IT&BUSINESS COLLEGE

Department: COMPUTER SCIENCE

Project title: GATE

Group Name: DREAM TEAM

Members:
Myrzagulov Azim - 238715030
Zhekshaliev Baitemir - 238715045
Dzholoev Samat - 238715037
Zhamalov Bekzhan - 238715029
Sagynbekov Alikhan - 238715059
Kamchybekov Emir - 238715046
Instructor: Nurbekov Mirlan
Group: SCA-23C

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

Abstract

This project shows a small-scale automated gate system, built to explore the basics of sensor control and simple automation. A small group of students put together a model using an Arduino, mixing sensors, code, and a tiny actuator to mimic how real gates work. On top of that, the system can also be controlled through a mobile app, so the gate can open or close remotely pretty handy. It detects approaching objects, thinks a bit (through the microcontroller), and moves the gate automatically or via the app. The whole point of this prototype is to give a clear, hands-on look at how modern automated gates operate and to make their structure and function easy to understand.

Introduction

Automated gate systems are used almost everywhere today in residential complexes, parking areas, industrial zones, and various secured facilities. They increase safety, reduce the need for manual operation, and generally make everyday use more convenient. Because of this, a small group of students decided to create a simplified, small-scale model of an automated gate to better understand how such systems work in practice. During the project, it was decided to use an Arduino microcontroller, since it is easy to work with and well-suited for demonstrating basic automation principles. The main goal was to show how sensors, a bit of programmed logic, and a simple actuator can work together to automatically open and close a gate. The resulting setup looked like a miniature version of a real gate system simplified, clear, and fully functional. In real automated gate systems, the work is usually done by three key components: sensors that detect changes around the gate, a microcontroller that processes this information and makes decisions, and an actuator that performs the physical movement. **The general structure of such a system is shown in Figure 1**, where it is clearly illustrated how the sensors send data to the control unit, which then signals the mechanical parts to open or close the gate. This represents the core concept behind many modern automated systems, simply demonstrated here on a smaller and more understandable scale.

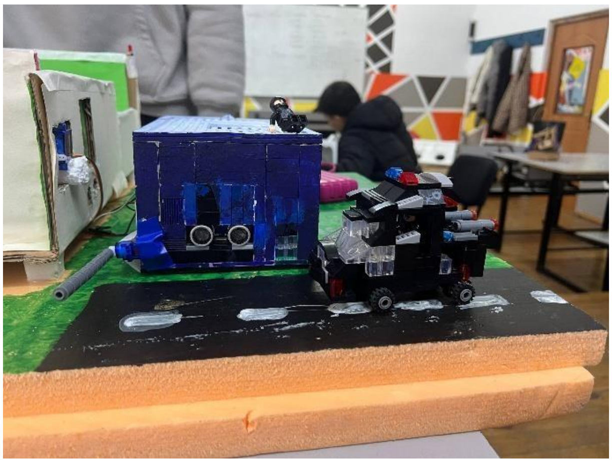

Figure 1: Structure of our gate

Comparison of Real Automated Gate Systems and the Educational Prototype, shown in **Table 1.**

Parameter	Real Automated Gate Systems	Our Small-Scale Prototype	Purpose of Simplification
Sensors	IR sensors, radar, loop detectors, LPR cameras	Ultrasonic sensor	Demonstrate basic object detection
Controller	PLCs, industrial microcontrollers	Arduino Uno	Easy programming and visualization
Communication	Wi-Fi, LoRa, GSM, RFID	Bluetooth	Simple and short-range control
Actuation	High-torque motors, hydraulic drives	SG90 servo motor	Safe, compact, low-power movement

Table 1: Comparison of components

Problem Statement:

With the increasing need for security and convenience in residential areas, parking lots, and industrial facilities, manual gate operation has become inefficient and sometimes unreliable. Traditional gates require constant human supervision, are prone to delays, and cannot provide remote control or integration with modern smart devices. There is a clear need for a small-scale, automated system that can demonstrate the principles of sensor-based gate control, allow for remote operation, and improve efficiency and safety.

Objectives:

1. To design a small-scale automated gate system using an Arduino microcontroller.
2. To integrate sensors that detect approaching objects and trigger automatic gate movement.
3. To implement a mobile application interface, allowing remote opening and closing of the gate.
4. To provide a functional prototype that demonstrates both hardware and software interaction.
5. To evaluate the system through testing, identifying any limitations or areas for improvement.

System requirements & constraints

The system must detect the object and set the mechanical element in motion**. The necessary components are listed in Table 2.**

N	Component	Quantity	Purpose
1	Arduino Uno	1	Main Control Board
2	Servo Motor SG90	1	Raises and lowers the barrier
3	Breadboard	1	For solderless connections
4	Female-to-Male Jumper Wires	10-15	Connects all elements
5	Power Supply	1	For powering the Arduino
6	Ultrasonic Sensor HC-SR04	1	Detects vehicle approach
7	HC-05	1	Bluetooth module

Table 2: Components

The system has several limitations:

1. **Ultrasonic Sensor** – The HC-SR04 sensor can give inaccurate readings when objects are soft or have irregular shapes, which absorb the sound waves.
2. **Servo Motor** – The SG90 has limited torque, so it can only lift a small barrier.
3. **Indoor Use Only** – The prototype is intended for indoor use. Components like the Arduino, servo, and breadboard are not protected against rain, wind, or extreme temperatures.
4. **Bluetooth Range** – The HC-05 module allows remote control, but its effective range is limited, so the gate cannot be controlled from a long distance.

System design (hardware & software)

The automated gate system relies on a combination of sensors, actuators, and a microcontroller to detect approaching objects and operate the barrier. The ultrasonic sensor HC-SR04 emits sound pulses and measures the distance based on the time taken for the echo to return. When a vehicle reaches a predefined threshold distance, the Arduino Uno processes the signal and activates the SG90 servo motor to raise or lower the barrier.

Component Selection:
HC-SR04 Ultrasonic Sensor (Figure 2):
Measurement range: 2–400 cm, suitable for small-scale gates.
High reliability, confirmed by official documentation (Datasheet HC-SR04, 2023).
Widely used in robotics and access control systems.

SG90 Servo Motor (Figure 3):
Up to 180° rotation angle, sufficient for gate movement.
Lightweight with low power consumption.
Fully compatible with Arduino power specifications.

HC-05 Bluetooth Module (Figure 4):
Enables remote control of the gate via a mobile application.
Compatible with Arduino serial communication (UART).
Allows convenient testing and demonstration of remote operation.

Figure 2: HC-SR04 Ultrasonic Sensor

Figure 3: SG90 Servo Motor

Figure 4: HC-05 Bluetooth Module

We selected the HC-05 Bluetooth module because it offers greater flexibility, stability, and functionality for our project. Unlike the HC-06, which supports only slave mode, the HC-05 can operate in both master and slave modes, allowing more advanced communication setups and easier integration with different devices. It also provides more reliable pairing, better configuration options through AT-commands, and higher overall compatibility with microcontrollers such as Arduino.

The advantages of the HC-05 compared to the HC-06 are demonstrated in **Table 3**.

Feature	HC-05	HC-06	WHY HC-05 better
Modes of operation	Master + Slave	Only Slave	HC-05 can initiate a connection or accept one — more versatile.
AT-commands	Extended set of AT-commands	Limited set of AT-commands	Allows fine configuration of baud rate, name, security, modes.
Transfer speed (baud rate)	Supports more modes	Limited	More options for optimization.
Compatibility with projects	Universal, suitable for large and small projects	Only for simple projects	HC-05 fits both prototypes and industrial solutions.
Connection stability	Very high	High, but may lose connection sometimes	HC-05 shows more stable operation.

Table 3: Advantages of HC-05

Prototype versions & progress

Prototype 0000:

A simple test setup was assembled using the SG90 servo motor connected to a push button to verify its basic operation. Pressing the button causes the servo to rotate, confirming that the motor responds correctly to control signals. The test version is shown in **Figure 5**.

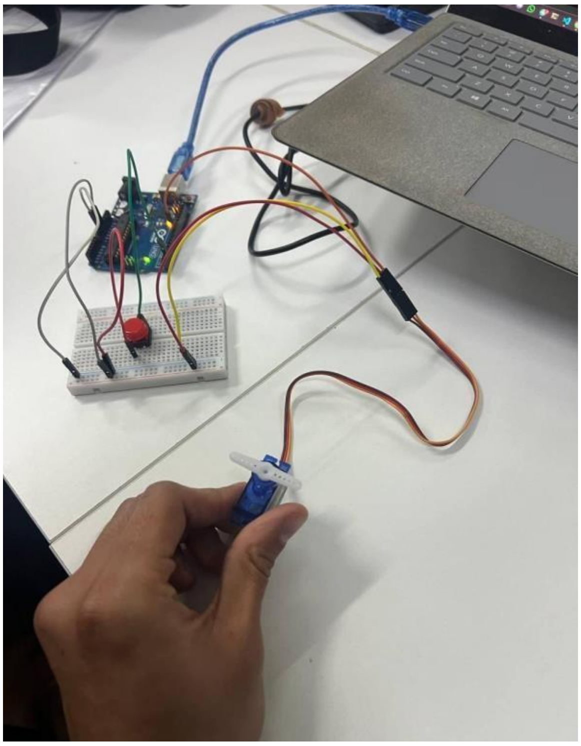

Figure 5: Servo motor with button

Prototype 0001:

This project uses an HC-SR04 ultrasonic sensor to detect objects and control a SG90 servo motor (barrier). When an object is detected within 25 cm, the barrier (servo motor) opens. It stays open for 3 seconds and then automatically closes. This version shown in **Figure 6.**

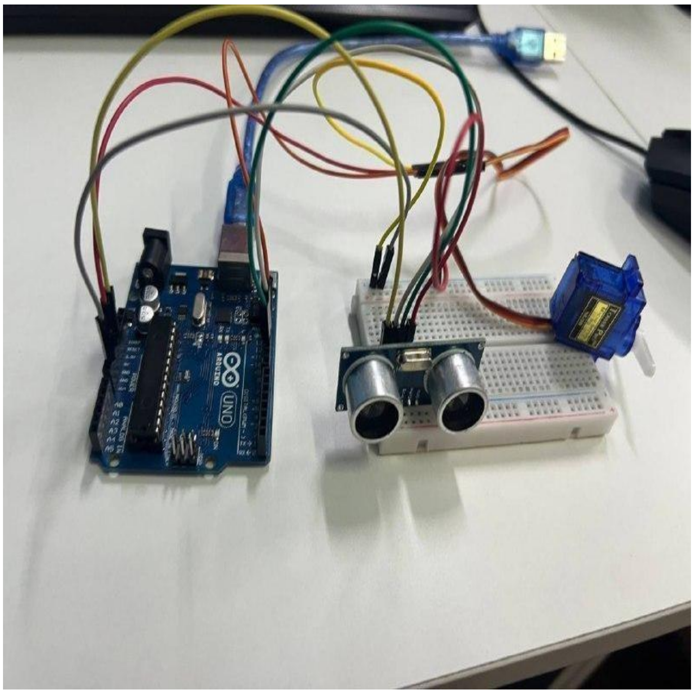

Figure 6: Testing ultrasonic sensor

When an object is detected at a distance of 25 cm, the Arduino sends a signal to the SG90 servo motor, causing it to rotate 180° to open the barrier. After a 3-second delay, the servo rotates back 90° to close the barrier, completing one automatic operation cycle. Code shown in **Figure 7**.

```
If (distance <= 25) {
Servo.write(180);

Delay(5000);
} else {
Servo.write(90);
}
```

Figure 7: Code

Prototype 0002:

A mobile application was developed using Flutter to provide remote access control for the Arduino-based gate system. Communication between the mobile app and the Arduino units is carried out through HC-05 Bluetooth modules. The app includes an administrator panel, five user accounts, and three independent gates. Access is distributed intentionally: the first two users are linked to Gate 1, the next two users are connected to Gate 2, and the fifth user has access only to Gate 3.

The administrator has full control over the system and can see which user is assigned to which gate. Access rights can be modified at any time. For example, when a user's subscription expires, the administrator can remove that user's access to a specific gate. This structure makes the system flexible and easy to manage, even as the number of users or gates increases. Mobile application shown in **Figure 8 and Figure 9.**

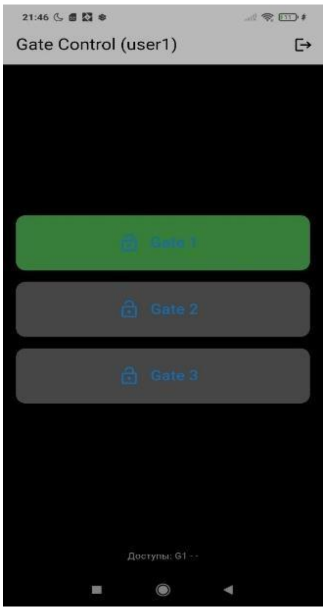

Figure 8: User panel

Figure 9: Admin panel

Prototype 0003:

The project is integrated with a smart home system. When the alarm is triggered, the gate remains closed until the owner deactivates the alarm. This ensures additional security by preventing unauthorized access while the alarm is active. Shown in **Figure 10.**

Figure 10: Gate with Smart home

Testing & Results

The system was tested in several stages to confirm the correct operation of each component and the complete gate mechanism. The ultrasonic sensor successfully detected approaching objects at distances between 5–25 cm, and the Arduino responded consistently by activating the servo motor. When the sensor measured a distance of 25 cm, the servo rotated 180° to open the barrier. After a 5-second delay, it returned to 90°, closing the gate.
Additionally, the Bluetooth module HC-05 was tested using a mobile application. The gate responded reliably to remote open/close commands.

Overall, the prototype demonstrated stable performance and confirmed the functionality of both automatic and remote-control modes.

Discussion

During testing, the prototype revealed several limitations and practical issues. The ultrasonic sensor occasionally produced inconsistent readings, especially when detecting soft or angled surfaces, because sound waves were absorbed or deflected. Connections on the breadboard and with jumper cables worked for testing but proved fragile and unsuitable for long-term or heavy-duty use.

The Bluetooth communication via the HC-05 module performed well indoors, allowing smooth remote control, but the signal weakened significantly through walls and over longer distances. Despite these minor limitations, the system performs its intended functions excellently

Conclusion & Future work

The project successfully demonstrated a functional small-scale automated gate system using Arduino, an ultrasonic sensor, a servo motor, and Bluetooth control. The prototype confirmed that object-based detection and mobile app control can be combined in a compact and efficient design.

Future improvements may include replacing the SG90 servo with a stronger motor, adding weatherproof housing, integrating Wi-Fi for longer-distance control, and using more stable hardware instead of a breadboard. These upgrades would allow the system to operate outdoors and handle heavier mechanical loads.

References

Bibliography

Suarta, I. M. e. a. *A Design and Implementation of Simulation of Microcontroller-Based Automatic Gate Opening System Practice Module Using Fingerprint Control..*
Available at: https://www.sciencepublishinggroup.com/article/10.11648/j.ajmie.20230803.12
[Accessed 08 December 2023].

Bibliography

Bhandari, P. *Feasibility Study of MEWA Khola Hydro Power Project. ResearchGate..*
Available at: https://www.researchgate.net/profile/Prajwal-Bhandari/publication/362232029_Feasibility_Study_of_MEWA_Khola_Hydro_Power_Project/links/62de7995aa5823729ee0b4fa/Feasibility-Study-of-MEWA-Khola-Hydro-Power-Project.pdf
[Accessed 08 December 2022].

Bibliography

Hasibuan, A. R. R. &. T. D. S. *Design and Development of an Automatic Door Gate Based on Internet of Things Using Arduino Uno..*
Available at: https://bcsee.org/index.php/bcsee/article/view/design-and-development-of-an-automatic-door-gate-based-on-intern
[Accessed 08 December 2021].

Bibliography

Okiandri, D. &. S. S. *Control System Design Using Automatic Gates on Arduino RFID.*
Available at: https://ejournal.uniramalang.ac.id/index.php/g-tech/article/view/643
[Accessed 08 December2021].

Bibliography

Sarkar, A. D. A. R. A. R. S. R. A. &. R. K., б.д. *Automatic Signal and Gate System..*
Available at: https://www.ijraset.com/research-paper/automatic-signal-and-gate-system
[Accessed 08 December 2023].

Appendices

The video presents prototype 0002, which has been successfully connected to our mobile application. The demonstration confirms that the barrier operates correctly and all system components function reliably. **Link given in Link 1.**

https://youtube.com/shorts/VjqvtiLa3Ic?si=5AHMJGDddPtonA9i **– Link 1.**

The video presents prototype 0003, in which we successfully integrated the barrier with the smart home system. **Link given in Link 2.**

https://youtube.com/shorts/-ub4HDtwXT0?si=xERXIOegROzOoiwP **– Link 2.**

The advantages of prototype 0003 are shown in **Table 4.**

Feature	**Prototype 0002**	**Prototype 0003**	**Advantage of 0003**
Smartphone Control	Yes	Yes + smart home app control	More convenient and flexible
Access Security	Basic user/card check	Enhanced smart home verification + logs	Higher security and tracking
Logs & Monitoring	Minimal	Full monitoring via smart home	Better admin control
Connection Reliability	Standard	Stable smart home network	Fewer lags and failures
Notifications	No	Push notification	Shows who used it
Multi-Barrier Sync	Manual	Automatic via smart home system	Easier multi-gate management

Table 4: Advantages of prototype 0003

The final result can be viewed by scanning **QR code 1**.

QR-code 1: Final Result

You can reach our GitHub repository with the project code by scanning **QR code 2**.

QR-code 2: GitHub repository

Final View

This project was an exciting journey into the world of automation. We successfully built and tested two small-scale automated gate prototypes, each with its own unique strengths. Prototype 0002, controlled via a mobile app over Bluetooth, worked exactly as intended: the ultrasonic sensor reliably detected objects, the servo smoothly opened and closed the gate, and the system responded instantly to remote commands. Watching it work for the first time was a real thrill it was incredible to see theory come alive in such a tangible way.

Prototype 0003 took things a step further by connecting the gate to a smart home system. Suddenly, the gate wasn't just responding to our phones it became part of an ecosystem, reacting to smart home routines and even voice commands. This part of the project really highlighted the potential of combining small-scale hardware with modern home automation. It was inspiring to see how much could be achieved with relatively simple components.

Through this project, we achieved all our goals: demonstrating automatic, object-based operation, enabling remote and smart home control, and ensuring that both prototypes worked reliably and stably. Of course, we also discovered areas for improvement: stronger motors, a dedicated PCB, weatherproofing, Wi-Fi integration, and enhanced security features would make the system even more impressive and ready for real-world use.

Overall, this project was not just about building a gate it was about learning, experimenting, and bringing ideas to life. The final prototypes are not only functional and educational but also a source of pride and excitement. They show clearly how automation principles can be applied in real life and provide a solid foundation for future exploration and innovation.