Development Of IoT-Based Emission Test System

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ABSTRACT

The IoT-based emission test system produces authentic digital emission test certificates. The objective is to overcome some of the disadvantages of the current emission test system where the sensor values are easily altered in the certificates in order to avoid vehicle servicing overhead in case of exceeding the standard emission threshold. The current system of emission test certificate generation requires manually collecting the sensor readings and generating paper-based certificates where the veracity of the information on the certificate is not ensured. The proposed technology uses sensor MQ2 to collect smoke readings, RSA encryption to encrypt the sensor data and transfers data to the certification authority (CA) for processing over the cloud using AWS. The CA is responsible for verifying the authenticity of received data, producing corresponding results and making it available to the authenticated users. This technology induces efficiency, authenticity and integrity by minimizing the manual work.

Keyword: *Cloud, IoT, Arduino, CA, sensor MQ2 and RSA encryption*

1. INTRODUCTION

Air pollution is one of the major environmental concerns that has led to the development of technologies all around the world to mitigate it. In urban areas 50 to 90 percent of the air pollution is due to vehicle emission. As a preventive measure, Government of India has made periodic vehicle emission test mandatory. However, people have found ways to generate fake emission test results that has led to the failure of the whole idea of reducing pollution.
The proposed system addresses the loopholes in the system by introducing automation in the collection of the data and processing it to produce final certificate. Security and integrity against data diddling due to human intervention is provided by RSA encryption. Administrator of the CA approves or rejects the certificate generation based on the authenticity by comparing the data received with the one present in the CA database. For this system to work, every emission test center needs to register to the CA. By minimizing the manual work and maximizing the efficiency the system promises to produce accurate and authentic digital certificates.

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1.1 Existing System

Existing system is based on manual collection of sensor readings and certification production. The person at the Emission Test Center (ETC) collects the emission readings through smoke sensors, feeds vehicle and owner details to the system. Comparison of the collected sensor readings with the current emission standards is carried out. If the vehicle meets the requirements then paper based emission test certificate is produced and given to the vehicle owner. In case the vehicle fails the emission test, certificate is not generated and the owner is advised to service his vehicle.

Drawbacks:

- One of the disadvantages of the existing system is that it has no way to detect whether the integrity of the data has been compromised.
- The system doesn't ensure authenticity of the data provided by the vehicle owner.
- Vehicle owners can easily bribe the Emission Test Center (ETC) workers to obtain results that conform to the emission standards. Along with the increased manual work, this system also has negative impacts on the environment.

1.2 Proposed System

This project proposes a secured mechanism of collecting the sensor readings using MQ2 smoke sensor thus avoiding any third party intervention at the emission testing agency. The sensor readings and the vehicle number is encrypted in the Arduino using RSA cryptosystem. The encrypted data is sent over cloud to the CA for further processing and certificate generation CA ensures the authenticity by comparing the received owner details with the one in the CA database. Certificates are generated according to the test results.

Advantages over the existing system:

- Integrity of collected readings is ensured by data encryption and directly sending it to the CA, hence avoiding any kind of manipulation.
- Vehicle and owner details present in the CA helps to verify the received data for authenticity.
- Since there is no way of altering the sensor readings at the center or at the CA, malpractices in the existing system can be prevented leading to lesser impact on the pollution in the environment.

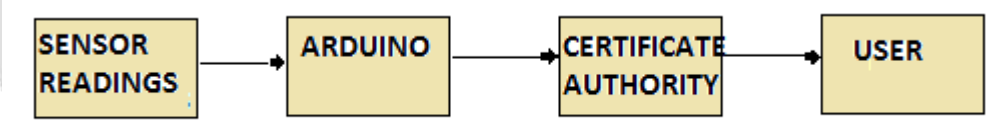

Fig -1.2.a: Data flow diagram of the proposed system.

2. SYSTEM DESIGN

- Emission Test Center (ETC)
- Arduino
- CA
- End user

Fig-2.1.a: System design

2.1 Emission Test Center (ETC)

- **Registration:**

In this step ETC needs to send a registration request to the CA for approval to conduct emission test. CA identifies different ETCs using their MAC addresses. Once the ETC gets approval, it is authorized to perform emission test on the vehicle**.**

- **Emission test**

Sensor MQ2 is used to collect CO, NOx and HC (Hydrocarbons). The analog data readings from the sensor are sent to Arduino via serial port. The worker at the ETC captures an image of the vehicle's number plate for authentication in future. This data along with the sensor readings is fed to the system for encryption.

2.2 Arduino:

Arduino receives analog sensor readings from the serial port. Analog to Digital Converter (ADC) will convert the analog data into digital data. Sensor values are read by the arudino using C programming which is then displayed on the monitor connected to it. User Interface (UI) displays the sensor readings along with captured number plate image where none of the data can be manipulated. RSA cryptosystem is used to encrypt the data which is sent to the CA over the cloud.

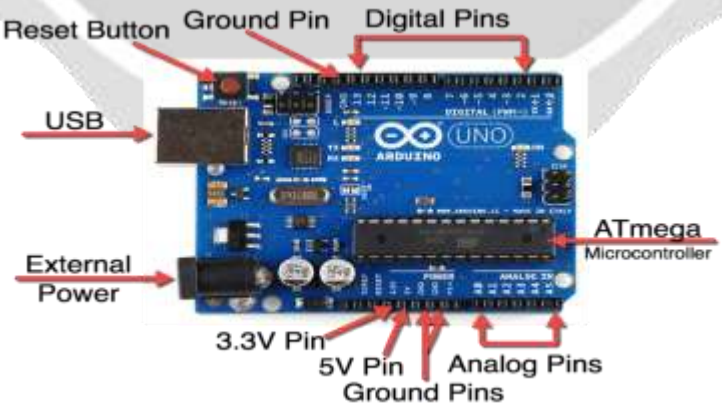

Fig-2.2.a: Arduino UNO

2.3 Certificate Authority

Certificate authority consists of vehicle details that include vehicle number, vehicle model, engine type and owner details in its database. This database is used to map the received data for comparison and certificate production**.** Comparison is carried out based on the threshold value fixed according to the current emission standards. Threshold value for a particular vehicle is based on its model and engine type. If the sensor readings exceed the threshold values then the CA declares that the vehicle has failed the emission test to the intended user. Otherwise digital certificate is sent to the personal device of the authenticated user.

CATEGORY	VEHICLE	YEAR	REFERENCE	TEST	CO	HC	NOx	HC+NOX
Heavy-duty diesel	Trucks and buses	1992	-	ECE R49	17.3-32.6	2.7-3.7	-	-
		1996	-	ECE R49	11.20	2.40	14.4	-
		2000	EURO I	ECE R49	4.5	1.1	8.0	-
		2005	EURO II	ECE R49	4.0	1.1	7.0	-
		2010	EURO III	ESC	2.1	0.66	5.0	-
				ETC	5.45	0.78	5.0	
		2010	EURO IV	ESC	1.5	0.46	3.5	-
				ETC	4.0	0.55	3.5	
Light-duty diesel		1992	-		17.3-32.6	2.7-3.7	-	-
		1996	-		5.0-9.0	-	-	2.0-4.0
		2000	EURO I		2.72-6.90	-	0.14-0.25	0.97-1.70
		2005	EURO II		1.0-1.5	-	0.08-0.17	0.7-1.2
		2010	EURO III		0.64	-	0.50	0.56
					0.80	-	0.65	0.72
					0.95		0.78	0.86
		2010	EURO IV		0.50	-	0.25	0.30
					0.63	-	0.33	0.39
					0.74	-	0.39	0.46
Light-duty petrol	4-wheeler	1991	-		14.3-27.1	2.0-2.9		-
		1996	-		8.68-12.4	-		3.00-4.36
		1998	-		4.34-6.20	-		1.50-2.18
		2000	EURO I		2.72-6.90	-		0.97-1.70
		2005	EURO II		2.2-5.0	-		0.5-0.7
		2010	EURO III		2.3	0.20	0.15	
					5.17	0.25	0.18	
					5.22	0.29	0.21	-
		2010	EURO IV		1.0	0.1	0.08	
					1.81	0.13	0.10	-
					2.27	0.16	0.11	
	3-wheeler	1991			12-30	8-12		-
		1996			6.75	-		5.40
		2000			4.00	-		2.00
		2005	BS II		2.25	-		2.00
		2010	BS III		1.25	-		1.25
Diesel vehicles	2-wheeler	1991			12-30	8-12		-
		1996			5.50	-		3.60
		2000			2.00	-		2.00
		2005	BS II		1.5	-		1.5
		2010	BS III		1.0	-		1.0
	2 and 3 wheeler	2005			1.00			0.85
		2010			0.50			0.50

Fig-2.3.a: Datasheet referred to evaluate the emission test by CA.

2.4 End user

The CA evaluates the test results to decide whether the vehicle has passed the emission test or not. If the vehicle passes the emission test the user receives the digital certificate through e-mail. In case the vehicle fails the test, the CA notifies the same to the end user i.e. the vehicle owner and recommends to get the vehicle serviced.

3. USE CASE DIAGRAMS

3.1 Use case diagram for ETC:

The ETC collects the credentials like vehicle and owner details from the owner along with the sensor readings and an image of the vehicle number plate.

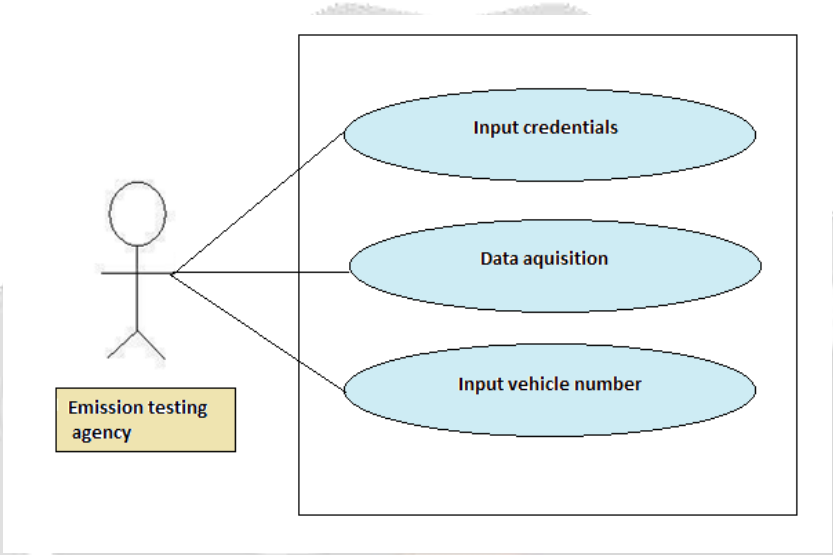

Fig -3.1.a: Use case diagram for ETC

3.2 Use case for the CA

The certificate authority receives the sensor readings and vehicle details via cloud. Authenticity is ensured by mapping the received vehicle details with the data present in its database. Sensor readings are decrypted and compared with the threshold values for the vehicle type and model. CA decides whether the passes or fails the test and conveys the same to the end user as mentioned in the Fig-3.2.a.

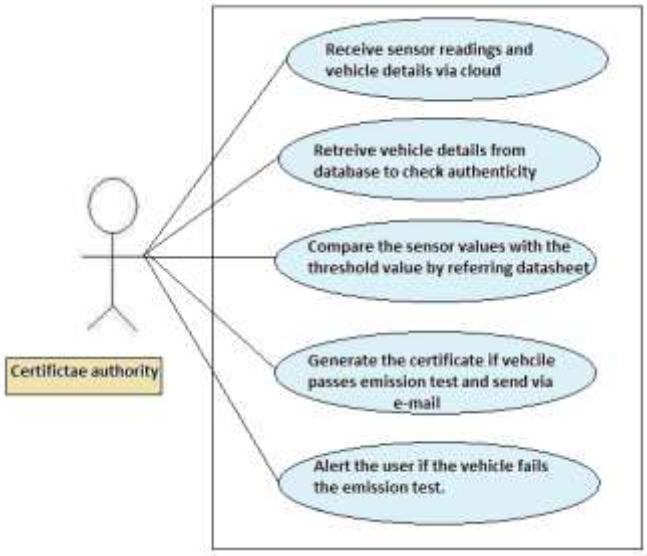

Fig-3.2.a: Use case for CA

4. SEQUENCE DIAGRAMS FOR ETC AND CA

The sequence of events for ETC and CA is shown in the fig-4.a and fig-4.b respectively**.**

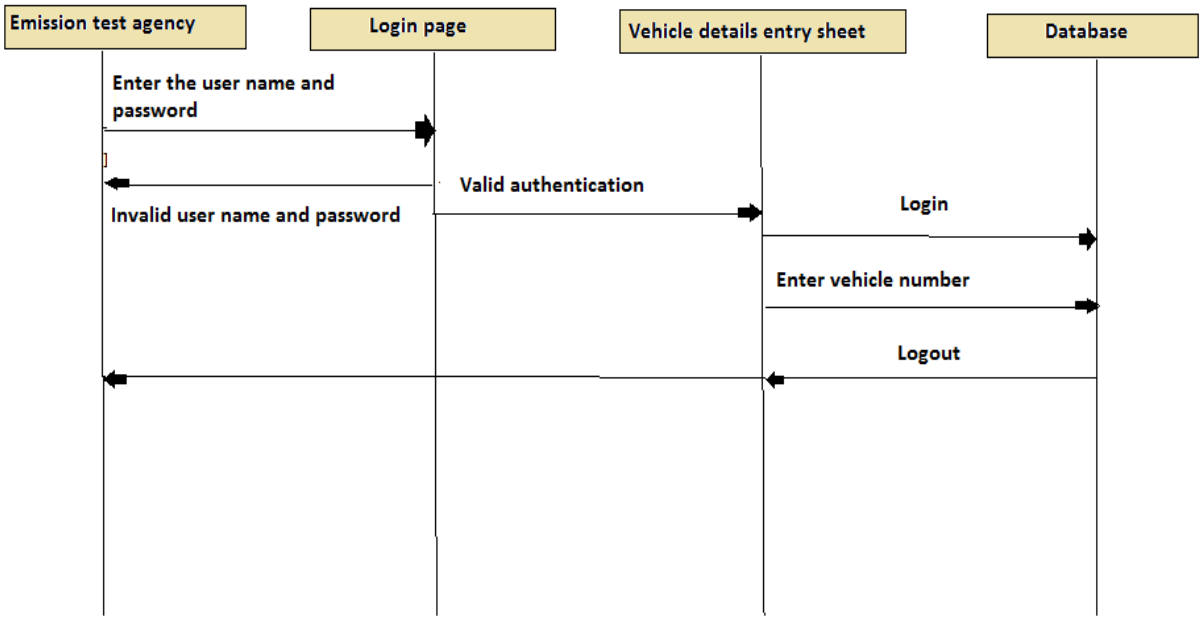

Fig-4.a: Sequence diagram for ETC

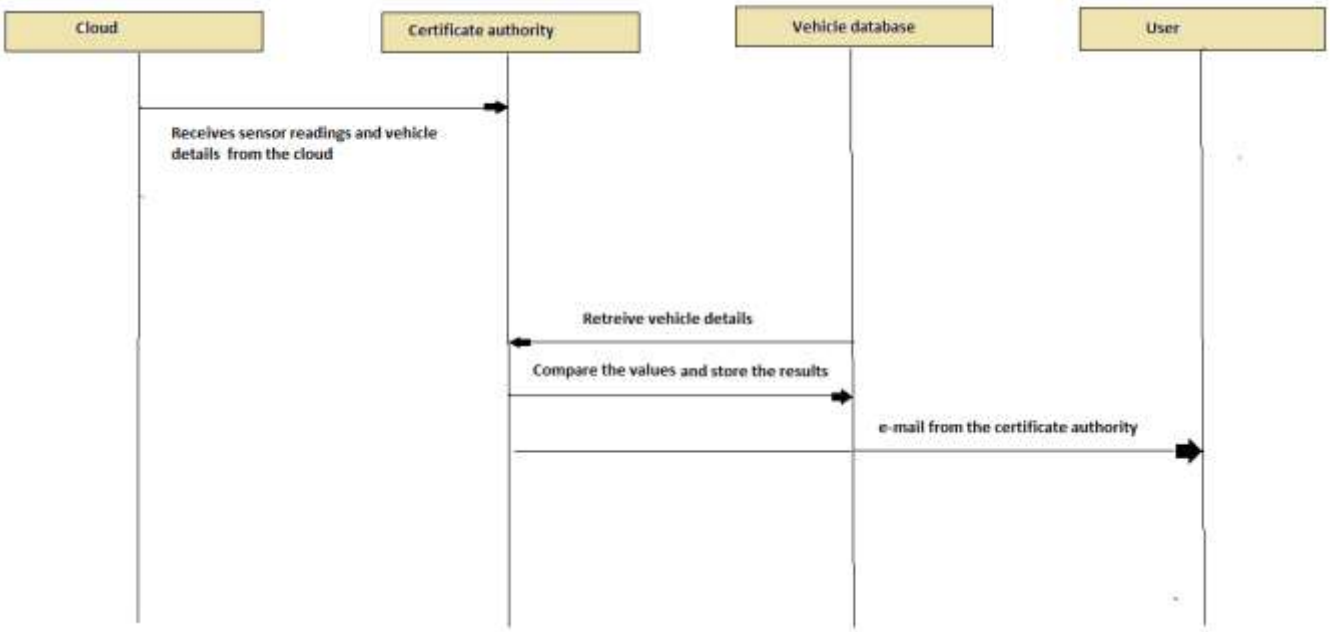

Fig-4.b: Sequence diagram for CA

5. DATA FLOW DIAGRAMS FOR CA

The DFD for CA shows how the data flows to and from the CA. The sample RTO database mentioned in the fig-5.a stores all the necessary information about vehicles that is used by the CA for authentication process.

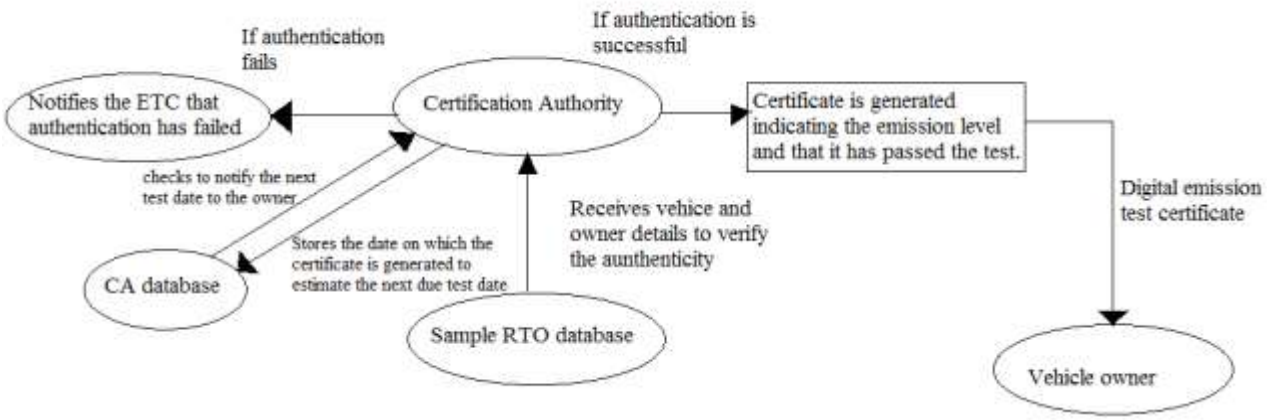

Fig-5.a: DFD for CA

6. CONCLUSION

The IoT based emission test system is an efficient and reliable system that ensures that the data collected by the smoke sensors at the ETC is accurate and the integrity is maintained. The system addresses two important disadvantages of the existing system; firstly, the system induces automation and digitalisation. Secondly, the system ensures integrity and authenticity of data. This improved mechanism will help in controlling the amount of smoke emission through vehicles into the environment and gradually will help reduce the air pollution that is one of the major environmental issues. The proposed system has not implemented image processing at CA to verify the authenticity and hence requires an administrator to approve or reject the generation of the certificate. This feature can be considered for the future work.

7. REFERENCES

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