Keypad

A **keypad** is a hardware input device used to allow users to interact with electronic systems by pressing buttons to input data or commands. Keypads are widely used in embedded systems for user interface applications, such as on **security systems**, **calculators**, **home appliances**, and more.

Keypads typically consist of a grid of keys arranged in rows and columns, with a set of **pushbuttons**. When a button is pressed, it completes a circuit that corresponds to a specific **row and column**.

Types of Keypads:

1. **4x3 Keypad** (4 rows x 3 columns)
    - This is one of the most common types, with **4 rows** and **3 columns**, totaling **12 keys** (numbers and symbols).
2. **4x4 Keypad** (4 rows x 4 columns)
    - A more advanced keypad with **4 rows** and **4 columns**, totaling **16 keys** (often includes 0-9, * and #, or letters).
3. **Membrane Keypads**:
    - **Flexible** and **thin**, used in many consumer products (e.g., microwaves, remote controls).
4. **Mechanical Keypads**:
    - These have **physical buttons** that provide tactile feedback when pressed.

How Keypad Works (Matrix Keypad):

A **matrix keypad** is a grid of buttons arranged in **rows and columns**. When a key is pressed, it connects a specific row and column, and this combination is read by the microcontroller.

Keypad Matrix:

- Each key in the keypad corresponds to a **unique row-column combination**.
- The matrix is scanned by sequentially activating each row and reading the columns.
- **Rows and columns** are connected by **wires**, and a **key press** between a row and column is detected by the microcontroller.

Keypad Wiring:

- The **rows** and **columns** of a keypad are connected to digital pins on a microcontroller.
- When you press a key, the **microcontroller detects** the combination of row and column, determining which key is pressed.

For example, in a **4x4 keypad**:

- Rows: **4 pins**
- Columns: **4 pins**
- You will use **8 digital pins** (4 for rows, 4 for columns) to connect the keypad to your microcontroller.

Keypad Pinout:

- **Row Pins**: Connected to the rows of the keypad.
- **Column Pins**: Connected to the columns of the keypad.

Example pin mapping for a **4x4 keypad**:

```
byte rowPins[4] = {9, 8, 7, 6};   // Connect rows to pins 9, 8, 7, 6
byte colPins[4] = {5, 4, 3, 2};   // Connect columns to pins 5, 4, 3, 2
```

Keypad Libraries:

There are popular libraries to help interface with keypads using Arduino, such as:

- **Keypad Library**: A popular library that simplifies the task of reading keys from a matrix keypad.

Applications of Keypads:

1. **Security Systems:**
    - Used to enter passcodes or PINs to unlock doors or access control systems.
2. **Embedded Systems:**
    - Simple input devices for **calculators**, **appliances**, and **robotics**.
3. **Home Automation:**
    - Often used in **smart home systems** to control lights, fans, or other devices.
4. **Point of Sale (POS) Systems:**
    - Used for entering amounts, prices, or product codes.
5. **Medical Devices:**
    - Used in devices that require user input, such as blood glucose meters or thermometers.

Advantages of Using Keypads:

1. **Compact**: They allow multiple inputs in a small space.
2. **Tactile Feedback**: Physical keys offer good user interaction.
3. **Easy to Integrate**: Keypads are easy to interface with **microcontrollers** using libraries like **Keypad**.
4. **Cost-effective**: They are inexpensive and widely available.

Disadvantages:

1. **Limited Input**: Typically limited to numerical and symbol input (depending on the size of the keypad).

2. **No Touch Input**: Unlike touch screens, keypads require physical contact.

3. **Wear and Tear**: Mechanical keypads may wear out over time with heavy usage.
