Controlling In-Vehicle Features Using NFC and Voice Recognition

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Abstract— New technology always tend to introduce products that help easing our daily routine. In vehicles nowadays, manufacturers put equal emphasis on improving in-car features as well. Connecting vehicle's entertainment system to owner cell phone for call and media purposes, is one of popular culture in today's scenario. But to use most of systems, driver may need to divert its focus from driving to find respective button for feature. That can cause driver to lose his sight from road. Completely automatic systems come in top brands and at high price. But almost all mid-range sedans lacks these systems, due to its high cost of implementation.

This paper will purpose In-vehicle system which uses NFC enabled smartphone and voice recognition for controlling basic functions without need of user to press any button. This system will be cost-effective and uses present day prevalent technologies. It can be used as whole system for new cars, as well as can be used as an upgrade option for existing cars.

Index Terms— NFC, Voice Recognition, Driver Assistance, In-Vehicle features, smart car, Contactless technology, NFC powered car control

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1 INTRODUCTION

Improving driving experience by reducing attention needed to activate other features in car is always top priority of automobile manufacturers. Sensors for avoiding collisions during parking[1], automatic rain wipers, auto headlamps etc are few most common technologies used nowadays. Most premium-class sedans come equipped with gadgets which are interactive and automates most of the features at touch of a button or using sensors. But mid-class sedans are most common vehicles we can see on roads, lacks these packages, and do not have option to upgrade or with a high cost label for same. In US, 700,000 sedans are sold monthly on average. Out of which approx 55% are mid-class sedans. In India approx 3.5 millions vehicles are produced yearly, out of which mid-class cars count to nearly 1 million. In these cars, main reason for not providing these features in mid-range sedans is that it will result in increase of cost for buyer. This paper will discuss low cost system for same features, with help of NFC enabled mobile device.

Near Field Communication (NFC) is used for communication between two ends through radio frequency operating at 13.56Mhz. This communication can be between two devices or between device and tag, in range of 4-10cm. Most of smart phones nowadays, comes with inbuilt NFC. In 2012, 140 million NFC enabled devices were sold and is expected to rise 6 times till 2017.

Using mobile device as medium to start service it is needed to authenticate device to prevent unauthorized usage. Speaker voice recognition[2] technique can be used here for authentication purposes. All mobile devices have feature to process speech and analyze for speech characteristics. This will block any unauthorized request made to mobile device to perform any action. This will add security layer to the system. Many car manufacturers provide ability to pair car system with user mobile device using Bluetooth[3]. But that consumes much power when compared to NFC. Also because of its feature of performing only when in close proximity adds security for performing various tasks.

Car manufacturers are signing deals with mobile phone companies for making systems that seamlessly connects with device. But those are limited to work with phones of particular company. Interoperability issues are major concern for consumers when buying these vehicles. NFC is found in almost all range of smart phones available in market. Many OS like Android,Tizen, BB10, Ubuntu Mobile have officially supported this technology. And API for implementation this technique on various devices can be easily accessible by developers. Issue regarding compatibility of system with different devices can be easily eliminated opting these technologies.

This paper will purpose a system that can be used to enhanced driver's experience while driving. User can operate features present in car through voice commands. There is no need for driver or user to divert his sight from driving to find or activate feature. On other hand, it is cost-effective way of providing feature enriched car. It do not involve presence of any high processing system in car. Basic processing is done on mobile device itself, and at car's processing unit there is no need of executing high end commands that needs more processing power.

2 NFC TECHNOLOGY

NFC was introduced commercially by Nokia, Philips, Sony in 2004 by forming NFC-Forum. This technology provides set of protocols for two mobile devices to communicate with each other either when touched or when placed in close proximity of 0-10 cms. NFC standards are based on RFID (radio frequency identification) standards and ISO/IEC 14443.

NFC is popular because of its application in one-touch payment. But with increase in number of sales of compatible devices, researchers are paying more attention towards its use in daily life. NFC tags are introduced that can perform any set of actions with just tapping mobile device on it. Peer-to-Peer communication is also provided by NFC. In our system we will be using this technology to push messages from mobile device to NFC reader.

3. SYSTEM DESIGN

In-car system is developed by using mobile phone with integrated NFC technology. Mobile phone will listen to commands, process these commands for voice recognition, after authentication generates request for desired function. This data is then forwarded to reader in proximity via NFC. This data is in form of commands to the computer chip in car, that translates incoming data to respective action. General description for purposed system is shown in Fig. 1.

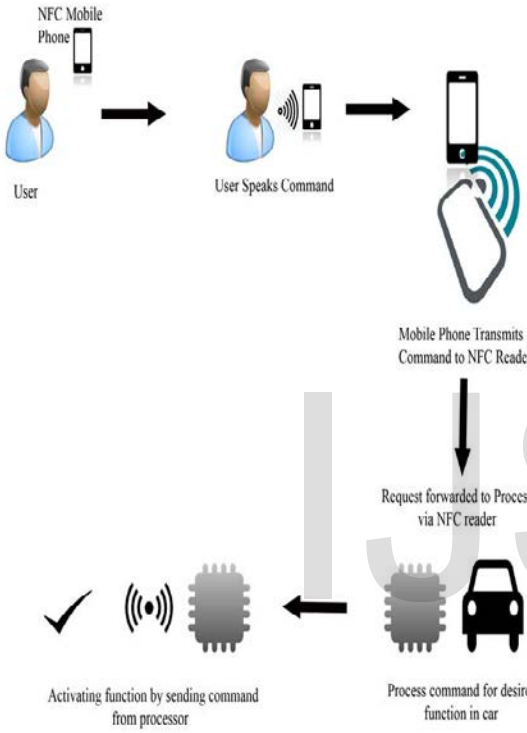

Fig.1 General System Design

System consists of two parts, namely mobile device and car on-board processor. Both of these parts will communicate with each other via NFC.

3.1. MOBILE DEVICE

Mobile device having integrated ability to process speech and with inbuilt NFC are compatible with system. Most of android based phones are capable of performing both tasks. For system to work with car owner mobile device should perform these processes

2 Car owner's voice sample to be recorded and analyzed
3 Owner identification through voice recognition
4 Accept commands only from Owner or approved user

When mobile device is in range of NFC reader, it will always be on speech recognition mode. So that whenever user speaks, it records respective command. It process received message for voice recognition[2]. Main purpose of introducing this layer is to add security. There might be more than one person traveling in same vehicle at same time. It becomes more confusing when all of them can control system via simple voice commands. With some programming techniques multi-user experience can also be introduced in same system.

After authenticating user, mobile device itself process recorded command for its speech to text conversion. Text that we will receive after conversion will be made into request format and ready to be transmitted to processor installed in car. Mobile device that is already placed in proximity of NFC reader will transfer text command to reader via NFC technology.

3.2. ON-BOARD PROCESSOR

This on-board processor consists of NFC reader and processor unit. Data received by receiver from mobile device is processed for its matching action. A feature set table is maintained based on user need which includes functions with their respective commands to activate them. Table.1 shows some example values and look of feature set table.

TABLE 1. Feature set table for illustration

FeatureId	Command
1	Start AC
1	Activate AC
2	Volume up
3	Volume down

As shown in above table, FeatureId is not unique value. We can have many different commands that results in same action to be triggered. Like in example, we have 3 different commands to activate air-condition of car. We use same Id to identify action desired by user and give them one single id.

Command is processed and matched with desired action and FeatureId of same is generated. This FeatureId is then sent to processor to trigger desired action. Processor is connected to dashboard unit of car, from where we can send activate/deactivate function desired by user.

4. SYSTEM FLOW

In order to facilitate user interaction with proper security in system, we need to setup system flow that work for routine tasks with ease. Fig. 2 shows flow chart of decision making process at mobile device end.

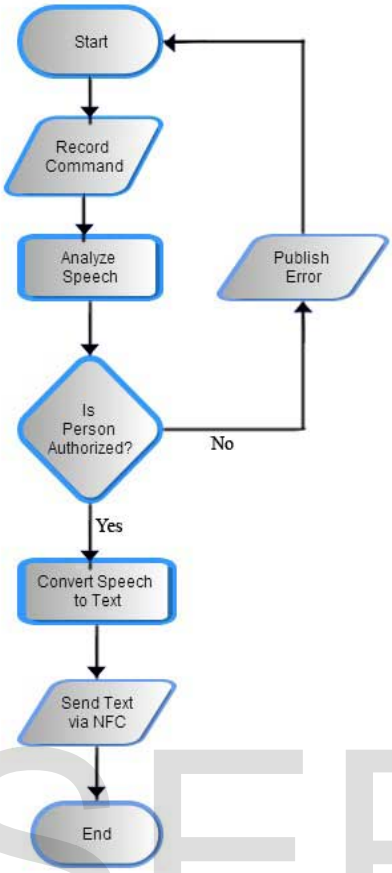

Fig. 2 Flow chart for Information Process in Mobile Device

7 Android mobile devices have ability to listen to particular voice command and become active. User start interaction with system by speaking commands.

8 Mobile device records particular command and process information for authentication by speaker recognition[2][4]. If authentication process fails, mobile device will go in inactive state again.

9 After successful authentication, recorded command will be converted into text[5] and will be sent to device present on car via NFC.

Communication between device and mobile will be peer-to-peer communication via NFC[6].

1. NFC reader will receive command as text string from device and forwards it to processing unit.
2. Processing unit matches received command with predefined commands in feature set table or database, illustrated in Table. 1.
3. If command exist in table, respective command will be generated.
4. That command will be transferred to specific sensor or to any dashboard controller, that can activate that feature.

Fig. 3 is showing flow chart representation of process after receiving command from mobile device

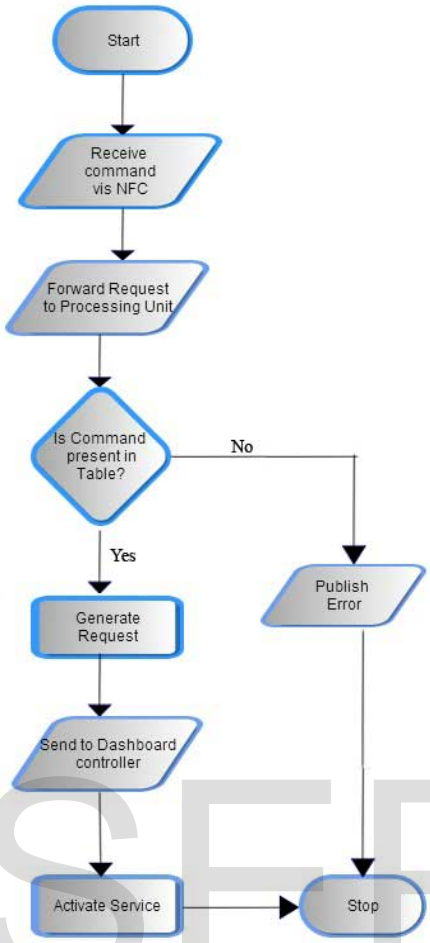

Fig. 3 Flow Chart representation of process after receiving command from mobile device

Dashboard Controller here refers to control unit in car which activates feature for requested process.

5. SECURITY

Implementing security in these kind of systems are very important as well as crucial. Because it deals directly with valuable product in terms of money. The system proposed may not impose any threat to life, even on road, in case of any kind of intrusion. But these systems can be extended for providing extra controls to user, that increases risk factor. Security can be implemented at following levels

2 Car system receives requests only from authorized cell phones. These can be enforced by matching IMEI numbers of device. As IMEI number is unique for every device, it is quite difficult to duplicate it. If any other device is used for sending request to car system, it will discard the request.

3 On mobile device speaker recognition technique is applied to authenticate user. This will verify that device is not used by any unauthorized person.

6.FUTURE SCOPE

We do not have much systems in market that are capable of interacting with user via voice commands. Many manufacturers introduced such technologies in their products, but they limit it to expensive line-up of cars. Mid-range cars do not have such features, because technology used to implement such features are expensive. There is huge scope of products like this to be introduced, because majority cars are compatible with this technology. This system can proved to be helpful in following cases

3 Cost effective alternative to technology prevalent in today's time. NFC is always known for its cost effectiveness. It is popularly used along with android, which is open source operating system for mobile devices, and developer API is available free of cost on internet.

4 NFC does not depend on pairing up devices first to start communication. Device authentication can be done at receiver end before executing any requested action.

5 Mobile device is only active when placed in close proximity of reader. It should be in range of 0-10cm. It adds another layer for security, as during driving it is impossible for any intruder to act without being noticed by driver.

6 These systems can also be provided as upgrade package to previously installed systems in cars. Presently there is no such technology available in market that can provide such features and is available to install into older cars too.

Implementation of such systems in old cars, as upgrade option to those, does not involve any complex task too. But the features that can be provided by using this system is limited to already available digitally controlled features in car. So universal system for every car is not possible. But with limited number of features, or systems with basic functions can be made universal for all cars and manufacturers.

7. DISCUSSION

With growing number of NFC compatible devices in market, it is possible to introduce product that can rely on these technologies. These technologies can provide user smart environment, that requires less physical interaction to perform a task. NFC can be applied to fields other than payment gateways and various authentication systems.

Purposed system in this paper take advantage of NFC to provide voice controlled features in car. System can be applied at various levels in vehicle depending upon the necessity of user. It can perform tasks ranging from simpler task of turning on air-condition to task highly complex task like cruise control. As complexity of task increases, risk involved also increases.

With implementation of security features such as voice recognition and device recognition, as suggested in paper, we can develop a security layer. This security layer can prevent intruders and unauthorized access to our system.

This system is not limited to number of features a manufacturer can provide. Every feature that is digitally controlled by car itself, can be programmed to work with this system.

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