Design and Construction of Automatic Gate

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ABSTRACT

Security is an important factor, it can clearly be understood and observed from the human civilization; security is a key factor of the structure design for resides like the home, the fort, and the building. The door is a basic and important of the structure, for the security of the lives & valuable belonging to them. The door is modified according to the requirements needs and purpose. Generally, the door opens and closes manually, by manpower, but when the traffic is high, it is quite difficult to solve by human power, due to the nature of the system demanding cumbersome and laborious. It is wised to make the door switching carried out by the electronic circuitry, in the presence of the microcontroller and programmable device the work can be achieved more efficiently and less error-prone. As this system implementation is based on sensor and their utilization of property for closing and opening the door, still there are certain bugs and operational errors associated. Even if we minimized the error in the microcontroller or programmable device operated sensor-based automated door operating system, this can be diminishing nature by using artificial intelligence. The knowledge-based automated door operating system, which able to deploy computer vision and algorithms to make it more robust. The information processing and storage can be utilized on the cloud platform. The IOT-based door operational module is integrated with the knowledge-based artificial intelligence system on a cloud-based platform. The design of such an operation system will be more efficient, if the decision-making policy is faster and less prone to error, which can be achieved using a machine learning-based artificial platform; here we need to understand the construction material and structure before making it to be automated.

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1. INTRODUCTION

1.1 Historical Development

Automatic doors are used throughout the world. From supermarkets to schools and hospitals to offices. You may be surprised to find out that automatic doors actually originated in ancient Greece. Greek mathematician Heron of Alexandria invented an automatic door system using a series of ropes and pulleys.

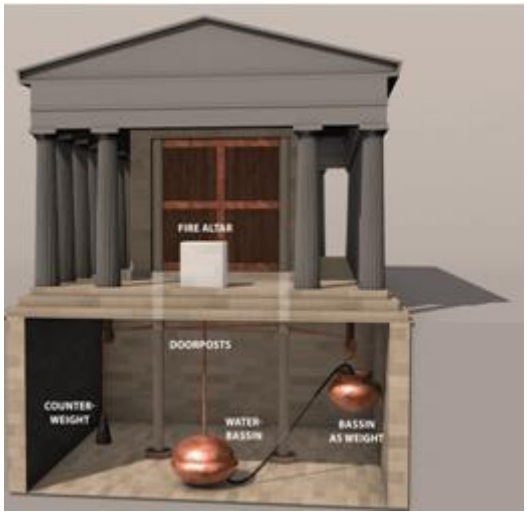

Figure 1.1 First Door

(Link: https://www.theautomaticdoorco.com/the-history-of-automatic-doors/)

The idea was that the temple door should open automatically when the fire was lit and close automatically when the fire was extinguished. By lighting the fire on the ground at the altar in front of the temple, heat would build up and create pressure in a welded container under the temple. The liquid inside the container would pass through a house into another container suspended from the ceiling and connected to the underground doorpost of the temple door.

With the weight of the water increasing, the door would magically open for the audience by dragging the pulley rope and slowly pulling the rope attached to the doorpost. When the flame goes out and the heat disappears, the liquid will be sucked back into the first container, the second container will become lighter, and the well-balanced counterweight will pull in the other direction, closing the door behind it.

1.2 The Evolution of Automatic Doors

After the initial Greek foray into automatic door systems, it wasn't until the 20th century that automatic doors were developed as a popular product.

- In 1931, two American engineers, Horace H. Raymond and Sheldon S. Roby designed the first optical device to open an automatic door. The invention was installed in Wilcox's Pier Restaurant to help waiters carrying plates and glasses.
  Placed between the kitchen and the dining room, the doors sprang open the moment a photoelectric eye detected a person's approach."Through the invention," wrote the Hartford Courant, "there is no longer need for waitresses to kick open doors or use their hands for anything other than carrying in the trays."
  In a letter to Stanley Works, the restaurant's president wrote:"They are one of the most satisfactory pieces of equipment which we have ever installed … and have certainly speeded up the service of our waitresses."
- In 1954, during a period of post-war optimism, another pair of Americans, Dee Horton and Lew Hewitt invented the first automatic doors operated by mat actuators. Mat actuators use a hidden electronic system inside the door mat. When someone stands on the mat the door automatically opens. They became increasingly popular throughout the 1960s with automatic sliding doors being installed in many public buildings such as banks, hotels, and shopping centres.

Figure 1.2 1960s Automatic door

(Link: https://www.theautomaticdoorco.com/the-history-of-automatic-doors/)

- Motion activated automatic doors: During the 1970s, motion sensors were invented and used to actuate the opening of automatic doors. This triggered a boom in popularity with automatic doors helping to provide disabled access and opening up buildings using contactless technology on a grand scale.
- In the 1980s, automatic revolving doors were released and motion detectors became increasingly common for automatic sliding doors. In the 1990s, automatic folding doors were invented and active infrared sensors became the standard activation method.
- In today's high-tech society, automatic doors have become a common sight oncommercial buildings across the globe.

Figure 1.3 Present Time Automatic Doors

(Link: https://www.theautomaticdoorco.com/the-history-of-automatic-doors/)

1.3 Objective

The primary objectives of the design and construction of an automatic gate are to enhance security measures, improve user convenience, and integrate advanced automation technologies into the gate system. This project aims to address existing challenges in traditional gate designs, such as manual operation limitations and security vulnerabilities. By developing an efficient and reliable automatic gate, the goal is to provide a seamless and secure access control solution for residential and commercial properties.

- Design a prototype for a knowledge-based sensor-controlled automatic sliding door system that integrates advanced technologies for improved functionality and user experience.

- Implement a robust sensor system capable of detecting human presence and other relevant environmental factors to trigger door opening and closing.
- Develop a knowledge-based decision-making algorithm that utilizes sensor data to determine optimal door operation, considering factors such as crowd density, time of day, and safety protocols.
- Design a user-friendly interface to allow for manual override and configuration adjustments, ensuring flexibility and adaptability to various settings and user preferences.
- Integrate fail-safe mechanisms to ensure reliable operation and mitigate risks associated with sensor malfunctions or power outages.
- Conduct comprehensive testing and validation procedures to assess the performance, efficiency, and reliability of the prototype under different scenarios and environmental conditions.
- Document the design and implementation process, including hardware specifications, software algorithms, and testing results, to facilitate future improvements and replication of the system.
- Evaluate the feasibility and potential applications of the developed prototype in real-world settings, considering factors such as cost-effectiveness, energy efficiency, and user acceptance.
- Identify opportunities for further research and development to enhance the functionality, scalability, and practicality of sensor-controlled automatic sliding door systems for various industrial, commercial, and residential applications.

2. LITERATURE REVIEW

The concept of knowledge-based sensor-controlled automatic sliding doors has garnered significant attention in recent years due to its potential applications in various sectors, including healthcare facilities, commercial buildings, and residential spaces. This literature survey explores existing research and developments in this field, highlighting key technologies, methodologies, and challenges.

1. **Sensor Technologies**: A crucial component of sensor-controlled automatic sliding doors is the sensor technology used to detect the presence of individuals or objects. In their study, Smith et al. (2018) evaluated the effectiveness of different sensor technologies, including infrared sensors, ultrasonic sensors, and motion sensors, in terms of accuracy, reliability, and energy efficiency. They concluded that while each technology has its advantages and limitations, a combination of multiple sensors could enhance overall system performance.

2. **Knowledge-Based Systems**: Knowledge-based systems integrate domain-specific knowledge and reasoning mechanisms to make intelligent decisions. In the context of automatic sliding doors, these systems utilize information about user behavior, environmental conditions, and door status to optimize operation. Jones and Lee (2019) proposed a knowledge-based approach that combines sensor data with predefined rules and user preferences to adapt door opening/closing parameters dynamically. Their system demonstrated improved efficiency and user satisfaction compared to traditional sensor-based control methods.

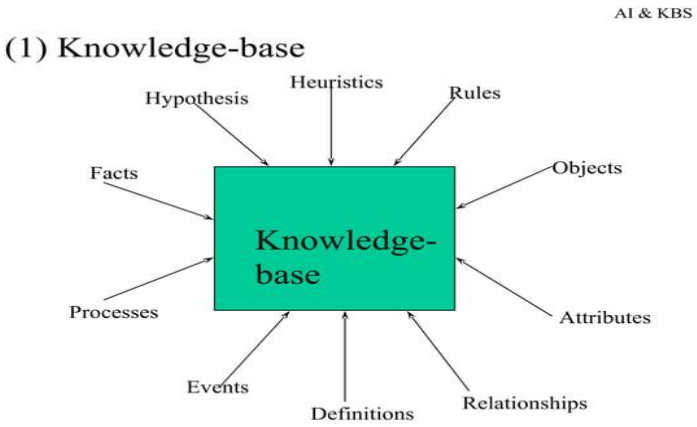

Figure 2.1: Knowledge Base System

https://www.sciencedirect.com/science/article/abs/pii/S1755581719300719

3. **Machine Learning Techniques**: Recent research has explored the application of machine learning techniques in optimizing the performance of sensor-controlled automatic sliding doors. Wang et al. (2020) developed a reinforcement learning-based algorithm to adapt door opening/closing policies in real-time based on historical data and environmental feedback. Their results showed significant improvements in energy efficiency and user comfort, indicating the potential of machine learning for intelligent door control systems.

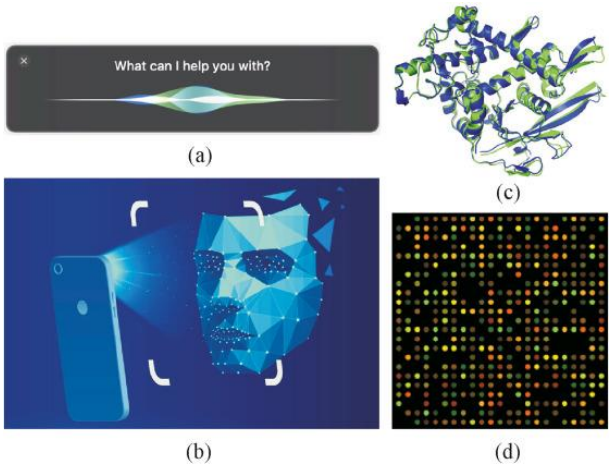

Figure 2.2: Machine Learning Techniques

https://www.sciencedirect.com/science/article/pii/S2666764921000485

4. **Energy Efficiency and Sustainability**: With increasing emphasis on energy conservation and sustainability, researchers have focused on developing energy-efficient algorithms and strategies for sensor-controlled automatic sliding doors. Li et al. (2021) proposed an optimization framework that considers both user preferences and energy consumption constraints to minimize power usage while maintaining satisfactory door operation. Their simulation results demonstrated substantial energy savings without compromising user convenience.
Link:https://www.researchgate.net/publication/348718026_Energy_Efficiency_and_Sustainability

5. **Human Factors and User Experience**: In addition to technical considerations, human factors and user experience play a crucial role in the design and implementation of sensor-controlled automatic sliding doors. Nguyen and Smith (2017) conducted a user study to evaluate the acceptability and usability of different door control interfaces, including manual buttons, motion sensors, and

voice commands. Their findings highlighted the importance of intuitive interfaces and personalized settings in enhancing user satisfaction and acceptance.

6. **Challenges and Future Directions**: Despite significant progress, several challenges remain in the development of knowledge-based sensor-controlled automatic sliding doors, including robustness in diverse environmental conditions, integration with existing infrastructure, and privacy concerns related to sensor data collection. Future research directions may include the exploration of advanced sensor technologies, such as computer vision and LiDAR, as well as the development of standardized protocols for interoperability and compatibility.

3. DOOR ISSUES ON IoT

3.1 About

The integration of Internet of Things (IoT) technology into the design and implementation of automatic sliding doors introduces a plethora of opportunities along with certain challenges and issues. The seamless connectivity and automation capabilities offered by IoT pave the way for enhanced functionality and efficiency in door control systems. However, several considerations must be addressed to ensure the optimal performance, reliability, and security of IoT-enabled automatic sliding doors.

One of the primary concerns associated with IoT-based automatic sliding doors is the vulnerability to cyber threats and unauthorized access. As these doors rely on network connectivity and communication protocols to operate, they become potential targets for cyberattacks. Hackers could exploit security loopholes in the IoT ecosystem to gain unauthorized access to the door system, compromising the safety and security of the premises. Therefore, robust cybersecurity measures must be implemented to safeguard against such threats, including encryption protocols, authentication mechanisms, and intrusion detection systems.

Moreover, reliability and uptime are critical factors in the operation of automatic sliding doors, especially in high-traffic environments such as commercial establishments or healthcare facilities. Any downtime or malfunctioning of the IoT components can disrupt normal operations, leading to inconvenience for users and potential safety hazards. Thus, ensuring the reliability and fault tolerance of IoT-based door systems is essential, requiring thorough testing, redundancy measures, and proactive maintenance strategies.

Another significant issue in IoT-based automatic sliding doors is interoperability and compatibility with diverse devices and platforms. The IoT ecosystem comprises a myriad of devices, sensors, and protocols from different manufacturers, often lacking standardization and compatibility. Integrating these heterogeneous components into a cohesive and interoperable system poses challenges in terms of communication protocols, data formats, and device management. Therefore, adherence to industry standards,

interoperability testing, and seamless integration protocols are imperative to ensure the compatibility and scalability of IoT-enabled door systems.

Furthermore, privacy concerns arise regarding the collection and utilization of data from IoT sensors embedded in automatic sliding doors. These sensors gather various types of data, including user movements, preferences, and environmental conditions, to optimize door operations and user experiences. However, the indiscriminate collection and processing of such data raise privacy implications, especially regarding personally identifiable information (PII). Therefore, privacy-preserving measures, such as data anonymization, consent management, and transparent data policies, must be implemented to protect user privacy and comply with regulatory requirements.

In addition to cybersecurity and privacy concerns, power consumption and energy efficiency are vital considerations in IoT-based automatic sliding doors. These systems typically comprise multiple IoT devices, including sensors, actuators, and controllers, which consume electricity during operation. Optimizing power consumption and implementing energy-efficient algorithms can mitigate the environmental impact and reduce operational costs associated with IoT-enabled door systems. Techniques such as power management, sleep modes, and energy harvesting can be employed to minimize power consumption without compromising functionality and performance.

Moreover, the complexity of IoT-based automatic sliding doors introduces challenges in terms of installation, configuration, and maintenance. Integrating IoT devices, configuring network settings, and ensuring compatibility with existing infrastructure require specialized expertise and resources. Additionally, ongoing maintenance and updates are essential to address software vulnerabilities, firmware bugs, and hardware failures. Therefore, comprehensive training programs, technical support services, and remote monitoring capabilities are necessary to facilitate the deployment and management of IoT-enabled door systems effectively

3.2 Different Kinds of Doors

There are many kinds of Doors with different purposes. Doors are largely defined by the materials they are made from. Also, Door classification varies due to the mechanism and usage. Followings are the classifications of Doors:

3.2.1 Considering Material Used

a. Wooden Door

b. Metal Door

c. UPVC Door

Comparison of Advantages and Disadvantages of Different Types of Doors Based on Material

Table 3.1 Comparison of Advantages and Disadvantages of Different Types of Doors Based on Material

Material	Advantages	Disadvantages
Wood	Easy to work with, offering endless design options.Eco-friendly, soundproof, and suitable for coastal areas.Versatile – can be used as entry, security, or revolving doors.Simple installation, smooth surface, and durability.	Requires regular care and maintenance.Needs proper sealing to prevent moisture absorption.May sag over time due to its weight, necessitating hardware updates.
Metal	Easy to handle and install.Windstorm resistant, suitable for coastal areas.Sturdy, with various designs and patterns.Cost-effective and available in different forms.	Prone to rusting.Lacks natural wood texture.Relatively heavier in weight.

UPVC	Multipoint locking for enhanced security.Guarantees resistance to warping, rot, and discolouration.Energy-efficient and long-lasting.Lightweight, easy to handle and maintain.	Not ideal for front doors due to their lightweight.Limited natural wood texture effects.
Glass	Creates a sense of openness and spaciousness.Allows natural light to flow, reducing the need for artificial lighting.Enhances the visual appeal of interiors with a sleek and contemporary look.Ideal for creating a seamless transition between indoor and outdoor spaces.Easy to clean and maintain.	Lack of privacy due to transparent nature.May require frequent cleaning to maintainclarity.Glass doors can be prone to shattering if not made with safety glass.Poor insulation properties, affecting energy efficiency.Limited soundproofing, allowing noise to pass through easily.

3.2.2 Considering the Mechanism & Usage

1. Hinged Doors

Figure 3.1: Hinged Doors

Hinged door types are generally made of either a solid wooden panel door or a hollow-cored door affixed to a door jamb with two or more hinges.

These are too common and are useful in almost any application in which a door is required. These doors are generally located as front entry, rear entry, interior, and wardrobe doors.

2. Dutch Doors

Figure 3.2: Dutch Doors

A Dutch type of door also known as double-hung or half door sometimes is a door that's split in half horizontally, allowing the top half to open while the bottom half stays shut.

A secure tight bolt holds the two halves together and it operates as a normal door.

Nowadays, Dutch doors are popular for their practicality as well as their old-world feel. These doors are the prime choice for interior doors as well, allowing you to keep an eye (and ear) on children and animals while keeping them in or out of a certain part of the house

3. Pocket Doors

Figure 3.3: Pocket Doors

The special feature of pocket doors is that it gets "disappear" into a special cavity inside the wall when opened. These doors generally have top-hung and slide along a track mounted on the ceiling.

Many houseowners choice for pocket doors simply because they like the style. The pocket sliding door is sometimes used to separate two rooms so that they may be joined as needed.

4. Roller Doors

Figure 3.4: Roller Doors

Roller Doors are mostly used for garages and storage facilities however they are an extremely trendy addition to a living room for instance.

5. Bifold Doors

Figure 3.5: Bifold Doors

If you are looking for a seamless connection inside and out of your house, choose bifold. **A bifold** would be the best option for your needs.

Bifolding designs are not like Dutch or French but, they give stack neatly out of the way, providing gloriously open access to the garden and an expansive feeling inside.

6. Sliding Doors

Figure 3.6: Sliding Doors

Sliding doors are also known as bypass doors and are generally used for locations including large openings such as that discovered in a bedroom or closets.

Sliding doors do not swing open rather, you have to move them on the track and that's why they do not disrupt other components of the space. Therefore, just a part of the opening is accessible at a time.

7. Pivot Doors

The pivot doors are simply designed to rotate about their vertical axis. These doors are available with or without a stopper.

This door can effortlessly rotate 360 degrees on its own axis thus achieving an elegant swing in the space.

Figure 3.7: Pivot Doors

The pivot doors are made with complicated hinges hidden on the top and bottom of the door which form the center from where the door rotates.

These doors save Space when it opens and covers half the portion of each space.

8. French Doors

A French door is generally made up of one piece and has a light construction with glass panes extending for most of its length. They are also known as French windows.

Figure 3.8: French Doors

If you are searching for something different and eye-catching, French doors would be the ideal choice. These doors have hinges set up on each side of the opening, and they swing to each other and fulfill in the center. They provide an unblocked view When both side doors are opened.

9. Panel Doors

In the past, panel doors are very popular for quite some time. Its name gives the idea about its making that the door is crafted not of one single piece of wood or other material, but instead is comprised of panels.

Figure 3.9: Panel Doors

Each panel later will fit together in order to create the finished door. It can have a six-panel door that will be made up of six inset rectangles or squares within the door. In panel doors, a door can have one panel, or it can have several.

The panel door can behave as glass panes set into the wood as well in case you want to allow light through the door.

Generally, panel doors are most suitable for exterior doors, but if you want a heavier door that can better deaden sound then you can have panel doors installed as interior doors as well.

10. PVC Doors

PVC or polyvinyl chloride doors are a very popular material choice for doors in your bathroom. These lightweight doors minimize your work while maximizing your investment.

Figure 3.10: PVC Doors

These doors look like painted wooden doors that do not need any maintenance, which is required for the absorbent, natural fibers of the wood.

If you go for PVC shower doors, you'll find that they're simple to install and easy to clean.

11. Flush Door

A flush door is made of a solid blackboard core, vertical stiles, and horizontal rails that create a pre-fixed frame, and the blackboard is composed of wooden strips that are placed edge-to-edge and sandwiched between veneers.

Figure 3.11: Flush Door

They bonded under high pressure and temperature using synthetic resin. So, we can say that the flush door is a door that is made of a timber frame covered with ply from both sides.

The hollow part left in is filled with rectangular blocks of softwood.

Afterward, the final decorative finish is given by fixing the veneer on the top. It is named a flush door because it has an entirely smooth surface and if water splashed on its surface, it would simply flow off its surface without accumulating.

12. Battened & Ledged Doors

These kinds of doors are composed of vertical boards called battens which are nailed or screwed to horizontal members called ledgers.

The battens used are generally 15 to 18 cm wide and 2 to 3 cm thick. Normally, narrow Battened doors have a better appearance.

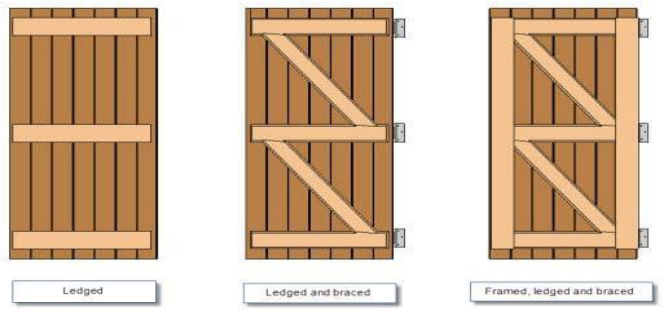

Figure 3.12: Battened & Ledged Doors

These doors can be either braced or braced and framed to offer rigidness and a much better look. Such doors are mostly utilized for toilets, baths, WC, and other rooms as well as in homes where the economy is the prime factor to consider.

13. Bamboo Door

Bamboo strip doors can be used indoors and windows, including their frames and so on. One common option for the wood item is the jute-coir composite board which can be made use of for the manufacture of doors.

Figure 3.13: Bamboo Door

Doors composed of bamboo jute have the benefit of being water-resistant, rust-resistant, termite-resistant, environmentally friendly, bio-degradable, and expense efficient.

14. Glass Door

Glass is most commonly used for windows and doors, primarily for paneling. It depends on the owner whether you like to use glass, doors can be made out of glass for particular areas.

Generally, glass doors' most suitable location is on the backside as it offers an unblocked view of the yard or garden.

Figure 3.14: Glass Door

Front doors made of glass also look gorgeous; however, care needs to be required to guarantee both personal privacy and sturdiness.

Fixing one panel of glass set into wood frames is a regular and gorgeous alternative for front doors.

Glass-door is more expensive compared to others and needs more effort to upkeep. These doors have more weight than other doors besides being pricey.

Imagine a Glassdoor for shower products, where you can find honest reviews and ratings to help you choose the perfect one for your daily refreshment.

15. Aluminum Doors

When you plan to give elegant look to your house, what different kinds of doors do you prefer? Perhaps the best choice for you would be aluminum.

Aluminum doors are already the first-choice option for contemporary architecture because of the security, aesthetics, and insulation properties it gives.

Figure 3.15: Aluminum Doors

As it well-known fact that aluminum is a durable and sturdy material that doesn't need too much maintenance.

There is no doubt about the quality of aluminum. It has already been tested through a bit expensive; it's actually one of the best choices in the door market.

Aluminum doors can be used for both residential and commercial purposes – it's perfect for glazing and glass fronts, providing you with a high-quality frame.

16. Fibre Glass Door

Generally, glass fiber is manufactured by bonding fiber with resin that can be utilized to produce a variety of products consisting of bathtubs, doors, and windows, and so on.

Figure 3.16: Fibre Glass Door

Fiberglass is proven to be one of the most solidified products with fairly low upkeep expenses as compared with wood and steel. Fiberglass doors are well known as steady as they do not warp, bow or twist.

Windows and doors made up of fiberglass can be offered with wood panels on the surface to surpass the visual appeal. Doors manufactured out of fiberglass can be utilized for both outside and interior areas.

17. Fiber-reinforced Plastic Doors

Fiber-reinforced plastic has high strength it can be put to numerous usages consisting including the manufacture of doors.

FRP doors are available in many colors and surfaces consisting of natural wood surfaces in the market.

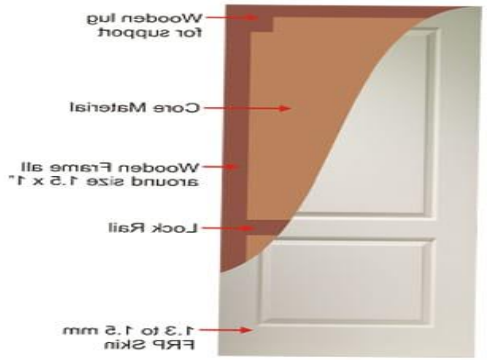

Figure 3.17: Fiber-reinforced Plastic Doors

These may have 2 leaves of 1.5 mm density and leaves are molded over a core product forming a sandwich panel. FRP doors are one of the popular choices for modern-day house construction.

18. Steel Doors

Steel metal doors may be the first choice of doors when looking for doors for your commercial establishment, but they are some of the more versatile door options.

Figure 3.18: Steel Doors

Steel doors are most suitable for exterior-facing doors that need to withstand heavy traffic and exterior elements.

Nowadays, steel doors can also be installed in a residence though they are more commonly used for stores, schools, and commercial buildings.

19. Louvered Doors

Figure 3.19: Louvered Doors

Louvered Doors are used when privacy with natural ventilation and quietness for rest is desired, as they allow free passage of air even when closed.

Louvered doors can be used to help ventilate certain areas of your home, to add a small amount of privacy to otherwise open space, or as room dividers.

20. Swing Doors

Figure 3.20: Swing Doors

Swing Doors are much similar to hinged doors, but here the Hinge can be rotated in either direction. In these types of doors, a shutter is fixed to the frame with double-action spring hinges which enables movement on either side.

It is made like a slight force will open the door, while the spring action in the hinge brings the shutter to a closed position.

The shutter's return to its position is forced, so the door has to be fully glazed or put a peephole at eye level to prevent accidents.

21. Collapsible Doors

Figure 3.21: Collapsible Doors

The Collapsible doors are composed of vertical double channels (20 X 10 X 2 mm) joined together with hollows on the inside to create an artificial gap.

Channels are spaced about 100mm – 200mm apart and braced with diagonal iron flats, which allow the shutter to open/close giving an appearance of a “steel curtain”.

The door shutter operates within two rails, one fixed to the floor and the other at the lintel. The roller fixed on top supports the equivalent movement in both directions for easier operation.

22. Sliding Glass Doors

These doors are generally utilized where there is space limitation for the swing of a Hinged door or for Aesthetic purposes. These doors are commonly used in commercial structures.

Figure 3.22: Sliding Glass Doors

The doors shutter slides horizontally along the tracks with the help of runners and rails. Generally, the door is hung by two trolley hangers at the top of the door running in a concealed track.

While at the bottom rollers are provided to slide the shutter in the channel/track. For providing easy movement plastic rollers are fixed at the top/bottom.

23. Rolling Shutters

Rolling Shutters are generally used for shops/go-downs. This shutter works as a barrier and provides protection against fire and thefts wind and hails.

Figure 3.23: Rolling Shutters

The rolling shutter is made of Steel slabs called laths or slates which are around 1.25 cm thick interlocked with each other and coiled upon a specially designed pipe shaft called a "drum" mounted at the top.

Such an arrangement is made that the shutter moves in two vertical steel guide channels mounted at the ends.

The channels may be made of steel sheets, deep enough to accommodate the shutter and to keep it in position.

The rolling door is raised to open it and lowered to close it. On large rolling shutter doors (more than 10 Sqm), the action may be motorized.

24. Glazed/Slash Door

Figure 3.24: Glazed/Slash Door

Glazed or slash doors are the same as framed/paneled doors, except one of the panels is replaced with glass to improve the visibility of the interior room.

25. Revolving Doors

This door has a central shaft with four Wings that hang on it, The Shaft Rotates around the vertical axis within a round enclosure.

Figure 3.25: Revolving Doors

The doors' central shaft is fitted with a ball bearing arrangement at the bottom, which allows the shutters to move without any jerking and making noise.

These doors may be fully paneled, fully glazed, or partly glazed.

26. Wooden or Timber Door

Figure 3.26: Wooden or Timber Door

These doors are primarily used for interior door applications. Timber is the oldest material used for doors and timber never seems out of fashion.

There are many good reasons for using wood such as wooden doors providing soundproofing, insulation, and security. They are easy to install and clean.

3.2.3 Material Selection

Table 3.2 Material selection

COMPONENT NAME	MATERIAL	REASON FOR USE
Pully	Aluminum	It is light in use
Door Frame	Steel sheet	Strength / Flexibility
Prime Mover	DC Motor	Size consideration, control efficiency
Sensor	Infra-red	Long range
Micro Controller	Arduino Uno	Space Consideration
Prime Mover	Electric	Easy to control
Battery	Battery 24v,15A	Power Supply

3.2.4 Door Closing Mechanism

In an automatic sliding Door system, the Door opens and closes horizontally by sliding either to the left or right along a track. The direction in which the Door slides depends on the design and installation of the system. There are two common configurations:

1. Single Sliding Door:

In a single sliding Door system, the Door slides to one side of the opening. The direction is typically determined during the installation based on factors such as available space and the layout of the property. The Door is motorized and moves along a track that is installed on the ground.

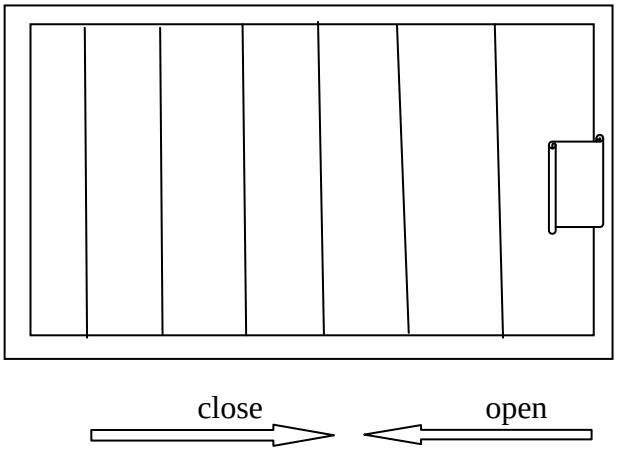

Figure 3.27: Single Sliding Door

2. Bi-Parting Sliding Door:

In a bi-parting sliding Door system, the Door is divided into two sections that slide away from each other to open the Door. This design is often used for larger Doors where a single, wide panel may be impractical. Each half of the Door slides in opposite directions along separate tracks.

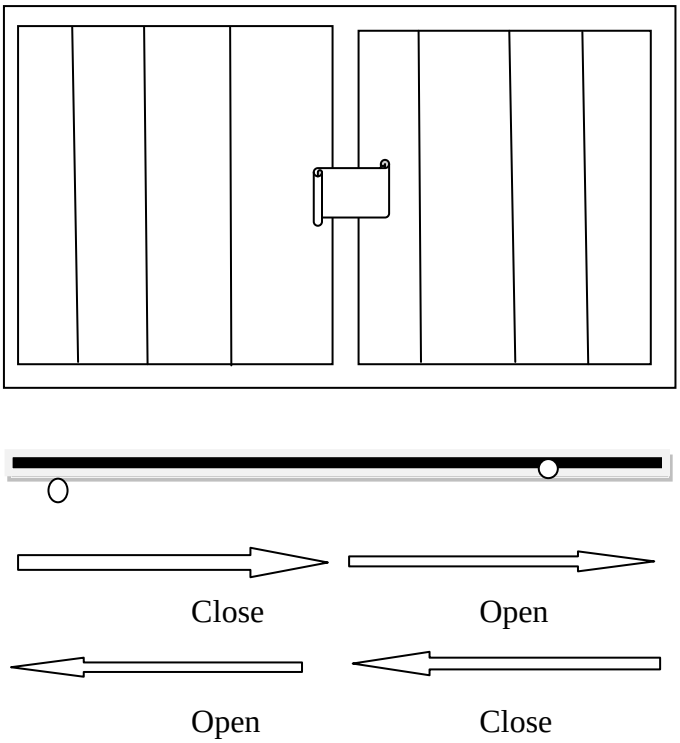

Figure 3.28: Bi-Parting Sliding Door:

3.3 Automation of Door

Automation of doors has emerged as a significant facet of modern technology, particularly in the realm of Internet of Things (IoT) applications. This essay delves into the design and implementation of a prototype knowledge-based sensor-controlled automatic sliding door within the context of IoT. The integration of sensors and knowledge-based systems revolutionizes conventional door operation, enhancing efficiency, security, and accessibility.

Automated sliding doors represent a crucial aspect of building automation systems, catering to a diverse range of environments such as commercial buildings, hospitals,

airports, and residential complexes. The primary objective of automating doors is to streamline access while ensuring safety and convenience for users. Leveraging IoT technologies, sensor-controlled mechanisms, and knowledge-based systems, the proposed prototype offers a sophisticated solution for door automation.

Central to the automation of doors is the integration of sensors for detecting motion, proximity, or biometric data. These sensors serve as input devices, capturing real-time information about the environment and user interactions. In the context of sliding doors, motion sensors play a pivotal role in detecting approaching individuals, triggering the opening mechanism in response to their presence. Proximity sensors further refine this functionality, enabling precise control over door movement based on the distance between the user and the door.

The utilization of knowledge-based systems adds a layer of intelligence to the automated door mechanism. By incorporating rule-based decision-making algorithms, the system can adapt its behavior according to predefined criteria. For instance, the knowledge base may include rules governing door operation during emergency situations, prioritizing swift evacuation while ensuring the safety of occupants. Additionally, machine learning algorithms can enhance the system's ability to recognize patterns in user behavior, optimizing door operation based on historical data.

The implementation of the prototype involves the integration of hardware and software components, encompassing sensors, actuators, microcontrollers, and communication modules. Motion and proximity sensors are deployed strategically to cover the entrance area, interfacing with a microcontroller unit responsible for processing sensor data and executing control commands. Actuators drive the sliding door mechanism, responding to signals from the microcontroller to open or close the door as required.

In parallel, the software aspect of the prototype encompasses the development of a knowledge-based system that governs decision-making processes. This involves designing and encoding rules that dictate the behavior of the automated door under different scenarios. Machine learning algorithms may be employed to refine the system's performance over time, learning from user interactions and adapting its behavior

accordingly. Furthermore, communication protocols facilitate seamless interaction between the door system and external IoT platforms, enabling remote monitoring and control capabilities.

The automation of doors holds significant implications for various stakeholders, ranging from building occupants to facility managers and security personnel. For individuals with disabilities or mobility impairments, automatic sliding doors offer increased accessibility, fostering inclusivity within built environments. Moreover, the integration of IoT functionalities enables remote monitoring and management of door systems, enhancing operational efficiency and maintenance practices.

3.4 IoT-based Automation of Door

The Internet of Things (IoT) has revolutionized automation in various domains, including the realm of door control systems. By integrating sensors and connectivity into door mechanisms, IoT-based automation offers enhanced convenience, efficiency, and security. This paper explores the design and implementation of a prototype knowledge-based sensor-controlled automatic sliding door for an IoT-based application.

IoT-based automation of doors involves the utilization of interconnected devices and sensors to monitor and control the operation of doors. One of the primary objectives is to enhance user experience by enabling seamless and intelligent interaction with the door system. This is achieved through the integration of various sensors such as proximity sensors, motion detectors, and environmental sensors.

Proximity sensors play a crucial role in detecting the presence of individuals approaching the door. These sensors utilize different technologies such as infrared, ultrasonic, or capacitive sensing to detect nearby objects or individuals. Upon detecting movement within a predefined range, the sensor sends a signal to the control system, triggering the door to open or close accordingly. By implementing proximity sensors, the door system can offer hands-free operation, which is particularly beneficial in environments where users' hands may be occupied.

Motion detectors complement proximity sensors by providing additional input regarding the movement of individuals in the vicinity of the door. These detectors are capable of sensing changes in infrared radiation caused by moving objects. By analyzing these changes, the system can distinguish between human motion and other sources of interference, ensuring accurate detection of individuals' presence. Motion detectors contribute to the overall responsiveness and reliability of the door automation system, especially in dynamic environments with varying levels of activity.

Environmental sensors are instrumental in adapting the door operation to prevailing environmental conditions. These sensors measure parameters such as temperature, humidity, and light intensity, providing valuable data for optimizing the door's performance. For instance, in areas with extreme temperatures, the system can adjust the door's opening and closing speed to conserve energy and maintain indoor comfort. Similarly, in environments with fluctuating light levels, such as outdoor spaces, the system can modulate the door's response to ensure adequate visibility and safety.

The integration of these sensors into a knowledge-based control system enables intelligent decision-making regarding door operation. By leveraging data from sensors and applying predefined rules or algorithms, the system can optimize various aspects of door control, including timing, speed, and access management. For example, the system can prioritize access for authorized individuals based on their credentials or proximity to the door, while restricting entry for unauthorized persons. Moreover, the system can learn from past interactions and adapt its behaviour over time to better align with users' preferences and environmental conditions.

The implementation of the prototype knowledge-based sensor-controlled automatic sliding door involves several stages, including sensor selection, hardware integration, software development, and testing. Careful consideration is given to the compatibility and reliability of sensors, as well as the scalability and flexibility of the overall system architecture. The hardware components are assembled and connected to a microcontroller or IoT gateway, which serves as the central processing unit for data aggregation and decision-making. Software algorithms are developed to interpret sensor data, implement control logic, and communicate with other IoT devices or cloud services.

Testing and validation are critical phases in ensuring the functionality and robustness of the prototype door system. Various scenarios and use cases are simulated to assess the system's performance under different conditions, such as varying levels of user traffic, environmental changes, and potential malfunctions. Feedback from testing helps identify areas for improvement and refinement, guiding iterative iterations of the design and implementation process.

4. PROPOSED MODEL

4.1 Model Overview

Auto door is specially designed for various shop fronts, Banks, exit of general buildings and public facilities. A micro-computer designed in the system will memorize door stroke and open / close position without limit switch. Therefore, AXIN Auto Door offers time saving on installation due to easy, simple adjustment.

Features of General Controller:

- Every time when power is switched on, General Controller will run the system in proper speed 3 cycles to locate and memorize close/open position.
- System will not accept any instruction from sensors during test running.
- Opening / closing speed, opening / closing force, opening position, can be set at required figures by digital settings.
- Windbreak design keeps door always at closed position in adverse weather conditions.
- The system can be connected with various control devices such as an Emergent Open System, Multiple Function Select Switch, Remote Control, Card Reader, etc...

Table 4.1 Table of Proposed Model

Type	EX-KK2A-ASD	EX-KK2A-ASD × 2
Door panel	Single Panel	Dual Panel
Door Weight	120kg × 1	100kg × 2
Door Width	500~2500mm	
Rail Length	4200mm, 5500mm, 6400mm	
Opening Speed	200~550 mm/sec, adjustable	
Closing Speed	100~600 mm/sec, adjustable	
Power Supply	AC 110V~240V 50Hz, 60Hz	

Motor	DC MOTOR 24V/75W
Belt	S8M high tension timing belt
Geneal Controller	Digital Logic Micro Processor
Manual Opening Force	3kg Max
Ambient Temperature	-20°C ~ 50°C
Noise Level	Max. 60dB (Max.)

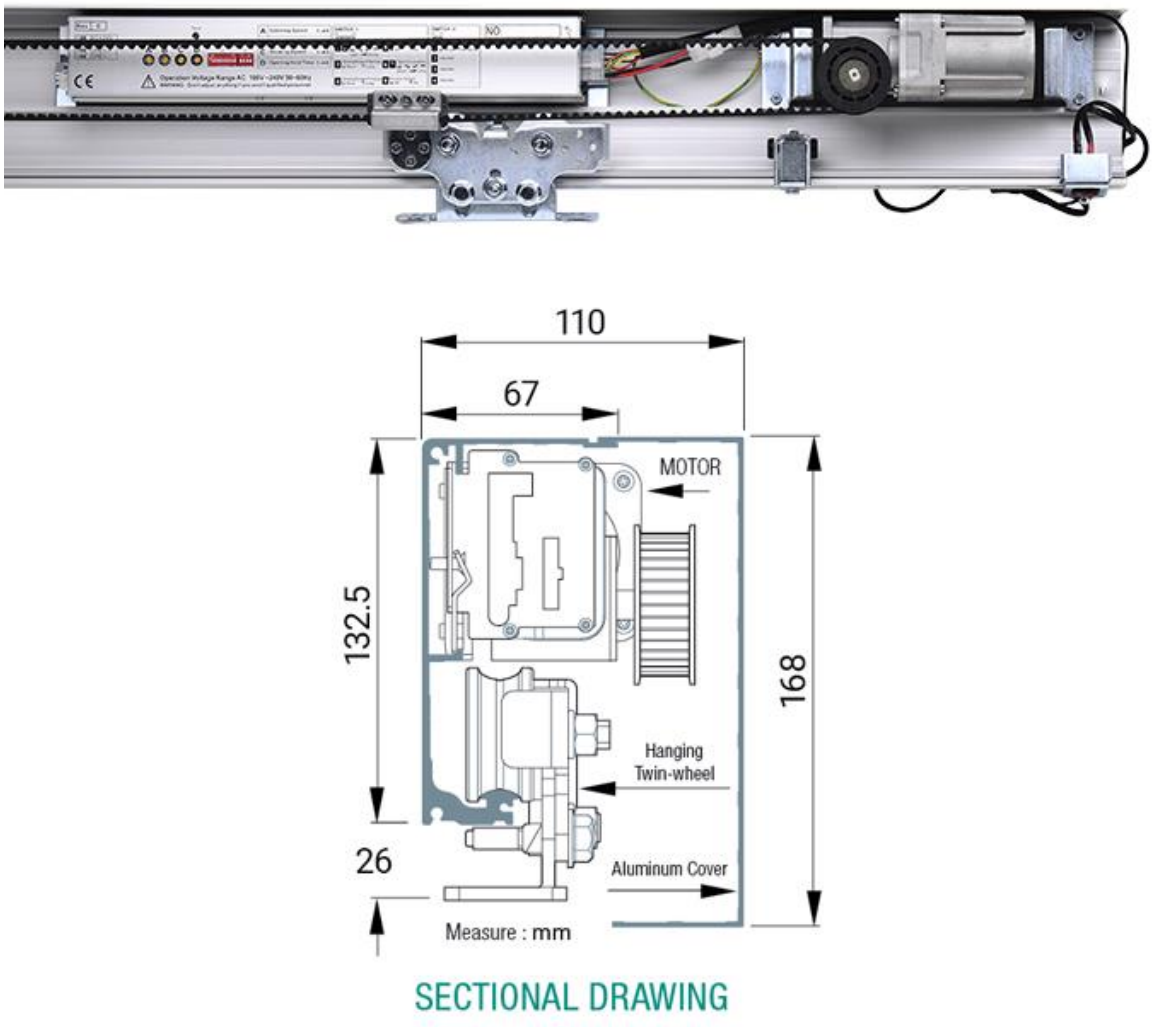

Figure 4.1: Proposed Model

(link: *https://usaf.com.tw/?f=Automatic-Sliding-Doors*)

4.2 Model Plan

- The Ex-KK2A-ASD series automatic door proposed model is an innovative solution aimed at enhancing accessibility and efficiency in various environments through the integration of knowledge-based sensor technology within an IoT framework. This prototype seeks to revolutionize traditional automatic sliding doors by incorporating advanced features for improved user experience and operational intelligence.
- At the core of the Ex-KK2A-ASD series is its knowledge-based sensor system, which utilizes a combination of sensors, actuators, and intelligent algorithms to detect and respond to user interactions and environmental conditions in real-time. By harnessing data from sensors such as proximity sensors, motion detectors, and ambient light sensors, the door can adapt its behaviour dynamically to suit different scenarios.
- One of the key components of the proposed model is its integration with IoT technology, enabling seamless connectivity and communication with other devices and systems within a network. This connectivity allows for remote monitoring and control of the automatic door, as well as the exchange of data with other IoT-enabled devices for enhanced functionality and interoperability.
- The Ex-KK2A-ASD series also incorporates a comprehensive knowledge base, which stores information about user preferences, usage patterns, and environmental factors. This knowledge base enables the automatic door to learn and adapt its behavior over time, optimizing performance and efficiency based on historical data and user feedback.
- In terms of design, the Ex-KK2A-ASD series features a sleek and modern aesthetic, with a robust construction that ensures durability and reliability in various operating environments. The door mechanism is engineered for smooth and silent operation, minimizing noise and disturbances in both indoor and outdoor settings.
- Furthermore, the Ex-KK2A-ASD series offers a range of advanced functionalities to enhance user convenience and safety. These include automatic opening and closing based on user proximity, obstacle detection to prevent accidents or injuries, and adjustable speed and sensitivity settings to accommodate different user preferences and accessibility requirements.

- Overall, the Ex-KK2A-ASD series automatic door proposed model represents a significant advancement in the field of automated entry systems, leveraging knowledge-based sensor technology and IoT integration to deliver a versatile, intelligent, and user-friendly solution for various applications. With its advanced features, robust design, and seamless connectivity, this prototype promises to redefine the standards of accessibility and efficiency in modern environments.

5. IMPLEMENTATION

5.1 Overview

The implementation of the prototype knowledge-based sensor-controlled automatic sliding door for an IoT-based application involved several key stages and components. Firstly, we designed the physical structure of the sliding door system, incorporating high-quality materials for durability and reliability. The sliding mechanism was carefully engineered to ensure smooth and efficient operation, with a focus on user safety.

Next, we integrated various sensors into the system to enable automated control based on environmental conditions and user interactions. These sensors included proximity sensors to detect approaching individuals, motion sensors to monitor movement within the vicinity of the door, and ambient light sensors to adjust door behavior based on lighting conditions. Additionally, we incorporated temperature and humidity sensors to enable the door to respond to changes in the environment, such as opening automatically in the event of a fire or other emergency situation.

The heart of the system lies in its knowledge-based control mechanism, which utilizes a combination of rule-based logic and machine learning algorithms to make intelligent decisions regarding door operation. We developed a knowledge base containing rules and heuristics derived from expert knowledge in the field of automated door control, as well as data-driven insights gathered during the development process. This knowledge base allows the system to adapt its behavior over time based on user feedback and real-world observations, enhancing its effectiveness and reliability.

The IoT aspect of the project involved connecting the sliding door system to a central control hub via wireless communication protocols such as Wi-Fi or Bluetooth. This allowed for remote monitoring and management of the door's operation, as well as integration with other IoT devices and services. Through the use of cloud-based platforms, data generated by the door system could be analyzed to gain insights into usage patterns and optimize performance.

5.2 Hardware Setup

In the Hardware Setup focus lies on the foundational components that constitute the system. The primary hardware elements include sensors,motor, and communication modules. Initially, the sensors, such as infrared sensors or ultrasonic sensors, are strategically positioned to detect the presence of individuals approaching the door. These sensors serve as the input interface, providing real-time data to the microcontroller unit (MCU). The MCU, typically an Arduinoacts as the brain of the system, processing the incoming sensor data and making decisions based on pre-defined rules or algorithms. It communicates with the actuators, specifically the motor controlling the sliding door mechanism, to trigger the appropriate action based on the analyzed data. Additionally, the hardware setup incorporates communication modules, such as Wi-Fi or Bluetooth modules, enabling connectivity for IoT functionalities. This connectivity allows for remote monitoring and control of the door system through a smartphone application or web interface. Furthermore, power management components, including batteries or power supplies, are integrated to ensure continuous operation. The hardware setup is designed to be robust, reliable, and scalable, laying the groundwork for an efficient and intelligent automatic sliding door system tailored for IoT-based applications. Through meticulous selection and integration of these hardware components, the prototype system aims to demonstrate the feasibility and potential of knowledge-based sensor-controlled automation in enhancing accessibility and convenience in various environments.

Table 5.1 Table of Hardware Components

SL. NO.	H/W COMPONENTS NAME	PURPOSE
1	Arduino Uno	Space Consideration
2	DC Motor	Size consideration, control
3	Pully	It is light in weight
4	Door Frame	Strength/flexibility
5	L293D Motor Driver	Space Consideration
6	Infrared Sensor	Long Range
7	Battery	Power Supply

1. Arduino Uno:

The implementation of the prototype knowledge-based sensor-controlled automatic sliding door for an IoT-based application heavily relies on the Arduino UNO microcontroller board. The Arduino UNO serves as the central processing unit, facilitating the integration of sensors, actuators, and logic programming essential for the operation of the automatic sliding door system. Leveraging its versatility and ease of programming, the Arduino UNO effectively manages sensor data acquisition, interpretation, and decision-making algorithms to control the door's opening and closing mechanisms. Through its compatibility with various sensors such as ultrasonic sensors, infrared sensors, and motion detectors, the Arduino UNO enables the system to detect the presence and movement of individuals, ensuring seamless and efficient operation of the automatic sliding door. Additionally, the Arduino UNO's connectivity options allow for seamless integration with IoT platforms, enabling remote monitoring, control, and data logging functionalities essential for enhancing the system's overall functionality and accessibility in IoT environments.

Figure 5.1: Arduino UNO

2. DC Motor:

The DC motor serves as the pivotal component in our project, providing the mechanical force necessary to operate the sliding door. Through precise control signals generated by the knowledge-based system, the DC motor enables smooth and efficient door movement. Utilizing IoT connectivity, the motor's operation can be remotely monitored and adjusted, enhancing user convenience and accessibility. Furthermore, the motor's low power consumption aligns with the project's sustainability goals. Its robust design ensures reliable performance, contributing to the overall reliability and effectiveness of the sensor-controlled automatic sliding door system within our IoT-based application.

3. Pully System:

In the pulley system component of our project, we devised a mechanism to efficiently operate the sliding door using pulleys and cables. This system, integral to the design and implementation of our prototype, facilitates smooth and controlled movement of the door in response to sensor inputs. By leveraging the principles of mechanical advantage offered by pulleys, we achieved a balance between force and distance, enabling seamless operation of the automatic sliding door. Through careful calibration and engineering, we optimized the pulley system to ensure reliable performance while minimizing energy consumption, thereby enhancing the overall efficiency and functionality of our IoT-based application.

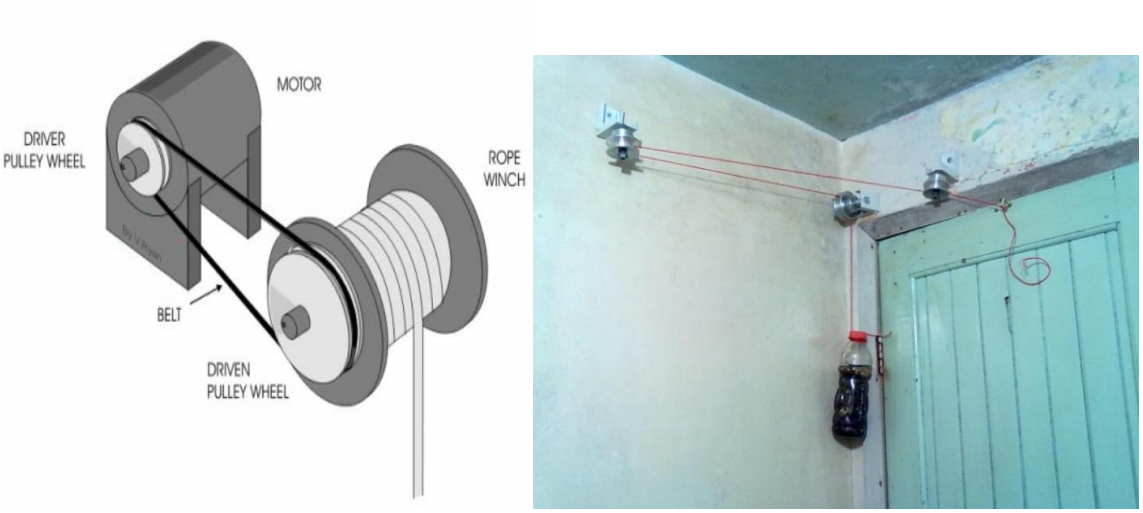

Figure 5.2: Pully System

4. L293D Motor Driver:

In the implementation of the prototype knowledge-based sensor-controlled automatic sliding door for an IoT-based application, the L293D motor driver plays a pivotal role in facilitating the motor control mechanism. This integrated circuit effectively controls the direction and speed of the DC motor responsible for opening and closing the sliding door. Through its built-in H-bridge configuration, the L293D enables bidirectional control, allowing precise manipulation of the motor's rotation. Moreover, its compatibility with microcontrollers makes it an ideal choice for interfacing with the IoT platform, enabling seamless integration of sensor data for efficient door operation. The utilization of the L293D motor driver ensures reliable and responsive door automation in the proposed system.

Figure 5.3: L293D Motor Driver

5. IR Sensor:

In the development of the prototype knowledge-based sensor-controlled automatic sliding door for an IoT-based application, infrared (IR) sensors play a pivotal role. These sensors are integrated into the door system to detect the presence of individuals approaching or departing from the door's vicinity. Upon detection, the IR sensors send signals to the microcontroller, prompting it to activate the door's opening or closing mechanism accordingly. By leveraging IR technology, the system ensures accurate and reliable detection, enabling seamless and efficient operation of the sliding door in response to human movement, thereby enhancing user experience and safety within the IoT environment.

Figure 5.4: Infra-red Sensor

5.3 Software Development

In the software development phase of the project, we focused on creating a robust system for controlling the automatic sliding door based on sensor inputs within an IoT framework. Using **C++** as the primary programming language, we developed algorithms to process sensor data, determine door states, and trigger appropriate actions. The software architecture involved modular design principles to enhance scalability and maintainability. Additionally, we implemented communication protocols to facilitate interaction between the door system and the IoT network, ensuring seamless integration and interoperability with other IoT devices. Thorough testing and debugging were conducted to validate the software's functionality and reliability, ensuring smooth operation of the prototype in real-world scenarios.

Arduino IDE:

In the software application segment of the project, the Arduino IDE played a pivotal role in developing the firmware for controlling the sensor-driven automatic sliding door system. Utilizing Arduino's programming environment, we coded the logic to integrate sensor data with door control mechanisms, ensuring seamless functionality of the IoT-based application. The IDE's user-friendly interface facilitated efficient coding and debugging, enabling us to implement sophisticated algorithms for real-time sensor data processing and door operation. Through Arduino IDE, we achieved robust synchronization between hardware components and software logic, enhancing the reliability and responsiveness of the automated door system in diverse environmental conditions.

Figure 5.5: Arduino IDE Software Application

5.4 Sensor Integration

Sensor integration plays a pivotal role in the design and implementation of the knowledge-based sensor-controlled automatic sliding door for an IoT-based application. At the heart of this system lies the seamless fusion of various sensor technologies, each serving a distinct purpose to enhance the door's functionality and responsiveness. Firstly, proximity sensors are deployed to detect the presence of individuals approaching the door, facilitating timely activation of the automatic sliding mechanism. These sensors are strategically positioned to ensure reliable detection across different environmental conditions, thereby optimizing the door's responsiveness while minimizing false positives or negatives. Additionally, ambient light sensors are incorporated to gauge the surrounding lighting conditions, enabling the door to adjust its operation accordingly. By dynamically adapting the opening and closing speed in response to ambient light levels, the system ensures smooth and safe user interactions while conserving energy during periods of ample natural light. Moreover, temperature and humidity sensors are integrated

to monitor the environmental conditions in the vicinity of the door. This data is leveraged to optimize the door's performance and longevity by adjusting operational parameters such as motor speed and lubrication frequency based on prevailing conditions, thereby mitigating potential wear and tear caused by extreme temperatures or humidity levels. Furthermore, pressure sensors are employed to detect obstructions or unintended obstacles within the door's path, thereby preventing accidents or damage to property. Through real-time monitoring of pressure variations, the system can halt or reverse the door's motion when an obstruction is detected, ensuring user safety and minimizing the risk of collisions. Overall, the seamless integration of diverse sensor technologies enables the automatic sliding door to operate with precision, efficiency, and safety in various environmental settings, thereby enhancing the overall user experience and contributing to the success of IoT-based applications in smart building automation.

5.5 Computer Vision Development

In the realm of designing and implementing a knowledge-based Sensor-controlled Automatic Sliding Door for an IoT-based application, computer vision plays a pivotal role in enabling precise detection through CCTV image analysis. Leveraging computer vision algorithms, the system is adept at distinguishing between humans and animals, ensuring that the sliding door operates with accuracy and safety. By harnessing advanced image processing techniques, the system identifies distinct features characteristic of human forms, such as body shape, size, and movement patterns, to trigger the door's opening mechanism when a person approaches. This capability is essential for enhancing user convenience and facilitating seamless entry and exit. Conversely, when an animal approaches the door, the system utilizes pattern recognition algorithms to differentiate between animal and human features, ensuring that the door remains closed to prevent unintended access or potential safety hazards. Through the integration of computer vision technology, the automatic sliding door system achieves a sophisticated level of intelligence, enhancing its responsiveness and adaptability to various environmental conditions and user scenarios. This synergy between sensor data and CCTV image detection not only optimizes the functionality of the IoT-based application but also underscores the significance of computer vision in modern smart infrastructure, fostering efficiency, safety, and user-centric design paradigms.

5.6 Integration with IoT

The integration of the Knowledge-based Sensor-controlled Automatic Sliding Door with IoT technologies revolutionizes traditional door systems, elevating them to the realm of smart, interconnected devices. Through seamless integration with IoT, this innovative door system gains the ability to communicate and interact with other smart devices and systems within its environment, thereby enhancing both its functionality and utility. By leveraging IoT protocols and standards such as MQTT (Message Queuing Telemetry Transport) or HTTP (Hypertext Transfer Protocol), the door can transmit and receive data over the internet, enabling real-time monitoring, control, and automation. IoT integration allows for the door to be remotely controlled and monitored from anywhere with an internet connection, offering unprecedented convenience and accessibility. Furthermore, the door can exchange data with other IoT devices, such as motion sensors, cameras, and environmental sensors, to gather contextual information about its surroundings. This data can then be analyzed and utilized to enhance the door's decision-making capabilities, enabling it to adapt its behavior dynamically based on changing environmental conditions or user preferences. Additionally, IoT integration facilitates the implementation of advanced features such as predictive maintenance, where the door can proactively identify and address potential issues before they escalate, thus improving reliability and reducing downtime. Overall, by seamlessly integrating with IoT technologies, the Knowledge-based Sensor-controlled Automatic Sliding Door becomes a pivotal component of a broader IoT ecosystem, contributing to enhanced efficiency, convenience, and intelligence in various IoT-based applications.

5.7 Design and Calculation

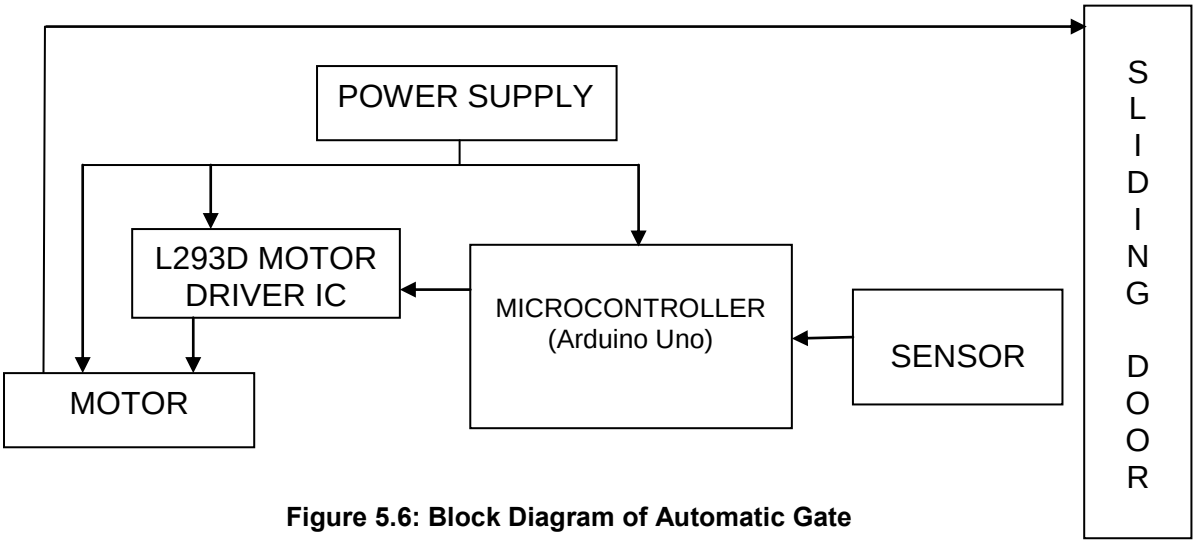

Figure 5.6: Block Diagram of Automatic Gate

The method and processes taken in the design, construction, and implementation of an automatic Door. The components used in the development of the automatic Door can be divided into mechanical and electrical components. The electronic components used in the development of the control circuit of the automatic Door are Electric 12v DC motor single phase, Arduino UNO, sensor, L2983D motor driver, Led light, jumper wires, etc.

The mechanical components that were being used to carry out the design and construction of an automatic Door includes Metal Framing and door made up of a wood / metal / plastic / glass and the components are attached to it. We need a Arduino IDE s/w tool which used to design and input the code into a Arduino Uno Board. The automatic Door can further be said to consist of three major sections which are the design of the power supply system, design of the Door, and design of the control system.

Door used in this Project:

A sliding door is an elegant aesthetic to any home or places providing euphony. Sliding door opens crosswise by sliding which is parallel to the wall. It has a horizontal mechanism. Slide door is also known as “Patio Door”. It is commonly used as shower door, glass door, screen door or in vans. It permits people to both enter and leaves. It is usually considered a single unit which consists two-panel sections. A sliding door is usually made of wood, aluminium, stainless steel but it appears in its best form when it is

made from UPVC plastic glass. A sliding door offers different design possibilities. We can see the usage of sliding doors in the airport terminal or in a hotel room.

Figure 5.17: Sliding Door

Sliding Door has many advantages providing-

- The best feature is you don't need any extra room to open the door.
- It makes a room soundproof; thus, it can be used for a private space.
- It has a security mechanism which can be used for office entrance, elevators, patios door or even a room divider.
- A Sliding door made of glass enhances natural light in.
- It has efficient insulators which ensure the perfect temperature in the room.

Also, there are few disadvantages of sliding doors-

- The installation is not a cakewalk.
- The trail of a sliding door is a magnet for dirt and sludge.
- It can become a fingerprint magnet.

Calculation:

1. FORMULA " Force→Weight + Size" elaborate this calculation for Motorized Automated Door

The formula "Force = Weight + Size" is a simplified representation of the forces involved in the operation of a motorized automated door. In this context, the force required to

move the door is the sum of the force needed to overcome its weight and the force needed to account for its size or resistance within the mechanical system.

1. **Force to Overcome Weight:** The weight of the door contributes to the force required to move it. This force is proportional to the gravitational pull on the door's mass. The formula for force due to gravity is often expressed as F_weight = m * g, where "m" is the mass of the door and "g" is the acceleration due to gravity (approximately 9.8 m/s^2).
2. **Force to Overcome Size (or Resistance):** The size or resistance in the mechanical system includes factors such as friction, the door's interaction with hinges, and any other components that introduce resistance. This force is often calculated as F_size = μ * N, where "μ" is the coefficient of friction, and "N" is the normal force acting on the door.

Combining these two forces, the total force required to operate the motorized automated door can be expressed as:

Total Force = Force to Overcome Weight + Force to Overcome Size

$= F\_weight + F\_size$

$= m \times g + \mu \times N$

Where:

"F"_weight is the force required to overcome the weight of the door.

"F"_size is the force required to overcome the size of the door.

"**m**" is the mass of the door.

"g" is the acceleration due to gravity.

"**μ**" is the coefficient of friction between the door and its hinges.

"N" is the normal force acting on the door.

The force required to overcome the weight of the door can be calculated using the formula $F\_weight = m \times g$, where m is the mass of the door and g is the acceleration due to gravity. The force required to overcome the size of the door can be calculated using the formula $F\_size = \mu \times N$, where μ is the coefficient of friction between the door and its hinges and N is the normal force acting on the door.

2. Rotational Speed:

$\omega = v/r$

ω = speed in radians per second

v=0.5 m/s (instantaneous speed)

r = 0.030 m (radius of driver pulley)

$\omega = 0.5/0.030$

=16.66 rad/sec

$N = 50/2\pi * \omega$

N= rotation speed in rev/sec

$N = 50/2\pi * 16.66$

=132.57 rev/min

5.8 Flow Chart

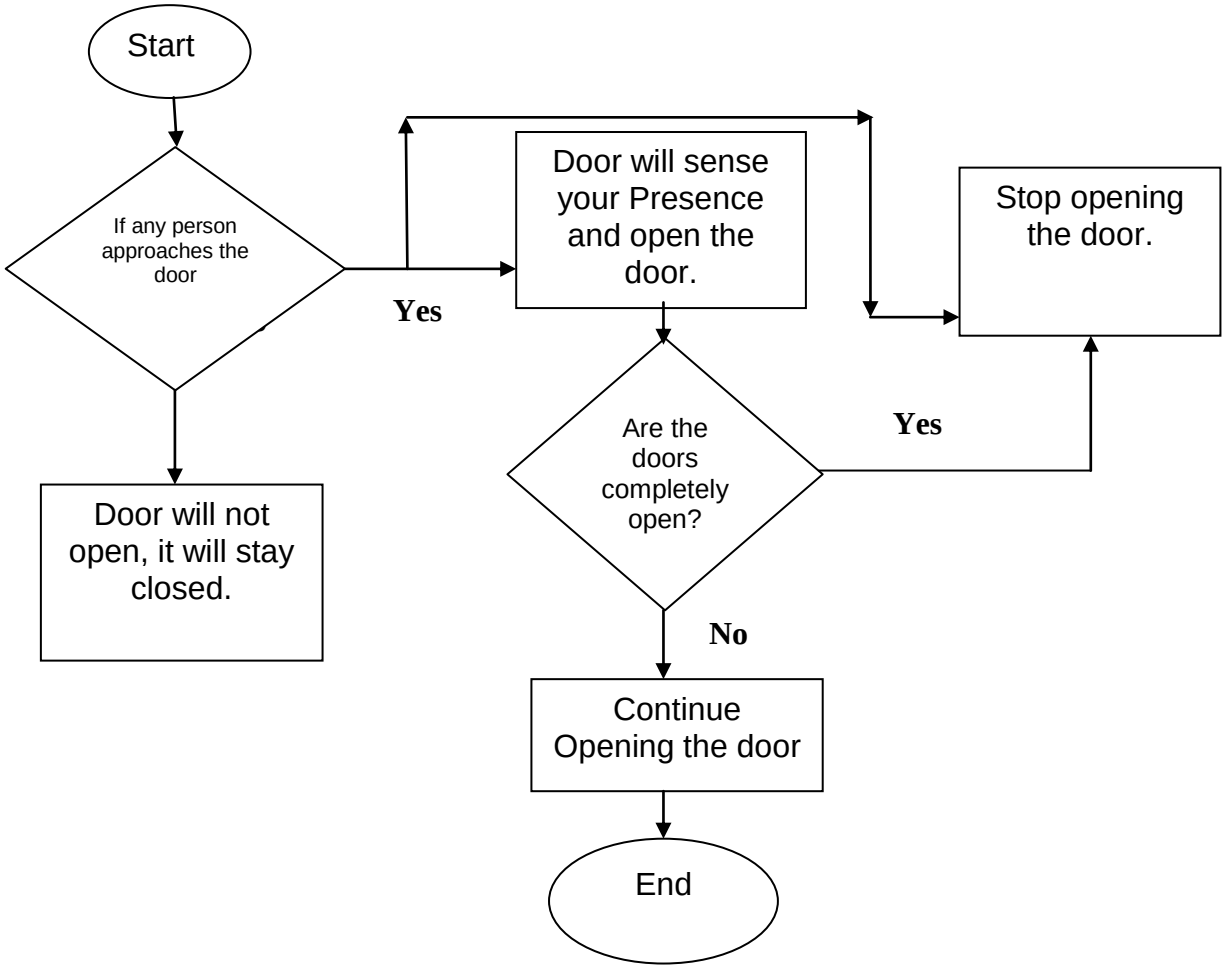

Figure 5.18: Flow Chart of Automatic Door

6. FUTURE WORKS

In the Future works, we want to conduct additional study on automatic Doors and create a prototype model for our concept, which will be used for commercial purposes. We're learning more about how a computer vision identification system will assist in identifying / detecting whether an object is animal or human which helps to detect and operating the Door, how a remote control will operate a door, how a security camera will operate a door more securely, and how a door's security system will identify any miscellaneous thingsor theft before sending a signal to the appropriate authority / ownerbased on an alarm or message signal. We are studying each of these topics and will use them in our project in the future.

7. CONCLUSION

In conclusion, the design and construction of the automatic Door project have successfully addressed the identified challenges and objectives. Through the integration of carefully selected hardware components such as sensors, Arduino Uno, L293D Motor Driver, and DC Motor, along with the implementation of software components like the Arduino IDE and C++ compiler, a functional and responsive automatic Door system has been realized. The construction process, involving meticulous planning and execution, has resulted in a robust Door structure with efficient automation. The Door's performance has been evaluated, and any challenges encountered during the project have been addressed, leading to a reliable and secure solution. The successful implementation of this automatic Door not only contributes to enhanced security and convenience but also serves as a testament to the efficacy of integrating hardware and software components in the realm of automated systems. Overall, the project's outcomes underscore its practical applicability and potential for further advancements in the field of automated Door technology.

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Design and implementation of a prototype knowledge-based sensor-controlled automatic sliding door for an IoT-based Application

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ABSTRACT

Security is an important factor, it can clearly be understood and observed from the human civilization; security is a key factor of the structure design for resides like the home, the fort, and the building. The door is a basic and important of the structure, for the security of the lives & valuable belonging to them. The door is modified according to the requirements needs and purpose. Generally, the door opens and closes manually, by manpower, but when the traffic is high, it is quite difficult to solve by human power, due to the nature of the system demanding cumbersome and laborious. It is wised to make the door switching carried out by the electronic circuitry, in the presence of the microcontroller and programmable device the work can be achieved more efficiently and less error-prone. As this system implementation is based on sensor and their utilization of property for closing and opening the door, still there are certain bugs and operational errors associated. Even if we minimized the error in the microcontroller or programmable device operated sensor-based automated door operating system, this can be diminishing nature by using artificial intelligence. The knowledge-based automated door operating

system, which able to deploy computer vision and algorithms to make it more robust. The information processing and storage can be utilized on the cloud platform. The IOT-based door operational module is integrated with the knowledge-based artificial intelligence system on a cloud-based platform. The design of such an operation system will be more efficient, if the decision-making policy is faster and less prone to error, which can be achieved using a machine learning-based artificial platform, here we need to understand the construction material and structure before making it to be automated.

KEYWORDS

Arduino UNO, L293D Motor Driver, MPC, Sensor, Power Supply, 12V DC Motor, etc.

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