Project Title:Serverless IOT Data processing

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SMARTPARKING

IntroductiontoSmartParking

Smart parking is a modern technological solution aimed at revolutionizing the way weapproach parking in urban and suburban environments. As cities around the world faceincreasingchallengesrelatedtotrafficcongestion,limitedparkingspaces,andenvironmentalconcerns,smartparkingsystemshaveemerged asapromisinganswer totheseissues.

Smart parking leverages a combination of advanced technologies such as sensors, dataanalytics,mobileapps,andautomationtoprovideamoreefficientanduser-friendlyparkingexperience. The key idea behind smart parking is to optimize the utilization of parkingspaces, reduce the time and fuel wasted in the search for parking, and enhance the overallurbanmobilityandqualityoflife.

Inasmartparkingsystem,sensorsareinstalledinparkingspacestomonitortheiravailabilityinreal-time.Thisdataisthenrelayedto usersthroughmobileapplicationsordigitaldisplays,allowing them to easily find and reserve parking spots. Additionally, smart parking solutionsoften include features like automated payment systems and integration with navigation appstoguidedriverstoavailableparkingspaces.

The benefits of smart parking extend beyond individual convenience. By reducing trafficcongestionandtheenvironmentalimpactofcirclingfor parking, thesesystemscontributetoimproved air quality and reduced emissions. They also have the potential to boost revenueformunicipalitiesorprivateoperatorsthroughdynamicpricingandefficientenforcement.

Furthermore, smart parking aligns with broader urban development goals by enhancingsafety, promoting sustainable transportation alternatives, and integrating with other aspects ofurbaninfrastructure,suchaspublictransportationandcityplanning.

In this age of increasing urbanization, where efficient use of space and resources isparamount, smart parking is a critical component of the smart city concept. It represents aproactive and innovative approach to tackling the parking challenges that accompany urbangrowth, making cities more livable and sustainable for residents and visitors alike. Astechnologycontinuesto advance,thefutureofsmart parking promiseseven moreinnovativeandintelligentsolutionstoimprovethewayweparkandmovewithinurbanenvironments.

ProjectObjectives

OptimizeParkingSpaceUtilization:Theprimarygoalofsmartparkingisto maximizetheuse of available parking spaces. This involves reducing congestion and minimizing the timeandfuelwastedbydrivers searchingforparkingspots.

ReduceTrafficCongestion:Byguidingdriverstoavailableparkingspacesandreducingthetime spent circling for a spot, smart parking systems aim to alleviate traffic congestion inurbanareas.Thiscanlead toreducedemissionsand improvedairquality.

Enhance User Convenience: Smart parking systems should make it easier for drivers tofind, reserve, and pay for parking. Mobile apps, online booking, and real-time availabilityupdatescontributetoamoreconvenientanduser-friendlyexperience.

ImproveRevenueGeneration:Manysmartparking initiativesaredesignedtoincreaserevenue for municipalities or private operators. This can be achieved through dynamicpricing,efficientenforcement,andimprovedspace turnover.

EnhanceSafetyandSecurity:Smartparkingsolutionscanincorporatesecurityfeatureslikesurvei llancecamerasand emergencycallbuttonsto enhance thesafetyofparkingfacilities.

ReduceEnvironmentalImpact:Reducingthetimevehiclesspendidlingandcirclingforparking spots can contribute to lower fuel consumption and emissions, thus helping tocombatairpollutionandclimatechange.

PromoteSustainableTransportation:Smartparkingprojectsoftenaimtoencouragetheuse of public transport, carpooling, and non-motorized modes of transportation by makingthese optionsmore accessibleandconvenient.

DataCollectionandAnalysis:Gatheringdataonparkingspaceutilization, trafficpatterns,and user behavior is a key objective. Analyzing this data can help urban planners makeinformeddecisions andoptimizeparkingpolicies.

EnhanceAccessibility:Smartparkingshouldbedesignedtocatertotheneedsofallusers,including those with disabilities, by providing accessible parking spaces and user-friendlyfeatures.

IntegrationwithUrbanInfrastructure:Smart parkingsystemsshould be integratedwithbroader urban infrastructure, including traffic management, public transportation, and cityplanning,to ensureacohesive and well-coordinated approachtourban mobility.

Sustainability and Green Initiatives: Some smart parking projects may include theimplementationofsustainable infrastructureelementslikeelectric vehiclechargingstations,solar-poweredparkingmeters,andgreenurbandesign.

Economic Development: In certain cases, smart parking projects are expected to stimulateeconomicgrowthbymakingiteasierforpeopletoaccessbusinessesandattractions inurbanareas.

Enforcement and Compliance: Ensure that parking rules and regulations are effectivelyenforcedthroughautomatedmethods, suchas licenseplaterecognitionorticketingsystems.

FeedbackandUserEngagement:Smartparkingprojectsshouldencourageuserfeedbackand engagement to continuously improve the system based on user experiences andpreferences.

ScalabilityandAdaptability:Thesystemshouldbedesignedtoadapttochangingurbanneedsandt obescalableasthecityorareagrows

IoTDevices :

1. ESP8266NodeMCU
2. UltrasonicSensor
3. DCServoMotor
4. IRSensors
5. 16x2i2cLCDDisplay
6. Jumpers

DevicesSetup:

Setting up an IoT project using an ESP8266 NodeMCU board, ultrasonic sensor,DCservomotor, IRsensors, a16x2I2CLCDdisplay, andjumpersinvolvesseveralsteps.I'llprovideanoverviewofhowyoucansetupthis project,butpleasenote that this is a complex project, and you may need to consult specificdocumentation and libraries for each component. Additionally, coding this projectwillrequireprogrammingskillsinplatformslikeArduino IDE.

1. GathertheRequiredComponents:

1. ESP8266NodeMCUboard.
2. Ultrasonicsensor(e.g.,HC-SR04).
3. DCservo motor.
4. IRsensors(forobjectdetection).
5. 16x2I2CLCDdisplay.
6. Jumperwiresandbreadboard.
7. Powersupplyfortheservomotor ifneeded.

2. ConnecttheUltrasonicSensor:

- ConnecttheVCCpinoftheultrasonicsensortothe3.3VoutputofNode MCU.
- ConnecttheGNDpinoftheultrasonicsensortotheGNDofNodeMCU.
- ConnecttheTRIGpinoftheultrasonicsensortoaGPIOpin(e.g.,D2).
- ConnecttheECHOpinoftheultrasonicsensortoanotherGPIOpin(e.g.,D3).

3. ConnecttheDCServoMotor:

- Connectthepositive(red) leadoftheservomotortothe5VoutputofNodeMCU.
- Connectthenegative(brown)leadoftheservomotortotheGNDofNode MCU.
- Connectthesignal(orange/yellow) leadoftheservomotortoaGPIOpin(e.g.,D4).

4. ConnecttheIRSensors:

- IRsensorsareusuallyanalogsensors.ConnecttheVCCandGNDpinsto3.3Van dGNDontheNodeMCU.
- ConnectthesignalpinoftheIRsensorstoanalogGPIOpins(e.g., A0andA1).

5. Connectthe16x2I2CLCDDisplay:

- ConnecttheSDA(data)andSCL(clock)pins oftheI2CLCDdisplaytothecorresponding pins on the NodeMCU (D1 and D2 on the NodeMCU,respectively).
- ConnecttheVCCoftheI2Cdisplayto5V onNodeMCUandGNDtoGND.

6. WriteandUploadtheCode:

WritetheArduinocodetocontrolyourproject.Thiscodewillinvolvereadingdatafromthe ultrasonicsensor,processingit,controllingtheservomotor,anddisplaying information on the LCD. You'll also need code to handle IR sensorinputsifthey'reusedfor object detection.

7. PowerSupply:

Makesureyouhaveasuitablepowersupplyforyourservomotor,astheNodeMCUmightn ot be abletoprovideenoughpowerforit.

8. AssembleandTest:

Connectallthecomponents,uploadthecodetotheNodeMCU,andassembletheproject.T esteachcomponentandensurethatthesystemfunctionsasexpected.

PlatformDevelopment:

1. DefineYourGoalsandObjectives:

- Clearlydefinetheobjectivesandgoalsofyoursmartparkingplatform.Unde rstand what problems you want to solve, whether it's reducingcongestion, enhancing revenue generation, improving accessibility, orpromotingsustainability.

2. HardwareSelection:

- Choosetheappropriatehardwarecomponents,suchassensors(ultrasonic,infra red, camera-based), microcontrollers (like Raspberry Pi or Arduino),communication modules (Wi-Fi, LoRa, or cellular), and displays for real-timeinformation.

3. SensorInstallation:

- Install sensors in parking spaces to monitor availability. Ensure the sensorscandetectthepresenceorabsenceofvehiclesaccurately.Thesesensorsma ybeultrasonicorinfrared-based,dependingonyourprojectrequirements.

4. CommunicationInfrastructure:

- Setupareliablecommunicationinfrastructurethatconnectsthesensorstoacentra l server or cloud platform. Wi-Fi, LoRa, or cellular networks arecommonly usedfor datatransmission.

5. CentralServer or CloudPlatform:

- Develop a central server or cloud-based platform to collect, process, andstore data from the sensors. Use a robust database system to manage real-timeparkingspaceavailability.

6. User-FacingMobileandWebApplications:

- Createuser-friendlymobileandwebapplicationsthatallowusersto:
    - Findavailableparkingspaces.
    - Reserveparkingspotsinadvance.
    - Makepayments forparking.
    - Receivereal-timeupdatesonparkingavailabilityand guidance.

7. PaymentIntegration:

- Integrate payment gateways into the mobile app for user convenience. Thiscanincludeoptions forcashlesspayments,creditcardpayments,andmobilewallets.

8. DataAnalyticsandPrediction:

- Implementdataanalyticstoanalyzehistoricalandreal-timeparkingdata.This can help in predicting parking demand, optimizing pricing, andimproving operationalefficiency.

9. UserFeedbackandSupport:

- Includefeatures foruserfeedback,customersupport,andassistanceincaseofissuesor emergencies.

10. SecurityandAccessControl:

- Ensurethesecurityofdataandtransactions.Implementuserauthenticationand access control features to prevent unauthorized use or tampering withthesystem.

11. Real-timeDisplaysandSignage:

- Installdisplaysattheparkingfacilityentrancestoguidedriverstoavailablespaces andprovide real-timeupdatesonspaceavailability.

12. EnvironmentalConsiderations:

- Forsustainability,considerincorporatingfeaturessuchaselectricvehiclechar gingstations,solar-poweredcomponents,andgreeninfrastructure.

13. ScalabilityandFlexibility:

- Designyourplatformtobescalable, allowingforeasyexpansiontomoreparkingareasasneeded.

14. RegulatoryCompliance:

- Ensureyourplatformcomplieswithlocalparkingregulations,privacylaws,ando ther relevantregulations.

15. TestingandMaintenance:

- Thoroughlytestthesystemtoensureitsreliabilityandaccuracy. Developamaintenanceplan forregularsensorand systemchecks.

16. UserEducationandOnboarding:

- Provideclear instructionstousersonhowtousetheplatformand makethetransitiontosmartparkingsmooth.

17. MarketingandAdoption:

- Promote your smart parking platform to attract users and encourageadoption.This mayinvolvepartnershipswithlocalbusinessesandmarketingcampaigns.

18. ContinuousImprovement:

- Continuouslymonitorthesystem'sperformanceandgatheruserfeedbackforongoing improvementand innovation.

CodeImplementation:

Program:

```
#include<ESP8266WiFi.h>

#include <Servo.h>

#include<LiquidCrystal_I2C.h>

#include<Wire.h>

#include<FirebaseArduino.h>

#defineFIREBASE_HOST"smart-parking-7f5b6.firebaseio.com"                    //
theprojectnameaddressfrom firebaseid

#defineFIREBASE_AUTH"suAkUQ4wXRPW7nA0zJQVsx3H2LmeBDPGmfTMBHCT"
                                                                    //thesecret
key generatedfromfirebase

#defineWIFI_SSID "CircuitDigest"
                                                                    //inputyourhomeo
rpublicwifiname

#defineWIFI_PASSWORD"circuitdigest101"
                                                                    //password
forWifi

StringAvailable="";                                    //availability

stringString fireAvailable="";

LiquidCrystal_I2Clcd(0x27,16, 2);          //i2cdisplayaddress27and16x2
lcddisplay

Servo myservo;                    //servo as

gateServomyservos;                    //servoasgate
```

```
intEmpty;
                                //availablespaceintegeri
ntallSpace=90;
intcountYes =0;
intcarEnter= D0;                  //entrysensor
intcarExited=D4;                 //exisensor
intTRIG =D7;                 //ultrasonictrigpin
intECHO = D8;
                          //ultrasonicechopinintle
d=D3;
                          //spotoccupancysignali
ntpos;
intpos1;
longduration,distance;v
oid setup()
{delay(1000);
  Serial.begin(9600);     // serial
  debuggingWire.begin(D2,D1);  //
  i2cstartmyservo.attach(D6);      // servo pin to
  D6myservos.attach(D5);          // servo pin to
  D5pinMode(TRIG,OUTPUT);  // trig pin as
  outputpinMode(ECHO,INPUT);
                           //echopinasinputpinMode(le
  d,OUTPUT);               // spot
  indicationpinMode(carExited,INPUT);
```

```
                                // ir as
inputpinMode(carEnter,INPUT);
                                //irasinput
```

```
  WiFi.begin(WIFI_SSID,WIFI_PASSWORD);
                                                                    //tryto
connect withwifi
  Serial.print("Connecting to
  ");Serial.print(WIFI_SSID);
                                                  //displayssid
  while (WiFi.status()!= WL_CONNECTED){
    Serial.print(".");
                                        //ifnotconnectedprintthisdel
    ay(500);
  }
  Serial.println();Serial.print("C
  onnected to
  ");Serial.println(WIFI_SSID);
  Serial.print("IPAddressis:");
  Serial.println(WiFi.localIP());                          //printlocalIPaddress
  Firebase.begin(FIREBASE_HOST,FIREBASE_AUTH);
                                                                  //beginfirebasea
uthentication
  lcd.begin();
                                  //beginlcd
  lcd.home();
  lcd.setCursor(0,0);
                                        //0throwand0thhcolumnlcd
  .print("Smart Parking");
}
voidloop(){
```

```
digitalWrite(TRIG,LOW);
                                        //maketrigpinlowde
layMicroseconds(2);
```

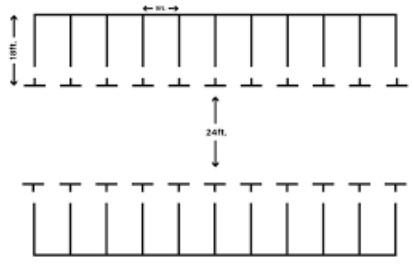
```
digitalWrite(TRIG, HIGH);
                                        //maketrigpinhighde
layMicroseconds(10);
digitalWrite(TRIG,LOW);duration
=pulseIn(ECHO,HIGH);
distance =(duration/2)/29.1;
                                          //takedistanceincmS
  erial.print("Centimeter: ");
  Serial.println(distance);
intcarEntry=digitalRead(carEnter);        //readirinput
if(carEntry==HIGH){
                                        //ifhighthencountandsenddatacountYes
  ++;                                   //increment count
  Serial.print("CarEntered=
  ");Serial.println(countYes);lcd.setCursor(0,1);
  lcd.print("CarEntered");
  for(pos= 140;pos>= 45;pos-= 1){
                                                  //changeservoposition
   myservos.write(pos);
   delay(5);
  }
  delay(2000);
  for(pos= 45;pos<=140;pos += 1){    //change servoposition
   //instepsof1degreem
   yservos.write(pos);d
```

```
  elay(5);
}
```

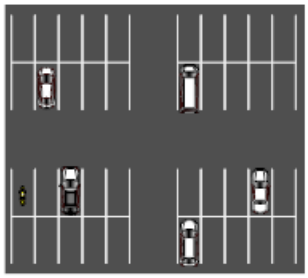
```
  Firebase.pushString("/ParkingStatus/",fireAvailable);
                                                        //sendstringtofi
rebase
  lcd.clear();
 }
 intcarExit=digitalRead(carExited);          //readexitirsensor
 if(carExit== HIGH){
                                    //ifhighthencountandsendcountY
  es--;                             //decrement
  countSerial.print("Car Exited = " );
  Serial.println(countYes);lcd.setCursor(0,1);
  lcd.print("CarExited");
  for(pos1= 140;pos1>= 45;pos1-= 1){
                                          //changeservoposition
   myservo.write(pos1);
   delay(5);
  }
  delay(2000);
  for(pos1= 45;pos1<= 140;pos1+=1){          //changeservoposition
   //instepsof1degreem
   yservo.write(pos1);d
   elay(5);
  }
  Firebase.pushString("/ParkingStatus/",fireAvailable);//sendstringtofirebaselcd.cl
  ear();
 }
```

```
  if(distance <6){                    //ifdistanceisless
       than6cmthenonledSerial.println("Occupied");
    digitalWrite(led,HIGH);
  }
  if(distance >6){                    //ifdistance
       isgreaterthan6cmthenoffledSerial.println("Available");
    digitalWrite(led,LOW);
  }
  Empty=allSpace-countYes;            //calculateavailabledata
  Available=String("Available= ")+String(Empty)+String("/")+
String(allSpace);       //converttheinttostring
  fireAvailable=String("Available=")+String(Empty)+String("/")+String(allSpace);
  lcd.setCursor(0,0);
  lcd.print(Available);               //printavailabledatatolcd
}
```

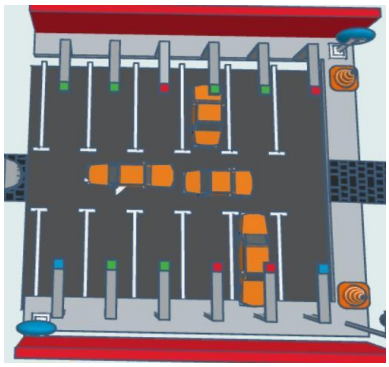
Diagram:



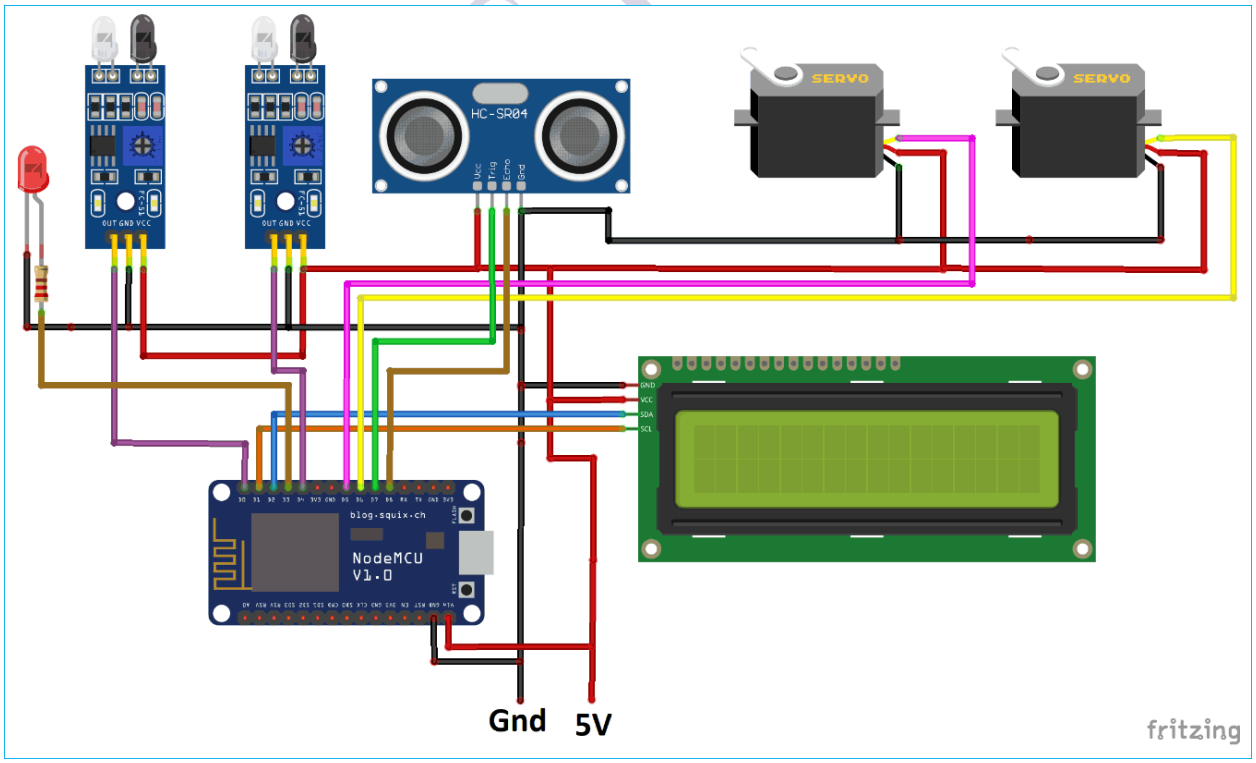
Schematic:



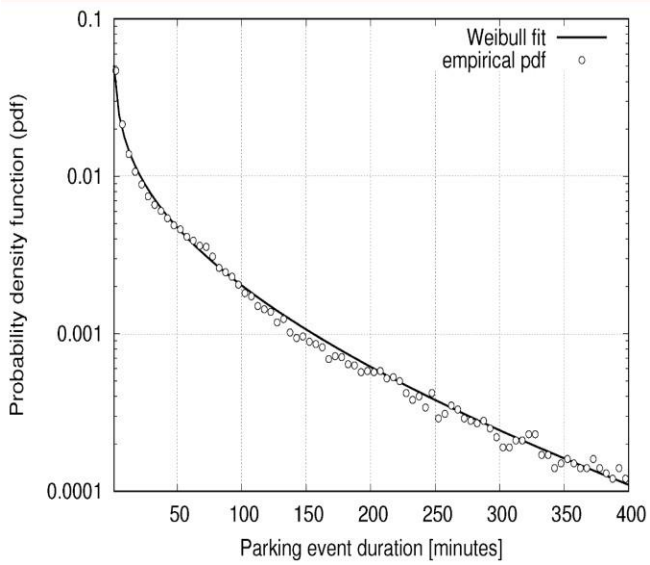
Screenshot:



IoTDevices ss:



DataSharing:



ProjectinDetail:

1. ProjectOverview:

- Start with an executive summary that provides a brief description of thesmart parking project. Explain the purpose and expected benefits of thesystem,suchasreducedcongestion,enhanceduserexperience,orincreasedrevenuegeneration.

2. ProjectObjectives:

- Clearlydefinethegoalsandobjectivesoftheproject.Bespecificaboutwhatyou aim to achieve, such as the number of parking spaces to be monitored,thereduction insearchtime,or therevenuetargets.

3. ScopeandFeatures:

- Outline the scope of the project. List the key features and functionalities ofthesmartparkingsystem.Thismayincludereal-timespacemonitoring,reservationandpaymentsystems,userapps,securityfeatures,environmentalconsiderations,andmore.

4. Stakeholders:

- Identify the project stakeholders, such as city authorities, property owners,users,andtechnologypartners.Definetheirrolesandresponsibilitiesint heproject.

5. HardwareandSensors:

- Specifythehardwarecomponentsandsensorstobeused.Detailthetypesofsensors (e.g., ultrasonic,infrared, camera-based),microcontrollers orplatforms (e.g., ESP8266, Raspberry Pi), communication modules, and anydisplaysor signage.

6. NetworkInfrastructure:

- Describethenetworkandcommunicationinfrastructure.Specifywhetheryou' ll use Wi-Fi, LoRa, cellular networks, or a combination to connectsensorstothecentralserveror cloud platform.

7. CentralServer orCloudPlatform:

- Provide details on the central server or cloud platform used to collect,process,andstoredata.Mentionthedatabasesystemandtechnologiesyou' lluse.

8. UserInterfaces:

- Explain the user interfaces, including mobile apps for users to find andreserveparkingspaces,makepayments,andreceivereal-time updates.Also,describeanyweb-based dashboardsforadministrators.

9. PaymentIntegration:

- Specifythepaymentgatewaysandoptionsforusers,suchascashlesspaym ents,credit cardpayments,andmobilewallets.

10. DataAnalyticsandPrediction:

- Outlinehowyouplanto usedataanalyticsforoptimizingparking,pricing,and improving operational efficiency. Describe any machine learning orpredictiveanalyticstechniques.

11. SecurityandAccessControl:

- Describesecuritymeasurestoprotectdataandtransactions.Includeuserauthentication and accesscontrol mechanisms.

12. EnvironmentalConsiderations:

- Detailanysustainable featureslikeelectricvehiclechargingstations,solarpower,or greeninfrastructure.

13. RegulatoryCompliance:

- Explainhowyoursystemwillcomplywithlocalparkingregulations,privacy laws,and otherrelevantregulations.

14. SystemTestingandMaintenance:

- Defineatestingstrategytoensuresystemreliabilityandaccuracy. Planforregularmaintenanceofsensorsandtheentiresystem.

15. UserEducationandOnboarding:

- Outlinehowyouwilleducateusersonusingtheplatformandensureasmooth transitionto smartparking.

16. MarketingandAdoption:

- Describe marketingstrategiestopromotetheplatformandencourage useradoption.Include partnershipsandmarketingcampaigns.

17. ProjectTimeline:

- Createadetailedprojecttimelinethatspecifiesmilestones,deadlines,anddependenciesbetweentasks.

18. BudgetandResources:

- Estimatethebudgetrequiredfortheproject,includinghardwarecosts,software development,personnel,andongoingoperationalexpenses.

19. RiskManagement:

- Identifypotentialrisksandchallengesintheproject,alongwithmitigationstrategies.

20. MonitoringandEvaluation:

- Explainhowyouwillcontinuouslymonitorthesystem'sperformanceandgatheruserfeedbackforongoing improvement.

21. Conclusion:

- Summarizetheprojectplanandrestatetheexpectedbenefitsandoutcomesofthesmartparkingsystem.

This detailed project plan provides a roadmap for the development,implementation,andmanagementofasmartparkingsystem.Itservesasacomprehensiveguideforallstakeholdersinvolvedinthe project.