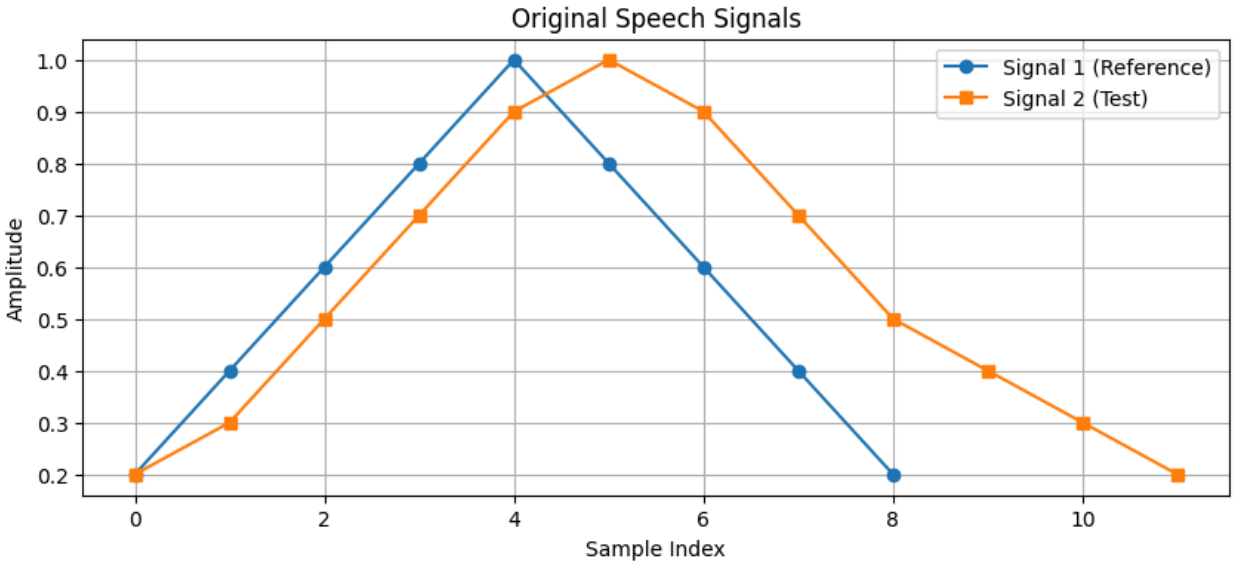
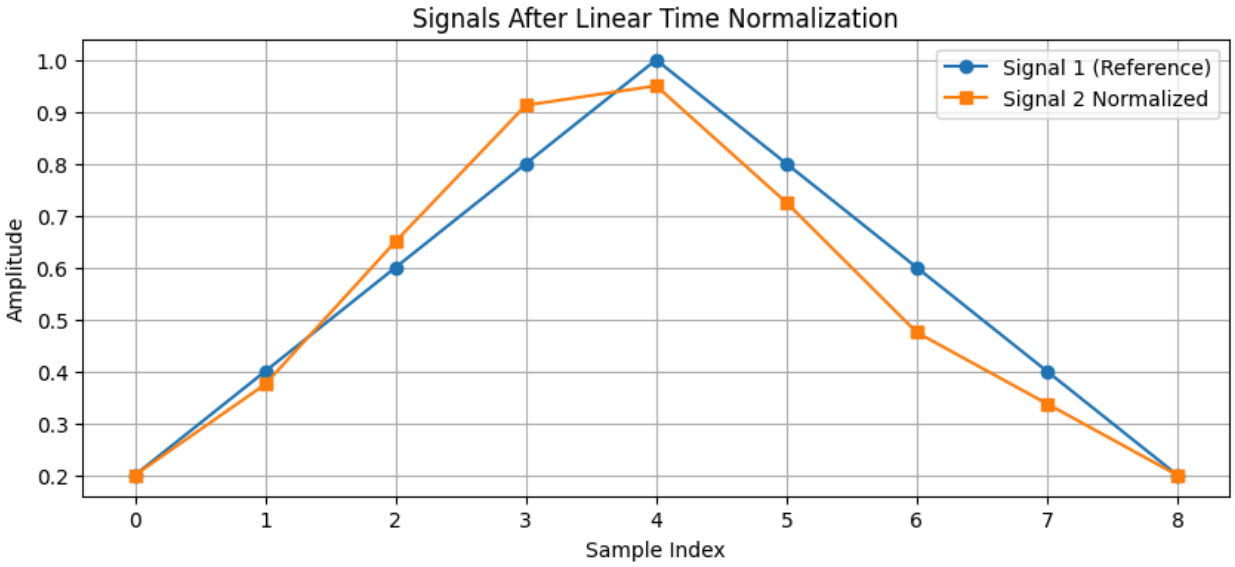
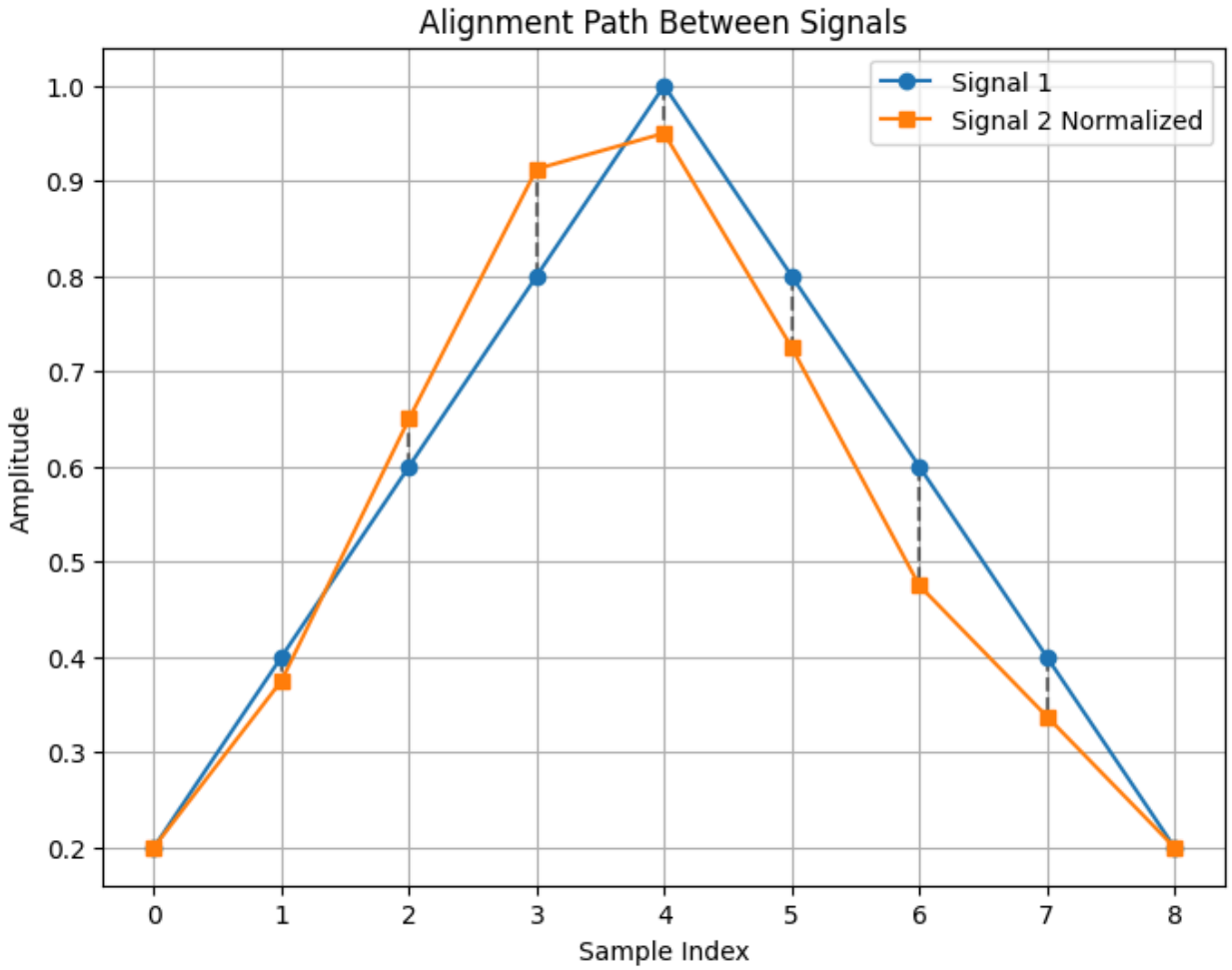
In [3]:

```python
import numpy as np
import matplotlib.pyplot as plt
from scipy.interpolate import interp1d

# =========================
# 1. Given Signals
# =========================
signal1 = np.array([0.2, 0.4, 0.6, 0.8, 1.0, 0.8, 0.6, 0.4, 0.2])  # Reference
signal2 = np.array([0.2, 0.3, 0.5, 0.7, 0.9, 1.0, 0.9, 0.7, 0.5, 0.4, 0.3, 0.2

# =========================
# 2. Plot original signals
# =========================
plt.figure(figsize=(10,4))
plt.plot(signal1, 'o-', label='Signal 1 (Reference)')
plt.plot(signal2, 's-', label='Signal 2 (Test)')
plt.title('Original Speech Signals')
plt.xlabel('Sample Index')
plt.ylabel('Amplitude')
plt.legend()
plt.grid(True)
plt.show()

# =========================
# 3. Linear Time Normalization (resample Signal 2)
# =========================
x_old = np.linspace(0, 1, len(signal2))
x_new = np.linspace(0, 1, len(signal1))
interpolator = interp1d(x_old, signal2, kind='linear')
signal2_normalized = interpolator(x_new)

# =========================
# 4. Plot normalized signals
# =========================
plt.figure(figsize=(10,4))
plt.plot(signal1, 'o-', label='Signal 1 (Reference)')
plt.plot(signal2_normalized, 's-', label='Signal 2 Normalized')
plt.title('Signals After Linear Time Normalization')
plt.xlabel('Sample Index')
plt.ylabel('Amplitude')
plt.legend()
plt.grid(True)
plt.show()

# =========================
# 5. Plot alignment path
# =========================
plt.figure(figsize=(8,6))
for i in range(len(signal1)):
    plt.plot([i, i], [signal1[i], signal2_normalized[i]], 'k--', alpha=0.5)
plt.plot(signal1, 'o-', label='Signal 1')
plt.plot(signal2_normalized, 's-', label='Signal 2 Normalized')
plt.title('Alignment Path Between Signals')
```

```
plt.xlabel('Sample Index')
plt.ylabel('Amplitude')
plt.legend()
plt.grid(True)
plt.show()

# ========================
# 6. Inference
# ========================
print("Inference:")
print("Linear Time Normalization aligns the slower speech signal to match the
print("allowing corresponding parts of the waveforms to align in time despite
```








```
Inference:
Linear Time Normalization aligns the slower speech signal to match the length o
f the reference signal,
allowing corresponding parts of the waveforms to align in time despite differen
ces in speaking speed.
```

In [ ]: