking lot must be

built in such a way that it effectively channel and collect runoff which would have otherwise become runoff.

2.2.2 Smart Parking using RFID and GSM technologies

Smart parking, which is another technology developed over the years, uses sensors, wireless communication technology and data analytics to solve parking issues. Smart parking solutions can be used to locate available parking space with the help of sensors. This saves customers time as well as minimizes wastage of fuel. Various technologies are being used to ease parking problems in public places. For example using RFID technology, the check in and checkout time for the vehicle can be reduced and also the payment system can be automated. Similarly using wireless sensors information like parking duration, available slot, billing details, directional details etc. can be obtained which will help the drivers and will thus ease out parking vows. Using GSM, Short message service can also be used to provide drivers with relevant parking information. The main components which are used are micro- controller, RFID module GSM module. The microcontroller is generally interfaced with GSM and RFID module. The GSM technology uses the SMS service to locate the available parking space in a parking lot. The IR sensor which is placed at that parking slot, examines if it is vacant, and if it finds that there is availability, then it sends a confirmation. The SMS contains details like the Parking slot number, allowed Parking period, the tariff for parking which is proportional to the time duration and a security code. In another technology which uses QR code, the user can pre book the desired parking space which saves his searching time and also saves fuel.

2.2.3 Smart Parking using Artificial Intelligence

Artificial Intelligence (AI) techniques were used to pro- cess images, which recognizes the parking occupied only by vehicles. The system provides guidance images towards the assigned slots, thus making it intelligent. Inter integrated circuit protocol was used along with car parking framework to assign radio frequency identification to each car which will be used to identify car parked over a slot. Variable message screen shows car parked over a given floor. Driver request processing center provides infrastructure to vehicle communication for assigning and reserving parking spaces using smart parking allocation center. Wide angle camera was used as a sensor which detects only free parking spaces and records them. These records were then

used to assign parking space to the incoming user. Intelligent Transport System and Electronic toll collection using optical character recognition (OCR) were used to create a record for all entering vehicle. Robotic garage (RG) was used along with Bluetooth which would be used to fully automate the placement of a car in the slot without the aid of the driver.

2.2.4   QR code based vehicle parking system

In this model the important components are the parking zones, the users and the database required for the smart parking system. The management decides the parking tariffs and broad- casts live parking information to vehicle drivers. On receiving parking details, the user chooses a desired parking space and also books a space. Upon confirmation of the parking space, SPSR generates a unique QR code and sends it to the user. As a result, users parking decisions changes the state of parking resources. The reservation authority distinguishes each user by the unique QR code which the management system has sent to the user at the time of reservation. After the reservation is done, the management updates the data. Based on the state of parking lot, the system analyses the congestion level and vacancy status, selects the parking prices depending on the pricing system, periodically shows the prices to all users and stores the QR code, prices and parking information for future analysis.

2.3   Objective

To develop automated software which facilitates online booking of parking slots in multi-layered parking of malls and other crowded public places. In the modern world, where parking-space has become a big problem, it has become very important to avoid the wastage of space in malls, companies and apartments. With the new technology of smart parking, majority of these issues will be solved. We also aim at effi- ciently utilizing the space provided for parking, by enhancing multi-level parking systems. Below is a graph which compares the commercial parking spaces available per year, over the years.

Chapter 3

Work Done

3.1 Proposed System

In this project we are focusing on semi-automated car park- ing system to be implemented in malls and other commercial places. Reservation based dynamic slot allocation in parking system first and foremost reduces human intervention required for parking vehicles. It is time efficient and cost effective as the whole process of building a software system is being automated. The delivery of the software system can be assured on time with reduced cost and quality code which is mostly spent on the resources if there were manual work. Hence, this approach plays a vital role in reducing time required in manual parking system.Providing sufficient parking for visitors is one of the main issues in developing shopping complexes. Offering safe and secure parking lots with a sufficient number of spaces and paying attention to handicapped drivers are a few of the factors which can increase customer loyalty and attract customers to visit a shopping mall more frequently.The Idea is to build an application where people can book slots to park their vehicles for a particular period of time. We have proposed a system that facilitates the public to get acquainted with the parking conditions at a mall before they come there. We will show them a map of each floor of the multi-level parking system, which contains the empty slots and booked slots with the duration mentioned. This will facilitate people to book parking slots online and reserve their space. If the slots are full, that will be shown in the map and people can make arrangements of parking their vehicles beforehand. This will reduce congestion on the already crowded streets. Automated parking systems can help cut CO_2 emissions and fuel consumption levels because they dont require the engine to be running while the car is moved about through the building. Moreover, this sort of parking lot automation will reduce the labour needed
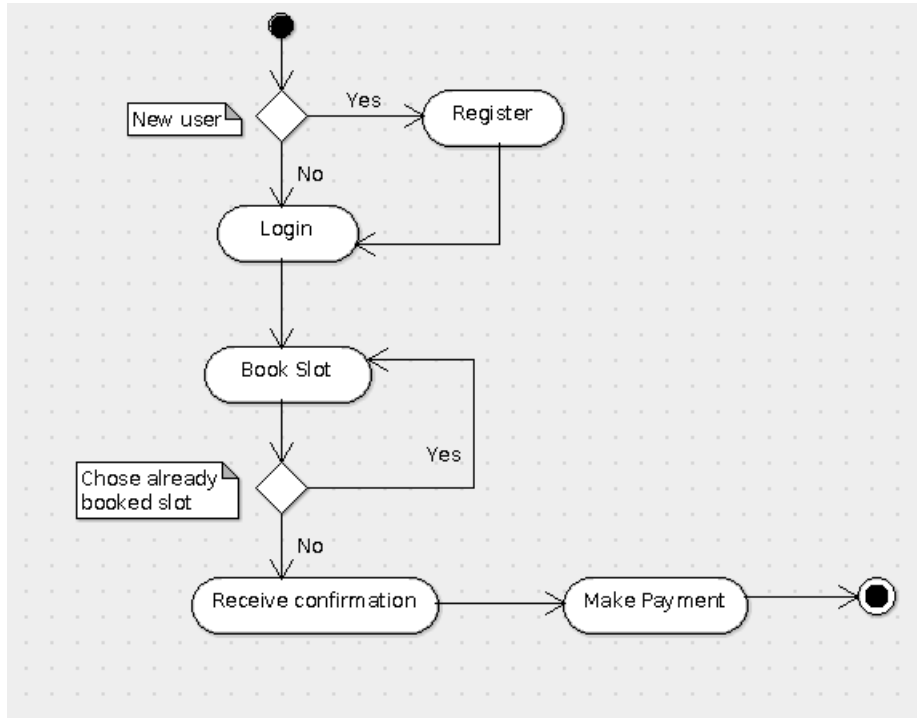
Figure 3.1: Automation System Workflow

at the mall parking lots. Most of the procedure will be automated and this increases the convenience of the general public. We also propose to reduce the cost of parking in commercial places, to improve the convenience of the public, as well as attract crowd towards automation and revolutionize the industry. Below is a graph which compares the average parking costs at different modes of parking.

3.2 Proposed Workflow

We propose the development of a parking lot automation system which allows users to book parking slots online. Each user will have a separate login id and password for himself. He can book an available parking slot of his choice as shown to him on the map.

The map will contain parking slots with 4 kinds of statuses. And they are Vacant, Booked, Booked Not Reported and Booked Reported. He needs to mention his duration of visit while booking. Initially, the status of a slot will be vacant. Once the booking is done, its status will change to Booked, and a confirmation SMS will be sent. Now when he enters the place, he
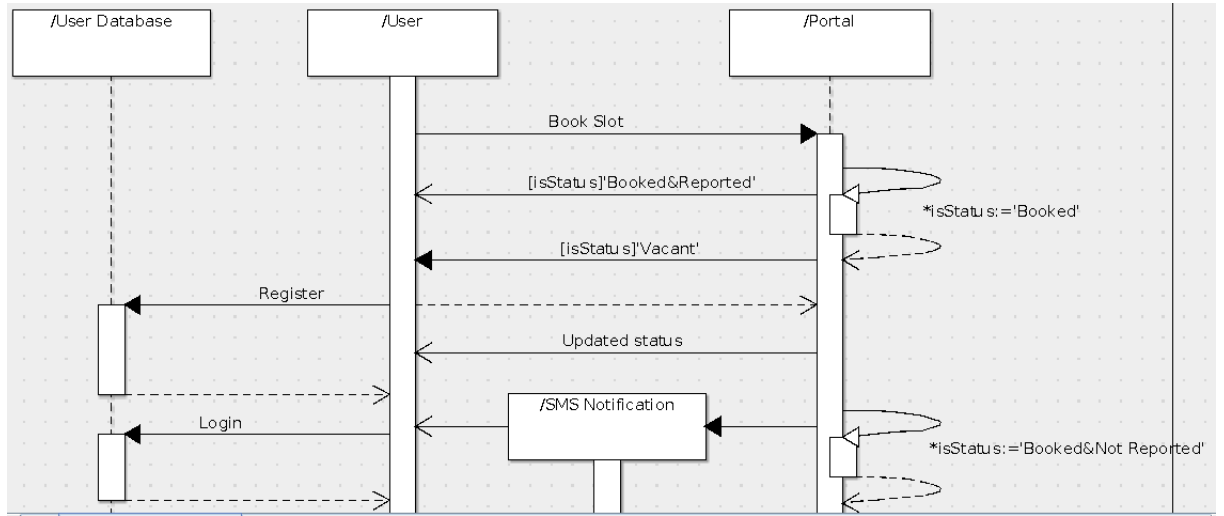
Figure 3.2: Sequential Representation

just needs to show that message to the security officials there and he will be allowed to enter the parking region and park his vehicle in the booked slot. The status of his slot number on the map will automatically be changed to Booked and Reported.Another possibility here is that, the status will be updated to Booked and Not Reported in case he does not report there at the time mentioned by him. To make sure that the company doesnt suffer any loss, that slot will be made free and its status will be changed to vacant if it remains Booked Not Reported for half an hour or more. While leaving from the place, he will have to tell out his slot number to the security official, who will then update the status of that slot on the website as vacant. The payment structure will be available in the software, and made known to the public. So while making his exit, he will have to pay the required cost incurred. If he happens to not leave the place by the time he had mentioned, then an extra fine will be charged to him per hour. There is an interaction diagram that shows how processes operate with one another and in what order. It shows object interactions arranged in time sequence.

The charges incurred for parking are Rs10/hour. These are very subsidized rates to attract customers and start the business. But they increase is case of a delay from the time interval for which the slot had been booked. A few exceptions can arise. These are handled in the following way.

1. If the user does not arrive at the time he had booked the slot for, then a timer should start. When the current time becomes half an hour more than the time end time of slot booking and the user hasnt arrived yet, then his slot will automatically be marked Vacant. In case he wants to come after
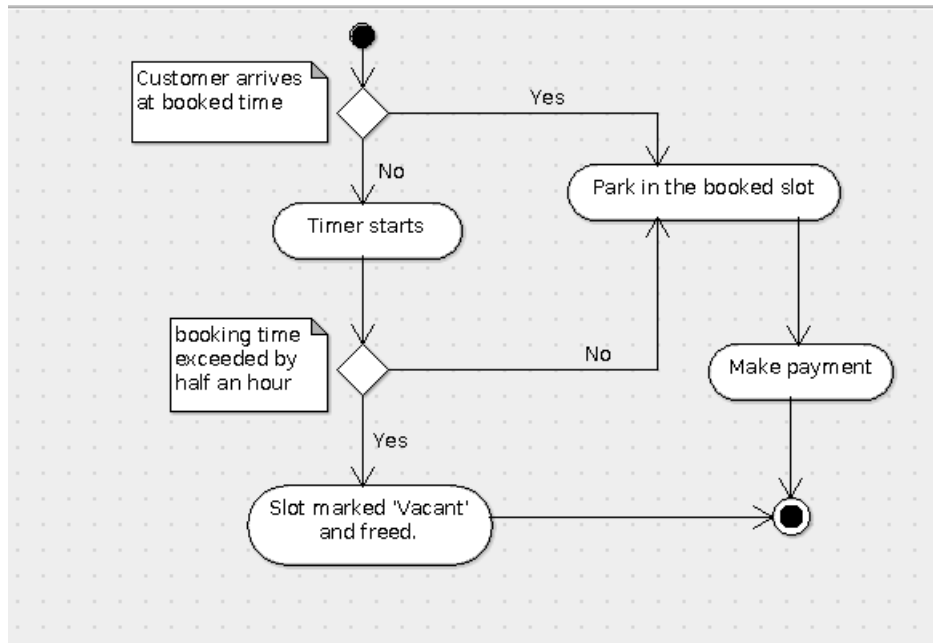
Figure 3.3: Exception Workflow

that, he will have to book again.

2. If the user does not turn up at the end time of his booking, then a fine will be incurred on him, depending on when he turns up. Moreover, if the user who had booked a slot after the previous one who hadnt turned up arrives, then he will be redirected to another slot in the parking area which was meant for walk-in users.

11

Chapter 4

Test Cases

The software called ParkWhizzis successfully developed with majority of the basic functionalities mentioned above. It facilitates online booking of parking slots. It has been designed to provide easy booking of slots in the parking lot of malls and other crowded places, much before entering the mall. One can book a slot for different time intervals. Each slot will have the following 4 statuses:

1. Vacant
2. Booked
3. Booked and Reported.
4. Booked and Not Reported.

Each slot will show a different status for different time intervals. The user can book a slot by mentioning the duration, and only if the status of that slot in that time interval is Vacant.

4.1   Test Case 1

1.The user books slot 1 on floor 1, for 1st Jan 2016.
  2. The slot status will be shown after booking.
  3. The slot statuses can be checked here.

4.2   Test Case 2

1. The admin login has been provided.
  2. He can change status of any slot, when needed.

Figure 4.1: Slot Booking

Figure 4.2: After booking

Slot No.	Floor No.	Slot Status	Date	Entry time	Exit Time	Total Cost
1	1	booked	1 - 1 - 2016	9 : 1	20 : 1	Rs. 110
1	1	booked and reported	1 - 1 - 2016	21 : 2	21 : 15	Rs. 2.16666666666
20	1	Booked and reported	7 - 4 - 2016	13 : 30	14 : 1	Rs. 5.16666666666

Figure 4.3: Check Status

Figure 4.4: Admin login

14

Figure 4.5: Slot Booking

Chapter 5

Conclusion

The biggest challenge that we envision in developing this project will be coming up with a good software design including an efficient and friendly user interface. A good design early on will make the development process easier by allowing team members to be assigned well defined areas of responsibility. Reduced coupling in the design will allow for better software verification, and also improve flexibility in case implementation has to be modified at a later stage.This systemis convenient to the general public, reduces congestion and crowding up on streets and reduces labour required at parking lots. The parked cars and their contents are more secure since there is no public access to parked cars. Driving around in search of a parking space is eliminated, thereby reducing engine emissions. Enhanced User Experience is promised.The functional requirements include:

1. Descriptions of data to be entered into the system.
2. Descriptions of operations performed by each screen.
3. Descriptions of work-flows performed by the system.
4. Descriptions of system reports or other outputs.
5. Who can enter the data into the system.
6. How the system meets regulatory requirements.

The non-functional requirements include Scalability, Ca- pacity, Availability, Reliability, Maintainability, Serviceabil- ity, Security, Regulatory, Manageability, Environmental,Data Integrity, Usability and Interoperability.The average driver spends 15 minutes looking for a parking spot. Many apps have been developed to mitigate these issues and they are working fine. This app would be a perfect user choice because of its user friendliness, reduction of parking costs as well as its efficient software development life cycle model. An extension to this would be including sensors to detect vacant parking slots and the use of timers to calculate the time of entry and exit at the parking lot. This would be a fully automated system,something which we

strive to achieve if this semi-automated system gets carved out successfully.
Drawbacks:

1. Since the status updation has to be done manually by the parking lot official, it is susceptible to mistakes.

2. Challenges in updating the map immediately after the time slot gets over.

Improvements:

1. Sensors can be incorporated.

2. It can be transformed into a fully automated system.

Chapter 6

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