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Smart Car Design Using Arduino Uno Based Speech Recognition Application

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Abstract: Designing a smart car using a speech recognition application based on Arduino Uno is an effort to improve vehicle control by utilizing speech recognition technology. Through the implementation of a speech recognition application, drivers can easily control various aspects of the vehicle such as the drive system, brake system, or navigation system, just by using their voice. In the design process, there are several areas that need to be considered, including needs analysis, speech recognition method selection, integration with existing vehicle systems, and intuitive user interface design. The final result of designing a smart car using an Arduino Uno-based speech recognition application is a vehicle system that allows the driver to control the vehicle using voice commands. This design provides a more intuitive driver experience, improves driving safety, and strengthens integration between voice technology and vehicle systems.

Keywords: Smart Car; Speech Application; Arduino Uno

INTRODUCTION

The development of computer technology today can be felt in the field of computers which have a very important role in the world of information technology and function as a medium that can process creativity and imagination into real forms. So that companies engaged in the production of electronic components for two-wheeled and four-wheeled motor vehicles must innovate in creating a product, one of which is to create using voice commands or a tool that functions with speech (Speech Recognition), where this technology allows a computer device to recognize and understand spoken words by digitizing and matching the digital signal with a certain pattern stored in a device(Achmady et al., 2022). Its integration is also accompanied by a smart car computerization system, which functions as a controller and command translator. This development has a special impact on the field of designing a system. So in this case, this mobile robot is designed to move in an Arduino system that uses an Android smartphone as a controller that has a suitable application to move the robot using the application (Speech Recognition), where this technology allows a computer device to recognize and understand spoken words by digitizing and matching the digital signal with a certain pattern stored in a device(Rahayu & Hendri, 2020). Smart car design uses Bluetooth as the main system media(Eka et al., 2024). The system that we will build now will be connected to a voice command application where the car owner will find it easier to control the car remotely using a smartphone. In the application, the car owner can control the automation system, for example, opening and closing the right and left doors, opening and closing the front hood, opening and closing the rear doors, turning on and off the front and rear lights, and the fan through the application on the smartphone(Hadari et al., 2021).

Arduino is an open-source minimum system microcontroller board. In the Arduino board circuit, there is an AVR 328 series microcontroller which is a product of Atmel. Arduino has its own advantages compared to other microcontroller boards, besides being open source, Arduino also has its own programming language in the form of C. In addition, the Arduino board itself already has a USB loader so it is easy when programming the microcontroller in Arduino(Ikhwanudin et al., 2023).

A servo motor is a rotary device or actuator (motor) designed with a closed-loop feedback control system (servo) so that it can be set up or adjusted to determine and ensure the angular position of the motor output shaft (Nugroho et al., 2020).

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Design is a process that aims to analyze, assess, improve, and compile a system, both physical and non-physical systems that are optimal for the future by utilizing existing information. Designing a tool is included in the engineering method, thus the steps in making the design will follow the engineering method. Merris Asimov explained that engineering design is an activity with a specific purpose towards the goal of fulfilling human needs, especially those that can be accepted by the technological factors of our civilization(Mujiburohman, 2022).

Smart Car is the integration of cars with computerized systems(Romdoni & Ramadhan, 2022). With the presence of Smart Car, comfort for car users is increasing. Controlling Smart Cars by voice is one form of integrating cars with computerized systems. Controlling Smart Cars using Speech Recognition to translate commands and control(Thiang & Agathon, 2022).

Speech Recognition is the process of identifying voice based on spoken words by converting an acoustic signal, which is captured by an audio device (voice input device)(Febriansyah et al., 2022). Speech Recognition is a type of biometric recognition, which is the process of a computer recognizing what someone says through a microphone based on the intonation of the voice that is converted into a digital print. The initial process is to convert sound spectrum data into digital form and change it into discrete form. Speech Recognition can also be said to be the procedure for recording speech using a microphone or telephone and converting it into digital data. In addition to Speech Recognition, there is also another voice recognition system, namely speaker recognition. Arduino Uno is a microcontroller board based on ATmega328 (datasheet). It has 14 input pins from digital output where 6 input pins can be used as PWM output and 6 analog input pins, a 16 MHz crystal oscillator, USB connection, power jack, ICSP header, and reset button. To support the microcontroller to be used, simply connect the Arduino Uno Board to the computer using a USB cable or electricity with an AC-to-DC adapter or battery to run it(Aditia & Ilham, 2022).

MySQL is a multi-threaded, multi-user SQL database management system software with approximately 6 million installations worldwide. MySQL is an implementation of a relational database management system (RDBMS) that is freely distributed under the GPL (General Public License)(Kadir, 2020b).

A database is an organized collection of interrelated data, stored in a medium that is used to access and manage it. A database allows users to store, retrieve, update, and analyze data easily. Data in a database can be text, numbers, images, videos, or other types of files(Kadir, 2020a).

LITERATURE REVIEW

Speech Recognition

Speech Recognition or commonly known as automatic speech recognition (ASR) is a development of techniques and systems that allow computers to receive input in the form of spoken words. This technology allows a device to recognize and understand spoken words by digitizing the words and connecting the digital signals with a certain pattern stored in a device (Kusumah et al., 2019). Spoken words are converted into digital signals by converting sound waves into a set of numbers which are then adjusted to certain codes to identify the words. The results of spoken word recognition can be displayed in writing or can be read by technological devices as a command to do a job, for example pressing a button on a mobile phone which is done automatically with a voice command (Azmi et al., 2022).

Arduino Uno

Arduino Uno is an open-source microcontroller based on the Atmel AVR microcontroller. Arduino Uno allows users to design and develop various electronic projects easily. This platform provides a combination of hardware and software that can be used to program various electronic functions and interactions. Arduino Uno was first developed in Italy in 2005 by a team led by Massimo Banzi. The goal was to create an easy-to-use tool for anyone interested in electronics and programming, without requiring in-depth technical knowledge (Ery Murniyasih et al., 2024). Arduino Uno uses the ATmega328P microcontroller which is the brain of the entire system. This microcontroller is equipped with 32 KB of flash memory, 2 KB of SRAM, and 1 KB of EEPROM. Arduino Uno has 14 digital input/output pins, of which 6 can be used as PWM (Pulse Width Modulation) outputs. In addition, there are also 6 analog input pins that allow users to read analog signals. Arduino Uno is equipped with a USB port that is used to connect the board to a computer. In addition, there is also an ICSP (In-Circuit Serial Programming) port to program the microcontroller directly (Saputra, 2023).

MIT APP Inventor

App Inventor is an application that allows new users to program computers. In addition, App Inventor also creates software applications for the Android operating system. MIT App Inventor is a platform to facilitate the process of creating simple applications without having to learn or use too many programming languages. Someone

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can design an Android application as desired. The design process can use a variety of layouts and components available. The following are easy steps to create an application using the MIT App Inventor (Triyanto et al., 2024).

METHOD

In collecting data, and information and designing programs needed in this study, researchers use several methods, namely: (1) Observation (Observation Research) The observation method can be used to collect data on the behavior of public vehicles related to speed and load directly. In this case, researchers can install sensors on public vehicles that will be observed and collect empirical data on speed and load carried. Observations can also include field observations of public vehicles in operation. (2) Literature Research The literature study method is used to collect information and knowledge that already exists in the scientific literature related to detection systems, Atmega328 Microcontrollers, vehicle speed, and overload problems 6 on public vehicles. Researchers will review previous studies, articles, books, and other theoretical sources to understand the theoretical basis and concepts relevant to the research topic. (3) Design Method The design method used by the author in this study is through the stage of making a flowchart with hardware design using a block diagram so that they can find out how the system is designed and what tools are needed. System design is a stage after the analysis process of a system development or construction, defining functional requirements, and preparing to design and build an implementation that describes how a system is formed. The main purpose of this system design is to provide an overview of the system design that will be built or developed and to understand the flow of information and processes in the system. The working system of Smart Car Design Using the Voice Command Method Based on the Atmega328 Microcontroller is shown in the block diagram of Figure 1 below.

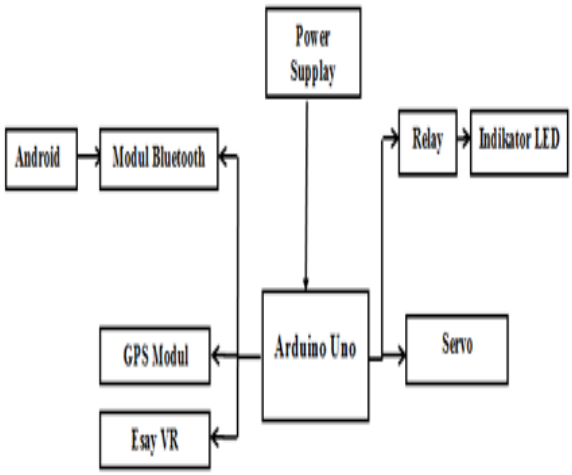

Figure 1. Block Diagram Design

The working system of each component in the image above is explained as follows:

1. Power Supply as a provider of voltage and current supply to all components so that all circuit blocks can work.
2. Android reads and analyzes sound remotely through the microphone on the device and also transmits detected voice commands to Smart Car to control the desired movement or action.
3. Bluetooth module as short-range wireless communication with each connected device.
4. The GPS Module detects location by capturing and processing signals from navigation satellites.
5. Easy VR as controlling electronic devices using voice commands.
6. Arduino Uno as input and output.
7. Relay as a switch or switch for other devices.
8. LED indicator as an indication of the status of the electronic device
9. Servo as opening the driver to open and close the door

The tools and materials used in this study are: 9 ml plywood, 3 ml acrylic, Arduino Uno, Servo, LED, Power Supply, Relay, Stepdown, terminal, cable, tin, acrylic glue, spray paint, grinder, jigsaw, solder, pliers, screwdriver, and adapter.

In designing this software system, the following software is used: Arduino IDE software, which is a software for programming Arduino(Rachman, 2022). In this software, Arduino is programmed to perform embedded

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functions through programming syntax. Arduino uses a modified C programming language. We call it the C for Arduino programming language. Arduino IDE is made from the Java programming language which is equipped with the CC++ library (wiring), which makes input output operations easier. The following is a display of the Arduino IDE software.

Figure 2. Arduino IDE Software Display

MIT App Inventor is used as software to create smart home applications(Suharto, 2021). MIT App Inventor allows anyone to create software applications for the Android operating system which is open-source and easy for anyone to access and learn. The following is a display of MIT App Inventor.

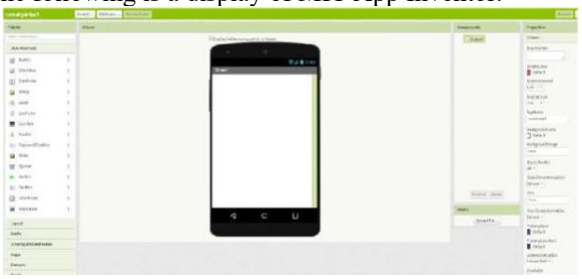

Figure 3. MIT App Inventor view

Smart cars are usually equipped with a control system that uses a microcontroller such as Arduino Uno or a similar platform. This control system is responsible for controlling the movement, speed, and other functions of the vehicle. Smart cars can be equipped with a speech recognition application that allows users to control the vehicle using voice commands. This application uses speech recognition techniques to interpret the commands given by the user and convert them into appropriate actions in the vehicle. Some smart cars are equipped with a navigation system that uses GPS or other technology to provide voice-controlled directions. This navigation system can be integrated with the control system and accept voice commands to set destinations and routes. Safety systems on smart cars can include automatic braking systems, obstacle monitoring, and other safety features. Safety systems aim to identify potential. Smart cars are usually equipped with a user interface such as a touch screen or buttons that allow users to interact with the control system and give commands.

The system to be designed is based on Arduino Uno as the control center of all systems to be built. Arduino Uno here functions as a place to place the program created for system design and as a chip that regulates all tool performance, this system will work according to the commands given by the user.

The next stage is to design a system consisting of two parts, namely hardware design (Electronic Circuits) and software. This hardware system design will be described using a block diagram which is a basic description of the system design to be built. Each block diagram has its own function.

RESULT

Based on the design results from the system analysis stage, system design, then the overall tool work system, both hardware and software, has been tested in the Robotics lab of the Indonesian Institute of Technology and Business Campus and can function as desired. The following is a display of the final results of the design that has been completed and is ready to be used using road simulation.

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Figure 4. Results Viewed From Above

The image above is the final design result of the physical design that has been made, the display above is a simulation display with a miniature house shape made using acrylic with a thickness of 2 to 3 mm. The display above is also the result of a simulation using 1 Arduino Uno, 1 Stepdown, 4 Servos, 2 Relays, 3 LEDs, 1 GPS Module, 1 Speed Sensor, and 1 Headsing Fan (Cooling Fan). Then the servo will work to open the right door, the left door, the front hood, and the rear hood when the voice command is given through the application on Android. The LED (Light Emitting Diode) will turn on when the user gives the command to turn on the LED through the application on Android. The Heading Fan (Cooling Fan) will rotate to cool the system when the user gives the command to turn on the LED through the application on Android. The benefits of testing the application are to determine the effect of voice commands on the performance of the tool, whether it functions or works as expected, namely: (1) Data entry process, in the process of entering data using voice commands and using an Android phone to capture the sound to be spoken. After the Android smartphone records sound, the sound is sent via a Bluetooth signal connected to the HC05 module circuit. Make sure your smartphone's Bluetooth is turned on first. (2) Data transaction process, the Arduino Uno microcontroller can run and process data sent by the smartphone application when the program list is attached. The list of programs created is uploaded to Arduino using the Arduino IDE programming tool.

Programming functions include resetting input or output pins, converting data sent by Android to "High" or "Low" logic commands that activate or deactivate relays and other outputs, and resetting the Bluetooth IP address, which is the destination address for sending data from Android. After the smartphone's Bluetooth and Bluetooth module is installed or connected, the smartphone application on the smartphone is ready to issue voice commands. When the Bluetooth signal receives sound, the Arduino receives Bluetooth, the Arduino processes the sound and sends it to the lamp, servo, and fan outputs. (3) Data presentation process, the data presentation process which includes the results of testing various types of components used in this thesis process. The purpose of presenting this data is to find out whether each part of the tool is working properly or not according to its function.

The purpose of this servo test is to find out whether the servo rotates properly or not. This test is done by connecting the servo to the step done and applying voltage and data input from the Arduino uno. The test result table can be seen below.

Table 1. Servo Test Results

No	Servo	Input Conditions	Servo Condition
1	Servo 1 is located on the front hood	HIGH	Turn
		LOW	Turn Off
2	Servo 2 is located on the right door	HIGH	Turn
		LOW	Turn Off
3	Servo 3 is located on the left door	HIGH	Turn
		LOW	Turn Off
4	Servo 4 located on the rear door	HIGH	Turn
		LOW	Turn Off

When testing the HC05 Bluetooth module to find out whether the signal between two Bluetooth is given at a certain distance or not, a certain distance or not, and the maximum distance of expected Bluetooth activity. The following is a table of the results of the Bluetooth module testing that was carried out.

Table 2. Bluetooth Test Results

No	Condition	Distance	Results	
			Connected	Not Connected
1	Without Barriers	1-10 Meters	√	
		12 Meters		√
2	There is a Barrier	1-10 Meters	√	
		11-12 Meters		√

This test is done to find out whether the lamp is on properly or not. The following is a table of lamp test results when the lamp is connected.

Table 3. Lamp Test Results

No	Input Signal	Light Condition	Voltage	Information
1	Low	ON	5	True
2	Hight	OFF	5	False

This test is done to find out whether the fan is running properly or not. The following are the results of the fan test when the fan is connected.

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Tabel 4. Fan Test Results

No	Sinyal Input	Kondisi Lampu	Tegangan (Volt)	Keterangan
1	Low	OFF	5	True
2	Hight	ON	5	True

The front hood view when opened by the control system using voice commands and the user knows the contents of the components inside the car's front hood.

Figure 5. Front Hood View When Opened

The right door view when opened by the control system using voice commands when the user wants to enter the car through the right car door.

Figure 6. View of the Right Door When Opened

The appearance of the left door when opened by the control system using voice commands when the user wants to enter the car through the left car door.

Figure 7. View of the Right Door When Opened

The fan display when turned on, users can turn the fan on and off via voice commands.

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Figure 8. Fan Display When Turned On

View of the rear door when opened by the user via voice command.

Figure 9. Rear Door View When Opened

The headlight display when turned on by the user via voice command.

Figure 10. Headlight Display When Turned On

Rear light display when turned on by the user via voice command.

Figure 11. Rear Light Display When Turned On

DISCUSSIONS

The research results of "Smart Car Design Using Arduino Uno-Based Speech Recognition Application" include the following aspects:

1. The speech recognition system can receive voice commands with a certain level of accuracy.
2. The use of a speech recognition module to translate user commands into instructions for Arduino.
3. Trials are conducted in various environmental conditions to assess system reliability.
4. The success of the system in executing commands according to the tested scenario.
5. Suggestions for further development, such as AI integration for more sophisticated speech recognition or increasing the system's response speed.

CONCLUSION

Based on the research results, it can be concluded that: (1) This design uses 1 Arduino Uno, 2 Relays, 3 LEDs, 1 GPS Module, 1 Speed Sensor, and 1 Headsing Fan (Cooling Fan). (2) This system minimizes the occurrence of

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vehicle loss without knowing when it will happen. (3) This system uses an Android application that can provide information about the location and also.

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