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Department of ECE

Term project

19EAC213 Digital Signal Processing and Processors

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ABSTRACT

In this project we design an simple moving average (SMA) filter and exponential moving average filter (EMA) . We used these two filters for analysing the daily closing prices for one financial year of JB Hi- Fi shares. This type of filters are used in stock markets to get an indication of market trends and to smooth out random fluctuations in a share's price or reduce the 'noise' in the price .

For both SMA and EMA filters , we designed two impulse response arrays representing short term filter and long term filter. By convoluting these filters with share prices, we obtained the required results.

INTRODUCTION

In stock market analysis, traders often use filters to analyze market trends and reduce noise in share prices. Two types of filters are used SMA and EMA . The SMA filter calculates the average of specific no.of past closing prices providing a smooth representation of share price over given period of time. EMA filter is commonly used in stock market analysis to identify trends and predict market behavior.

This project aims to design and implement SMA and EMA filters to filter the daily closing prices of JB Hi-fi shares for one financial year.

LITERATURE SURVEY

Title : Global Stock Market Development, Quantitative and Behavioural Analysis. Author: Marcin Kalinowski

This book focus on quantitative analysis technique. In this book author covers moving average filter as one of the tools used to analyze stock market data. This book discuss about how moving averages can be calculated and their applications in identifying market trends and generating trading signals.

Title: Reciprocating Engine Combustion Diagnostics, In-Cylinder Pressure Measurement and Analysis. Author: Rakesh Kumar Maurya

In this book the author discuss about the implementation of moving average filters as a preprocessing step for in-cylinder pressure data analysis. This book explore different types of moving average filters, their parameters, and their impact on the accuracy of combustion diagnostics. Additionally, the author discuss about moving average filters can assist in identifying specific features of the pressure traces, such as peak pressures, combustion timing, and rate of pressure rise.

Title: Technical Markets Indicators, Analysis and Performance. Author: Richard J. Bauer, Julie R. Dahlquist

In this book the author mentioned moving average as a fundamental technical indicator and its applications within the context of market analysis. This book discuss about types of moving average filters such as simple moving average, exponential moving average and weighted moving average. It also explain calculation methods for each type and discuss their strengths and weaknesses in different market conditions.

ABOUT JB Hi-fi

JB Hi-fi Limited is an Australian consumer electronics and home appliances retail company. It was established in 1974. In August 2018, JB Hi-Fi was ranked as the equal 7th largest consumer electronics and home appliance retailer in the world.

Today, JB Hi-Fi is one of Australia's most successful and prominent retailers, with over 300 stores across the JB and Good Guys brands, annual revenues of over $9 billion and profits of $544 million. Its shares are trading at $43.35, with a market capitalisation of $4.74 billion.

Industry: Consumer electronics.

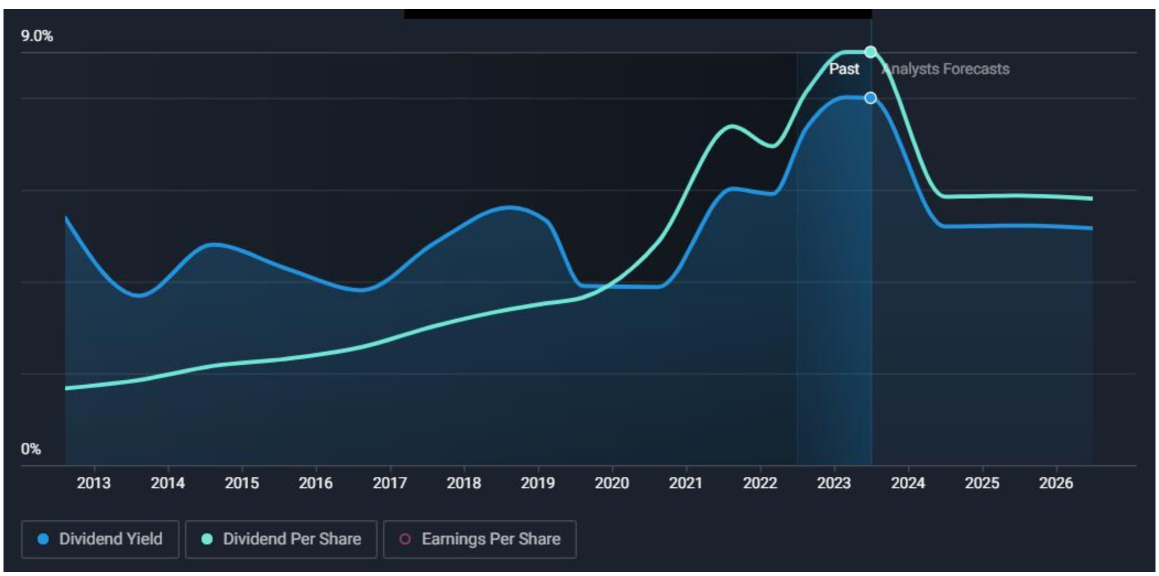
Main products: Mobile phones, computers, video games, whitegoods.

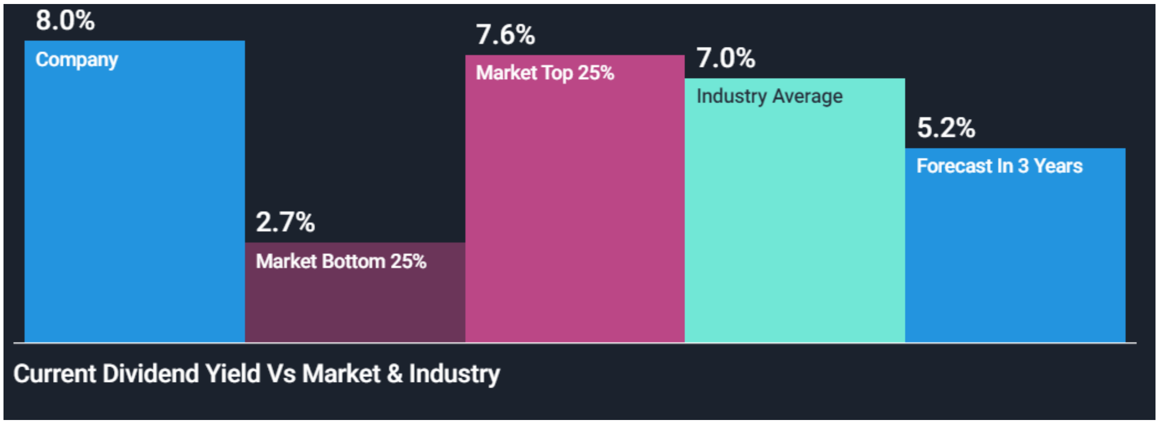
Key figures: Chief executive Terry Smart, chairman Stephen Goddard.

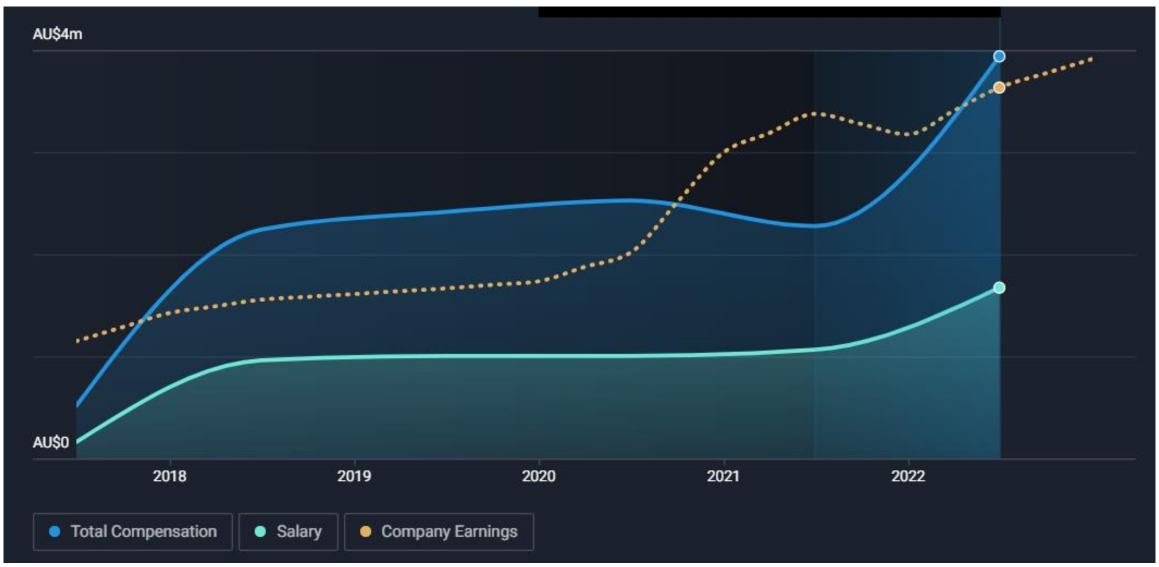
PERFORMANCE

JB Hi-Fi has been growing earnings at an average annual rate of 22.6%, while the Specialty Retail industry saw earnings growing at 21.8% annually. Revenues have been growing at an average rate of 8% per year. JB Hi-Fi's return on equity is 40.9%, and it has net margins of 6.1%.

JB Hi-Fi has a total shareholder equity of A$1.4B and total debt of A$0.0, which brings its debt-to-equity ratio to 0%. Its total assets and total liabilities are A$3.6B and A$2.2B respectively. JB Hi-Fi's EBIT is A$854.9M making its interest coverage ratio 43.2. It has cash and short-term investments of A$391.2M.

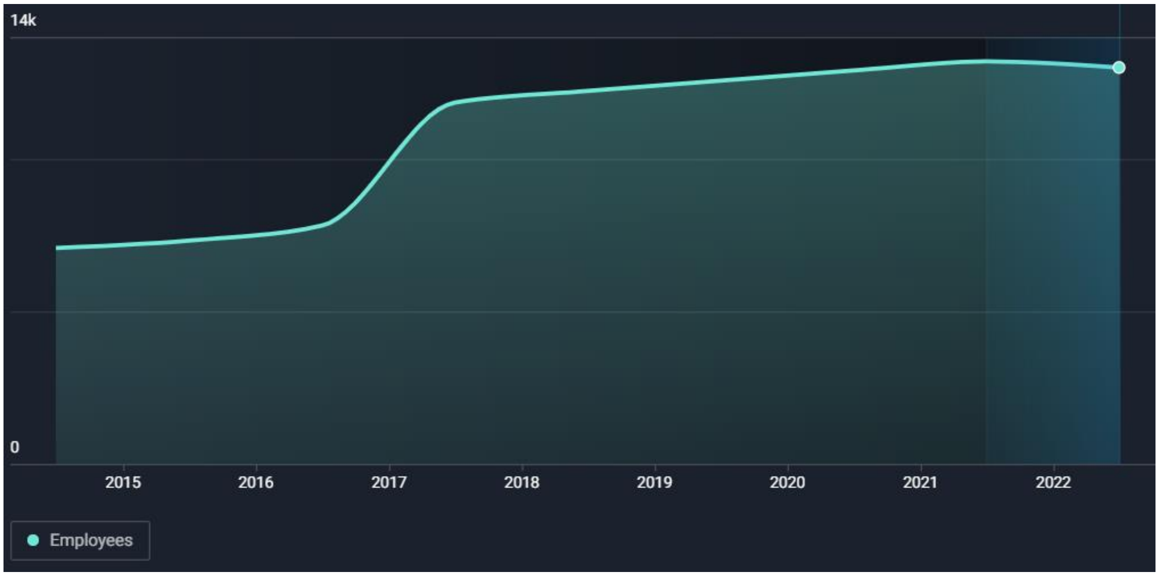



8.0%
Company
2.7%
Market Bottom 25%
7.6%
Market Top 25%
7.0%
Industry Average
5.2%
Forecast In 3 Years
Current Dividend Yield Vs Market & Industry


AU$4m
AU$0
2018
2019
2020
2021
2022
Total Compensation
Salary
Company Earnings

OTHER INFORMATION

Number of Employees



TASK

Task1:

In this project you are required to design a simple moving average (SMA) filter to filter the daily closing prices for one financial year of JB Hi-Fi shares. In stock market analysis this type of filter is commonly used by traders to get an indication of market trends and to smooth out random fluctuations in a share's price (or reduce the 'noise' in the price). These types of filters can be modelled in the same way as an FIR filter with an impulse response of:
$h[n]=1L\Sigma\delta[n-k]L-1k=0$
where L is the number of days the SMA filter is averaging over. create two impulse response arrays for two SMA filters; the first being a short-term filter (a 5-day moving average) and the second being a longer term filter (a 30- day moving average). Download the share prices for JB Hi-Fi from AUMS. Import the spreadsheet into your MATLAB Workspace and extract only the closing share prices. Use the conv() function to filter the closing prices using your two moving average filters. Plot the original JB Hi-Fi share prices (use a line plot does not stem) as well as the filters' outputs on the same MATLAB figure window. Explain how the fluctuations in stock prices vary as you increase the length of the SMA filter. Also think about what sort of filter this might be (e.g. high-pass, low-pass, band-pass, band-stop, etc).

Task 2:

Another type of filter used in stock market analysis is the Exponential Moving Average filter (EMA) which is equivalent to an IIR filter. Again long and short term EMA filters can be applied to stock prices to help predict when a market is a 'Bull' or 'Bear' market and hence when is the best time to buy and sell stock. Analyse an EMA filter which has the impulse response: $h[n]=\alpha((1-\alpha)nu[n])$ where $\alpha=2L+1$; L is again the period of time you are analysing (5- or 30-days). Repeat the same procedure described in Task 1. Compare the performance with Task 1.

FIR and IIR filter

FIR filter

It is a type of digital filter where the impulse response has finite duration. In the first task, the impulse response for both the short-term and long-term filters is defined as a finite sequence of non-zero values. FIR filters are characterized by their linear phase response, meaning that they introduce a constant delay across all frequencies.

IIR filter

It has an impulse response that extends infinitely in time. These filters rely on feedback, meaning that the output depends not only on the current and past inputs but also on past outputs. IIR filters can achieve higher filter orders with fewer coefficients compared to FIR filters, but they can introduce phase distortion due to their recursive nature.

However in the given task the concept of IIR filter is not used, instead they used EMA filter which is equivalent to IIR filter.

MANUAL CALCULATION

TASK 1

Impulse response, $h[n]=1/L(\Sigma\delta[n-k])$, given k=0 and n=L-1

For short term filter,

L = 5

n = 0:4

$h[n] = 1/5(\Sigma\delta[n])$

h[0]=1/5=0.2, h[1]=1/5=0.2, h[2]=1/5=0.2, h[3]=1/5=0.2, h[4]=1/5=0.2

For long term filter,

L=30

n = 0:29

$h[n]=1/30(\Sigma\delta[n])$

h[0]=1/30=0.033,
h[1]=1/30=0.033,
h[2]=1/30=0.033,
h[3]=1/30=0.033,
h[4]=1/30=0.033,
h[5]=1/30=0.033,
h[6]=1/30=0.033,
h[7]=1/30=0.033,
h[8]=1/30=0.033,
h[9]=1/30=0.033,
h[10]=1/30=0.033,
h[11]=1/30=0.033,
h[12]=1/30=0.033,
h[13]=1/30=0.033,
h[14]=1/30=0.033,
h[15]=1/30=0.033,
h[16]=1/30=0.033,
h[17]=1/30=0.033,
h[18]=1/30=0.033,
h[19]=1/30=0.033,
h[20]=1/30=0.033,
h[21]=1/30=0.033,
h[22]=1/30=0.033,
h[23]=1/30=0.033,
h[24]=1/30=0.033,
h[25]=1/30=0.033,
h[26]=1/30=0.033,
h[27]=1/30=0.033,
h[28]=1/30=0.033,
h[29]=1/30=0.033,
h[30]=1/30=0.033

TASK 2

Impulse response, $h[n]=\alpha(((1-\alpha)\text{^n})u[n])$, $\alpha=2/L+1$

For short term filter,

L = 5

n =0:4

$\alpha=2/5+1=1/3$

h[n]=1/3((1-1/3)^n)u[n])

h[0]=0.33, h[1]=0.222,
h[2]=0.148, h[3]=0.0987,
h[4]=0.0658

For long term filter,

L = 30

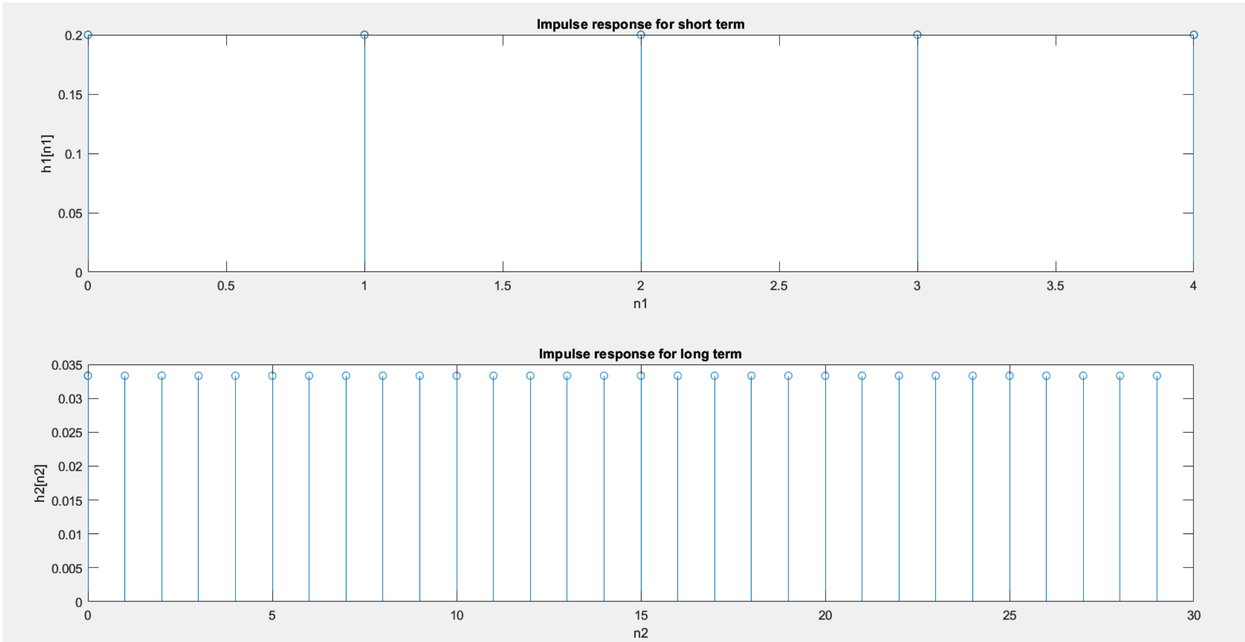
n =0:29

α=2/30+1=2/31

h[n]=2/31((1-2/31)^n)u[n])

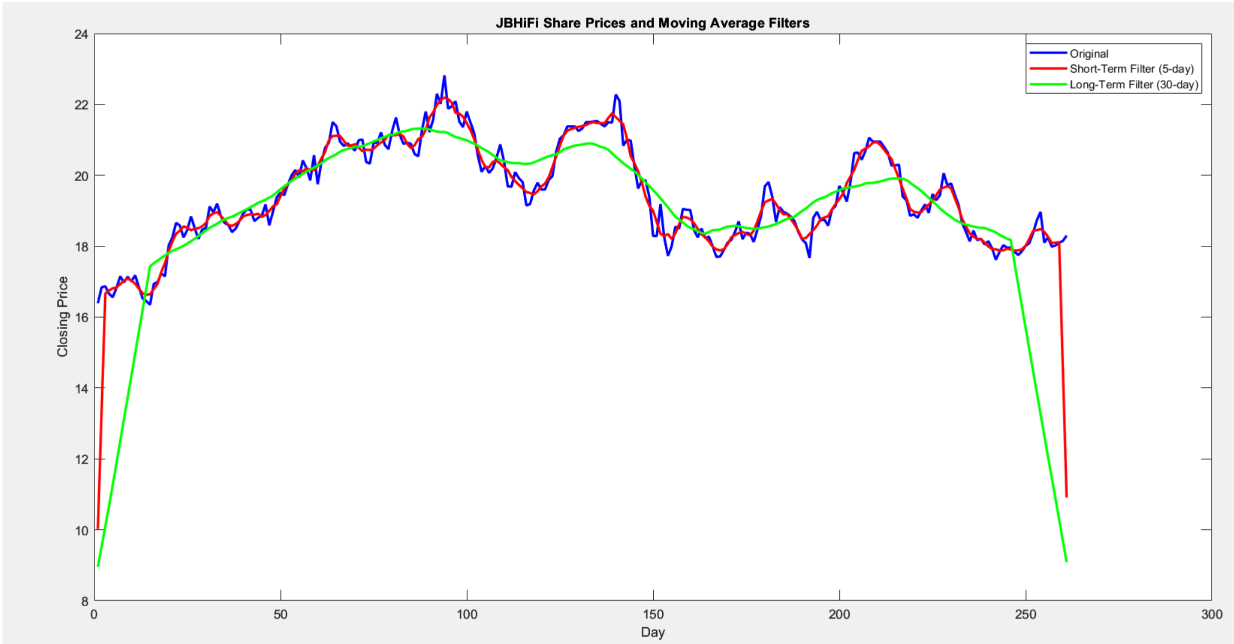
h[0]=0.0645, h[1]=0.0603,
h[2]=0.0564, h[3]=0.0528,
h[4]=0.0494, h[5]=0.0462,
h[6]=0.0432, h[7]=0.0404,
h[8]=0.0378, h[9]=0.0353,
h[10]=0.0331, h[11]=0.0309,
h[12]=0.0289, h[13]=0.0271,
h[14]=0.0253, h[15]=0.0237,
h[16]=0.0221, h[17]=0.0207,
h[18]=0.0194, h[19]=0.0181,
h[20]=0.0169, h[21]=0.0159,
h[22]=0.0148, h[23]=0.0139,
h[24]=0.0130, h[25]=0.0121,
h[26]=0.0113, h[27]=0.0106,
h[28]=0.0096, h[29]=0.0093

TASK 1-OBSERVATION



The above figure represents the impulse response for short term and long term of simple moving average filter with the impulse response given. The impulse response indicate how the filter average the input value for long term and short term to generate filtered output. The impulse response are plotted to visualize the weighting and the behavior of filters.

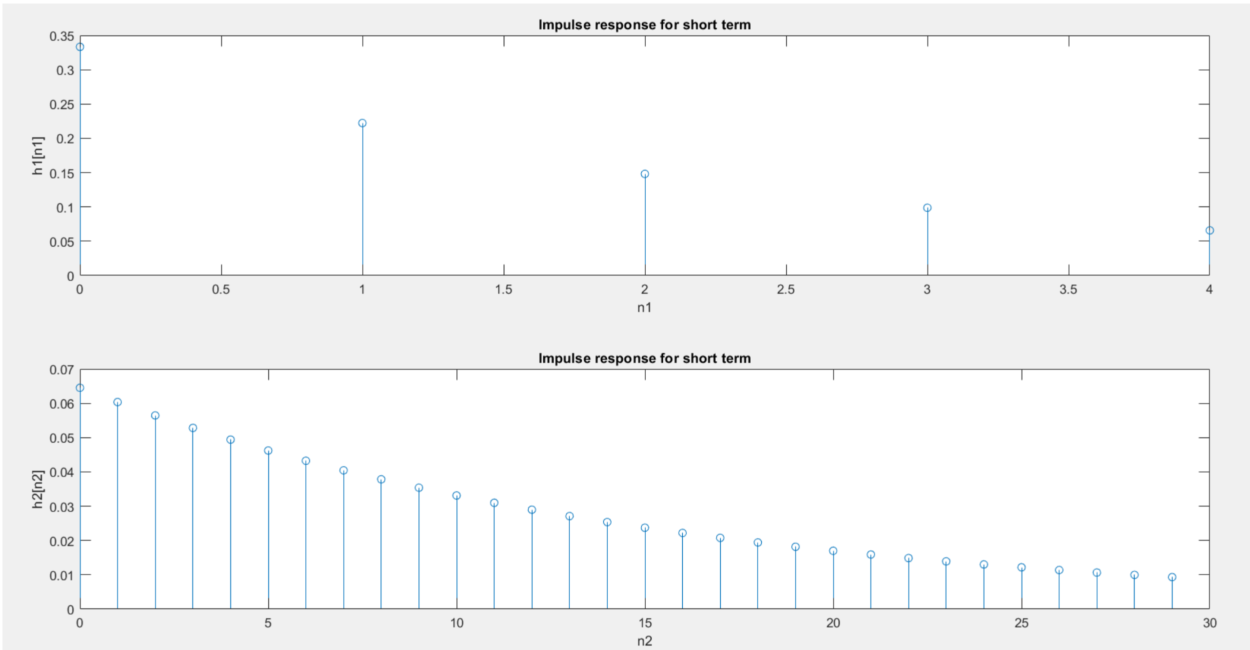
We can observe that the filter implemented here is a low pass filter. The SMA filter implemented here is low pass filter which allows the low frequency trends to pass through while attenuating the high frequency noise in the share prices.



This figure shows the original share price along with filtered price. It has become easier to compare the effects of moving average filters. The short term filter focuses on capturing shorter term trends and reducing noise at smaller time scale, while long term filter captures longer term trends and reduces noise at larger time scale.

This helps traders and analysts to identify trends and patterns in the share prices more clearly, allowing them to make more informed decisions based on the filtered data.

TASK 2 -OBSERVATION



The above figure represents the impulse response for short term and long term of exponential moving average filter with the impulse response given. By examining the impulse response, we can understand how the filters will behave when applied to time series. The shape and characteristics of impulse response give insights into the filtering operation, such as filter's time span and response to different frequencies.

The filter here implemented is low pass filter. The low pass filter is commonly used to smooth out random fluctuations or noise in stock price data, providing clearer indication of the underlying trends. The EMA filter achieves this by assigning exponentially decreasing weights to past samples, with the decay factor determined by the alpha value.

We can observe the effects of the EMA filters on the original share prices. The short-term filter (red line) will be more sensitive to short-term fluctuations, while the long-term filter (green line) will provide a smoother representation that highlights the long-term trends. The filtered lines help to reduce noise and provide a clearer indication of the underlying market behavior and direction. Overall, the plot allows you to visually analyze the original share prices and the effects of applying the EMA filters, helping you identify trends, patterns, and potential buy/sell signals based on the filtered data.

COMPARISON

I. Comparing the two approaches

SMA filter

This filter calculates the average of fixed no.of previous closing prices. The impulse response for this filter is a rectangular window.

EMA filter

This filter assigns exponentially decreasing weights to previous closing prices. The impulse response for this filter is an exponentially decaying curve.

II. Comparing in terms of performance

SMA filter

This filter provides a smoother output compared to raw closing prices. It removes high frequency fluctuations and provides general trend of stock prices. However, it may lag behind sudden changes or short term price movements.

EMA filter

This filter responds faster to price changes, making it more suitable for capturing short term trends. It is more sensitive to recent price movements but less affected by older data.

FLUCTUATIONS

1. Explain how the fluctuations in stock prices vary as you increase the length of the SMA filter.

Increasing the length of the SMA filter effectively acts as a low-pass filter on the stock prices. It attenuates the high-frequency components (short-term fluctuations) while preserving the low frequency components (long-term trends). As a result, the filtered output will have reduced fluctuations compared to the original prices.

2. Explain how the fluctuations in stock prices vary as you increase the length of the EMA filter.

Increasing the length of the EMA filter reduces the influence of short-term fluctuations and emphasizes the long-term trend of the stock price. The larger the EMA filter length, the smoother the filtered prices become, resulting in a dampened response to short-term price movements and a focus on the overall price trend.

LEARNING OUTCOMES

Moving Average Filters: The first task demonstrates the application of moving average filters, both short-term and long-term, in analyzing stock prices. It showcases how these filters can be used to smooth out price fluctuations and highlight trends in the data. It provides insights into the concept of impulse response and its implementation in filtering.

SMA and EMA Filters: The second task introduces the concept of Exponential Moving Average (EMA) filters as an alternative to Simple Moving Average (SMA) filters. It demonstrates how the EMA filter's exponential weighting scheme can result in different filter characteristics compared to the SMA filter. It highlights the importance of the filter length and the alpha parameter in shaping the impulse response and filtering performance.

Impact of Filter Length: Both tasks highlight the impact of changing the filter length on the filtered output. In the case of SMA filters, increasing the filter length results in smoother output with reduced sensitivity to short-term fluctuations. For EMA filters, a longer filter length leads to further smoothing and a greater emphasis on the long-term trend while attenuating short-term fluctuations.

Visualization of Filtered Data: The tasks provide visualizations of the original stock prices and the filtered prices using different moving average filters. The plots allow for a comparison of the filtered data against the original data, enabling an understanding of how the filters affect the overall trend, volatility, and noise in the price series.

Why filtering is essential in stock market?

Noise reduction: Short-term swings and random variations are common in stock market data, which is frequently noisy. Filtering methods aid in removing this noise and exposing hidden trends and patterns. It is simpler to recognize the real market signals and make wise judgments when the noise is removed.

Filtering techniques make it possible to extract significant signals or features from stock market data. For instance, by averaging out short-term changes, moving averages, such as the SMA and EMA filters, can assist in identifying long-term patterns. Based on the trend's direction, this can help identify prospective buying or selling opportunities.

Filtering can aid in the discovery of recurrent cycles or patterns in stock market data. You can find regular patterns like seasonality or cyclic activity in the market by using filters that accentuate particular frequencies or time intervals. By using this knowledge, trading techniques can be improved and future price changes can be predicted.

Analysis of Volatility: The stock market's volatility is an important factor. By concentrating on particular timeframes or price ranges, filtering strategies might aid in assessing and analyzing volatility. Volatility filters can draw attention to times of high or low volatility, giving information about the state of the market and associated hazards.

Risk management: By removing excessive price swings or outliers that could skew statistical metrics, filtering procedures can help in risk management. You can gain a more accurate depiction of the underlying market behavior and improve the quality of your risk management decisions by eliminating these outliers.

Technical indicators used in stock market analysis are frequently built using filtered data. Moving averages are used, for instance, by the MACD (Moving Average Convergence Divergence) indicator to spot impending trend reversals. Other indicators that use filtered data to produce indications include the Bollinger Bands and the Relative Strength Index (RSI).

APPENDIX

MATLAB CODE

TASK-1

```
a=5; %short term
b=30; %long term

%impulse response for short term
L1= a;
n1 = 0:L1-1;
h1= zeros(1, L1);
h1(n1+1) = 1/L1;
subplot(2,1,1);
stem(n1, h1);
xlabel('n1');
ylabel('h1[n1]');
title('Impulse response for short term');

%impulse response for long term
L2= b;
n2 = 0:L2-1;
h2 = zeros(1, L2);
h2(n2+1) = 1/L2;
subplot(2,1,2);
stem(n2, h2);
xlabel('n2');
ylabel('h2[n2]');
title('Impulse response for long term');

% Importing the data
data = readtable('JBHifi.xlsx');

%extract the closing price
close_price= data.Close;

%filter the closing price
f_short=conv(close_price,h1(n1+1),'sam
e');
f_long=conv(close_price,h2(n2+1),'same
');

%plotting the share
figure;
plot(close_price, 'b', 'LineWidth', 2);
hold on;
plot(f_short, 'r', 'LineWidth', 2);
plot(f_long, 'g', 'LineWidth', 2);
hold off;

title('JBHiFi Share Prices and Moving
Average Filters');
xlabel('Day');
ylabel('Closing Price');
legend('Original', 'Short-Term Filter (5-
day)', 'Long-Term Filter (30-day)');
```

TASK-2

```
a=5; %short term
b=30; %long term

%impulse response for short term
L1= a;
n1 = 0:L1-1;
alpha1= 2/(L1+1);
h1= zeros(1, L1);
h1(n1+1)=alpha1*((1-alpha1).^n1);
subplot(2,1,1);
stem(n1, h1);
xlabel('n1');
ylabel('h1[n1]');
title('Impulse response for short term');

%impulse response for long term
L2= b;
n2 = 0:L2-1;
alpha2= 2/(L2+1);
h2= zeros(1, L2);
h2(n2+1)=alpha2*((1-alpha2).^n2);
subplot(2,1,2);
stem(n2, h2);
xlabel('n2');
ylabel('h2[n2]');
title('Impulse response for short term');

% Importing the data
data = readtable('JBHifi.xlsx');

%extract the closing price
close_price= data.Close;

%filter the closing price
f_short=conv(close_price,h1(n1+1),'sam
e');
f_long=conv(close_price,h2(n2+1),'same
');

%plotting the share
figure;
plot(close_price, 'b', 'LineWidth', 2);
hold on;
plot(f_short, 'r', 'LineWidth', 2);
plot(f_long, 'g', 'LineWidth', 2);
hold off;

title('JBHiFi Share Prices and Moving
Average Filters');
xlabel('Day');
ylabel('Closing Price');
legend('Original', 'Short-Term Filter (5-
day)', 'Long-Term Filter (30-day)');
```

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