Versuch IV: Beobachterentwurf - Benutzeroberflächen

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REGELUNGSTECHNIK UND MECHATRONIK rtm

4.1 GUI - Entwurf

Unter Ausnutzung der schon erstellten Funktionen soll in diesem Versuch das Modell durch eine grafische Benutzeroberfläche und einen Lünberger-Beobachter erweitert werden. Zur Protokollierung des Versuchs werden im Folgenden die Ergebnisse als Listings und Screenshots vorgestellt.

Codes besser kommentieren

Listing 4.1: Quellcode der relevanten Callback-Funktionen

```
function varargout = simGUI(varargin)
% SIMGUI M-file for simGUI.fig
%      SIMGUI, by itself, creates a new SIMGUI or raises the existing
%      singleton*.
%
%      H = SIMGUI returns the handle to a new SIMGUI or the handle to
%      the existing singleton*.
%
%      SIMGUI('CALLBACK',hObject,eventData,handles,...) calls the local
%      function named CALLBACK in SIMGUI.M with the given input arguments.
%
%      SIMGUI('Property','Value',...) creates a new SIMGUI or raises the
%      existing singleton*.  Starting from the left, property value pairs are
%      applied to the GUI before simGUI_OpeningFcn gets called.  An
%      unrecognized property name or invalid value makes property application
%      stop.  All inputs are passed to simGUI_OpeningFcn via varargin.
%
%      *See GUI Options on GUIDE's Tools menu.  Choose "GUI allows only one
%      instance to run (singleton)".
%
% See also: GUIDE, GUIDATA, GUIHANDLES
```

```
% Edit the above text to modify the response to help simGUI

% Last Modified by GUIDE v2.5 27-Jun-2017 17:37:00

% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name',       mfilename, ...
                   'gui_Singleton',  gui_Singleton, ...
                   'gui_OpeningFcn', @simGUI_OpeningFcn, ...
                   'gui_OutputFcn',  @simGUI_OutputFcn, ...
                   'gui_LayoutFcn',  [] , ...
                   'gui_Callback',   []);
if nargin && ischar(varargin{1})
    gui_State.gui_Callback = str2func(varargin{1});
end

if nargout
    [varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
else
    gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT


% --- Executes just before simGUI is made visible.
function simGUI_OpeningFcn(hObject, eventdata, handles, varargin)
% This function has no output args, see OutputFcn.
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% varargin   command line arguments to simGUI (see VARARGIN)

% Choose default command line output for simGUI
handles.output = hObject;

% Update handles structure
guidata(hObject, handles);

% UIWAIT makes simGUI wait for user response (see UIRESUME)
```

```
% uiwait(handles.figure1);


% --- Outputs from this function are returned to the command line.
function varargout = simGUI_OutputFcn(hObject, eventdata, handles)
% varargout  cell array for returning output args (see VARARGOUT);
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Get default command line output from handles structure
varargout{1} = handles.output;

%% →
   ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%-
   ←
%% Arbeitspunkt
%% →
   ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%-
   ←



% --- Executes on button press in AP_2_1.
function AP_2_1_Callback(hObject, eventdata, handles)
    % hObject    handle to AP_2_1 (see GCBO)
    % eventdata  reserved - to be defined in a future version of →
       ←MATLAB
    % handles    structure with handles and user data (see GUIDATA)

    h = guihandles();

    value=get(hObject,'Value');
    if value == 1
        set(h.AP_2_2,'Value',0);

    elseif value == 0
        set(h.AP_2_2,'Value',1);

    end
    % Hint: get(hObject,'Value') returns toggle state of AP_2_1
```

```
% --- Executes on button press in AP_2_2.
function AP_2_2_Callback(hObject, eventdata, handles)
% hObject    handle to AP_2_2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

    h = guihandles();

    value=get(hObject,'Value');
    if value == 1
        set(h.AP_2_1,'Value',0);

    elseif value == 0
        set(h.AP_2_1,'Value',1);

    end
% Hint: get(hObject,'Value') returns toggle state of AP_2_2


%% →
   ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
   ←
%% Arbeitspunkt ENDE
%% →
   ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
   ←


%% →
   ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
   ←
%% Berechnung Regler reglerK
%% →
   ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
   ←

% --- Executes on button press in berechneK.
```

```
function berechneK_Callback(hObject, eventdata, handles)
    % hObject    handle to berechneK (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    structure with handles and user data (see GUIDATA)

    % Struktur mit den Handles aller Objekte der GUI erzeugen
    h = guihandles();

    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    % Auslesen der Matrix Q
    q11 = str2num(get(h.Q11,'String'));
    q22 = str2num(get(h.Q22,'String'));
    q33 = str2num(get(h.Q33,'String'));
    q44 = str2num(get(h.Q44,'String'));

    Q = diag([q11 q22 q33 q44]);
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    % Auslesen von R
    R = str2num(get(h.R,'String'));
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    % Auslesen des Arbeitpunkts
    % !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
    % Ggf. an eigene Codierung des Arbeitspunktes anpassen!
    % !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
    AP = [0 0 0 0];
    value1 = get(h.slider_AP,'Value');
        AP(1) = value1*pi;
    value2 = get(h.AP_2_1,'Value');
    if (value2 == 1)
        AP(3) = pi;
    else % (value == 0)
        AP(3) = 0;
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    [f_m, h_m] = nonlinear_model();
```

```
    [A, B, C, D, M_AP] = linearisierung(f_m, h_m, AP);


    [K poleRK] = berechneLQR(A, B, Q, R);

    % Anzeigen des Vektors 'K' im Textfeld 'reglerK'

    set(h.reglerK, 'String', num2str(K));
    set(h.poleRK, 'String', num2str(poleRK'));

    set(h.M_AP,'String',num2str(M_AP));
% end function berechneK_Callback


%% →
    ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
    ←
%% Berechnung Regler reglerK ENDE
%% →
    ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
    ←


%% →
    ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
    ←
%% Matrix R
%% →
    ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
    ←


function R_Callback(hObject, eventdata, handles)
% hObject    handle to R (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% Hints: get(hObject,'String') returns contents of R as text
%        str2double(get(hObject,'String')) returns contents of R as→
    ← a double
```

```
% --- Executes during object creation, after setting all properties.
function R_CreateFcn(hObject, eventdata, handles)
% hObject    handle to R (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

set(hObject, 'String', 1);

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end

%% %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% Matrix R ENDE
%% %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


%% %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% Matrix Q
%% %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

function Q11_Callback(hObject, eventdata, handles)
% hObject    handle to Q11 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% Hints: get(hObject,'String') returns contents of Q11 as text
```

```
% str2double(get(hObject,'String')) returns contents of Q11 as a double
% --- Executes during object creation, after setting all properties.
function Q11_CreateFcn(hObject, eventdata, handles)
% hObject    handle to Q11 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

set(hObject, 'String', 1);

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end


function Q22_Callback(hObject, eventdata, handles)
% hObject    handle to Q22 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% Hints: get(hObject,'String') returns contents of Q22 as text
%        str2double(get(hObject,'String')) returns contents of Q22 as a
%        double
% --- Executes during object creation, after setting all properties.
function Q22_CreateFcn(hObject, eventdata, handles)
% hObject    handle to Q22 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

set(hObject, 'String', 1);

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
```

```
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
    ←defaultUicontrolBackgroundColor'))
     set(hObject,'BackgroundColor','white');
end


function Q33_Callback(hObject, eventdata, handles)
% hObject    handle to Q33 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% Hints: get(hObject,'String') returns contents of Q33 as text
%        str2double(get(hObject,'String')) returns contents of Q33 →
    ←as a
%        double
% --- Executes during object creation, after setting all properties→
    ←.
function Q33_CreateFcn(hObject, eventdata, handles)
% hObject    handle to Q33 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns→
    ← called

set(hObject, 'String', 1);

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
    ←defaultUicontrolBackgroundColor'))
     set(hObject,'BackgroundColor','white');
end


function Q44_Callback(hObject, eventdata, handles)
% hObject    handle to Q44 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% Hints: get(hObject,'String') returns contents of Q44 as text
%        str2double(get(hObject,'String')) returns contents of Q44 →
    ←as a
%        double
```

```
% --- Executes during object creation, after setting all properties→
    ←.
function Q44_CreateFcn(hObject, eventdata, handles)
% hObject    handle to Q44 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns→
    ← called

set(hObject, 'String', 1);

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
    ←defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end


%% →
    ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
    ←
%% Matrix Q ENDE
%% →
    ←%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%→
    ←


% --- Executes during object creation, after setting all properties→
    ←.
function figure1_CreateFcn(hObject, eventdata, handles)
% hObject    handle to figure1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns→
    ← called



% --- Executes during object creation, after setting all properties→
    ←.
```

```
function reglerK_CreateFcn(hObject, eventdata, handles)
% hObject    handle to reglerK (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns→
    ← called




% --- Executes during object creation, after setting all properties→
    ←.
function record_sim_CreateFcn(hObject, eventdata, handles)
% hObject    handle to record_sim (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns→
    ← called


% --- Executes on slider movement.
function slider_AP_Callback(hObject, eventdata, handles)
% hObject    handle to slider_AP (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
    h = guihandles();
    value_AP = get(h.slider_AP,'Value');
    set(h.AP_1,'String',[num2str(value_AP*180) '°'])

% Hints: get(hObject,'Value') returns position of slider
%        get(hObject,'Min') and get(hObject,'Max') to determine →
    ←range of slider


% --- Executes during object creation, after setting all properties→
    ←.
function slider_AP_CreateFcn(hObject, eventdata, handles)
% hObject    handle to slider_AP (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns→
    ← called
```

```
% Hint: slider controls usually have a light gray background.
if isequal(get(hObject,'BackgroundColor'), get(0,'→
   ←defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor',[.9 .9 .9]);
end


% --- Executes on button press in startSim.
function startSim_Callback(hObject, eventdata, handles)
% hObject    handle to startSim (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
global stopAnimation;
stopAnimation = false;

h = guihandles();
cla(h.axes1);

x0(1,1) = str2num(get(h.x01,'String'));
x0(2,1) = str2num(get(h.x02,'String'));
x0(3,1) = str2num(get(h.x03,'String'));
x0(4,1) = str2num(get(h.x04,'String'));

AP = [0 0 0 0];
value1 = get(h.slider_AP,'Value');
    AP(1) = value1*pi;
value2 = get(h.AP_2_1,'Value');
if (value2 == 1)
    AP(3) = pi;
else % (value == 0)
    AP(3) = 0;
end

K = str2num(get(h.reglerK,'String'));
stPendel = ladePendel();
M_AP = str2num(get(h.M_AP,'String'));
%Simulation des Modells
[vT, mX, u] = runPendel(stPendel, AP, K, x0, M_AP, stObs);
%Animation des Pendels ohne avi-Video (Viertes Argument)
```

```
396 animierePendel(vT,mX,stPendel,h.axes1);



401 function x01_Callback(hObject, eventdata, handles)
    % hObject    handle to x01 (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    structure with handles and user data (see GUIDATA)

406 % Hints: get(hObject,'String') returns contents of x01 as text
    %        str2double(get(hObject,'String')) returns contents of x01 →
       ←as a double


    % --- Executes during object creation, after setting all properties→
       ←.
411 function x01_CreateFcn(hObject, eventdata, handles)
    % hObject    handle to x01 (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    empty - handles not created until after all CreateFcns→
       ← called

416 set(hObject, 'String', 0);

    % Hint: edit controls usually have a white background on Windows.
    %       See ISPC and COMPUTER.
    if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
       ←defaultUicontrolBackgroundColor'))
421     set(hObject,'BackgroundColor','white');
    end



426 function x02_Callback(hObject, eventdata, handles)
    % hObject    handle to x02 (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    structure with handles and user data (see GUIDATA)

431 % Hints: get(hObject,'String') returns contents of x02 as text
```

```
%        str2double(get(hObject,'String')) returns contents of x02 as a double


% --- Executes during object creation, after setting all properties.
function x02_CreateFcn(hObject, eventdata, handles)
% hObject    handle to x02 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

set(hObject, 'String', 0);

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



function x03_Callback(hObject, eventdata, handles)
% hObject    handle to x03 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of x03 as text
%        str2double(get(hObject,'String')) returns contents of x03 as a double


% --- Executes during object creation, after setting all properties.
function x03_CreateFcn(hObject, eventdata, handles)
% hObject    handle to x03 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called
```

```
466 set(hObject, 'String', 0);

    % Hint: edit controls usually have a white background on Windows.
    %       See ISPC and COMPUTER.
    if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
       ←defaultUicontrolBackgroundColor'))
471     set(hObject,'BackgroundColor','white');
    end



476 function x04_Callback(hObject, eventdata, handles)
    % hObject    handle to x04 (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    structure with handles and user data (see GUIDATA)

481 % Hints: get(hObject,'String') returns contents of x04 as text
    %        str2double(get(hObject,'String')) returns contents of x04 →
       ←as a double


    % --- Executes during object creation, after setting all properties→
       ←.
486 function x04_CreateFcn(hObject, eventdata, handles)
    % hObject    handle to x04 (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    empty - handles not created until after all CreateFcns→
       ← called

491 set(hObject, 'String', 0);

    function M_AP_CreateFcn(hObject, eventdata, handles)
    % hObject    handle to reglerK (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
496 % handles    empty - handles not created until after all CreateFcns→
       ← called


    % Hint: edit controls usually have a white background on Windows.
```

```
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
    ←defaultUicontrolBackgroundColor'))
     set(hObject,'BackgroundColor','white');
end


% --- Executes on button press in stopAnimation.
function stopAnimation_Callback(hObject, eventdata, handles)
% hObject    handle to stopAnimation (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
global stopAnimation;
stopAnimation = true;




function lam_b_1_Callback(hObject, eventdata, handles)
% hObject    handle to lam_b_1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of lam_b_1 as text
%        str2double(get(hObject,'String')) returns contents of →
    ←lam_b_1 as a double


% --- Executes during object creation, after setting all properties→
    ←.
function lam_b_1_CreateFcn(hObject, eventdata, handles)
% hObject    handle to lam_b_1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns→
    ← called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
    ←defaultUicontrolBackgroundColor'))
```

```
    set(hObject,'BackgroundColor','white');
end



function lam_b_2_Callback(hObject, eventdata, handles)
% hObject    handle to lam_b_2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of lam_b_2 as text
%        str2double(get(hObject,'String')) returns contents of ←lam_b_2 as a double


% --- Executes during object creation, after setting all properties←.
function lam_b_2_CreateFcn(hObject, eventdata, handles)
% hObject    handle to lam_b_2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns← called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'←defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end


function lam_b_3_Callback(hObject, eventdata, handles)
% hObject    handle to lam_b_3 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of lam_b_3 as text
%        str2double(get(hObject,'String')) returns contents of ←lam_b_3 as a double
```

```
571
    % --- Executes during object creation, after setting all properties→
        ←.
    function lam_b_3_CreateFcn(hObject, eventdata, handles)
    % hObject    handle to lam_b_3 (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
576 % handles    empty - handles not created until after all CreateFcns→
        ← called

    % Hint: edit controls usually have a white background on Windows.
    %       See ISPC and COMPUTER.
    if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
        ←defaultUicontrolBackgroundColor'))
581     set(hObject,'BackgroundColor','white');
    end



586 function lam_b_4_Callback(hObject, eventdata, handles)
    % hObject    handle to lam_b_4 (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    structure with handles and user data (see GUIDATA)

591 % Hints: get(hObject,'String') returns contents of lam_b_4 as text
    %        str2double(get(hObject,'String')) returns contents of →
        ←lam_b_4 as a double


    % --- Executes during object creation, after setting all properties→
        ←.
596 function lam_b_4_CreateFcn(hObject, eventdata, handles)
    % hObject    handle to lam_b_4 (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    empty - handles not created until after all CreateFcns→
        ← called

601 % Hint: edit controls usually have a white background on Windows.
    %       See ISPC and COMPUTER.
```

```
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
    ←defaultUicontrolBackgroundColor'))
     set(hObject,'BackgroundColor','white');
end

606

% --- Executes on selection change in popupmenu2.
function popupmenu2_Callback(hObject, eventdata, handles)
% hObject    handle to popupmenu2 (see GCBO)
611 % eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: contents = cellstr(get(hObject,'String')) returns →
    ←popupmenu2 contents as cell array
%        contents{get(hObject,'Value')} returns selected item from →
    ←popupmenu2

616

% --- Executes during object creation, after setting all properties→
    ←.
function popupmenu2_CreateFcn(hObject, eventdata, handles)
% hObject    handle to popupmenu2 (see GCBO)
621 % eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns→
    ← called

% Hint: popupmenu controls usually have a white background on →
    ←Windows.
%       See ISPC and COMPUTER.
626 if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
    ←defaultUicontrolBackgroundColor'))
     set(hObject,'BackgroundColor','white');
end


631

function x01b_Callback(hObject, eventdata, handles)
% hObject    handle to x01b (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
```

```
636
    % Hints: get(hObject,'String') returns contents of x01b as text
    %        str2double(get(hObject,'String')) returns contents of x01b→
       ← as a double


641 % --- Executes during object creation, after setting all properties→
       ←.
    function x01b_CreateFcn(hObject, eventdata, handles)
    % hObject    handle to x01b (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    empty - handles not created until after all CreateFcns→
       ← called
646
    % Hint: edit controls usually have a white background on Windows.
    %       See ISPC and COMPUTER.
    if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'→
       ←defaultUicontrolBackgroundColor'))
        set(hObject,'BackgroundColor','white');
651 end



    function x02b_Callback(hObject, eventdata, handles)
656 % hObject    handle to x02b (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    structure with handles and user data (see GUIDATA)

    % Hints: get(hObject,'String') returns contents of x02b as text
661 %        str2double(get(hObject,'String')) returns contents of x02b→
       ← as a double


    % --- Executes during object creation, after setting all properties→
       ←.
    function x02b_CreateFcn(hObject, eventdata, handles)
666 % hObject    handle to x02b (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    empty - handles not created until after all CreateFcns→
       ← called
```

```
% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end


function x03b_Callback(hObject, eventdata, handles)
% hObject    handle to x03b (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of x03b as text
%        str2double(get(hObject,'String')) returns contents of x03b as a double


% --- Executes during object creation, after setting all properties.
function x03b_CreateFcn(hObject, eventdata, handles)
% hObject    handle to x03b (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end


function x04b_Callback(hObject, eventdata, handles)
% hObject    handle to x04b (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
```

```
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of x04b as text
%        str2double(get(hObject,'String')) returns contents of x04b as a double


% --- Executes during object creation, after setting all properties.
function x04b_CreateFcn(hObject, eventdata, handles)
% hObject    handle to x04b (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end


% --- Executes on button press in aufnahme.
function aufnahme_Callback(hObject, eventdata, handles)
% hObject    handle to aufnahme (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hint: get(hObject,'Value') returns toggle state of aufnahme
```

Zur Berechnung der Beobachter-Matrix L soll die Funktion `berechneBeobachter(A, C, poleBeobachter)` implementiert werden.

Listing 4.2: Quellcode der Funktion berechneBeobachter

```
function L = berechneBeobachter(A, C, poleBeobachter)
MB = obsv(A,C);

if rank(MB)==length(A)
L = place(A', C', poleBeobachter)';
else
```

```
 disp('System nicht vollständig beobachtbar');
end

end
```

Für die Erweiterung soll zudem die Funktion `runPendel(stPendel, AP, K, x0, M_AP, stObs )` erweitert werden:

Listing 4.3: Quellcode der Funktion runPendel

```
function [ vT, mX, mXobs ] = runPendel( stPendel, AP, K, x0, M_AP, ...
    stObs )

vT = 'error';
mX = 'error';
mXobs = [];

if ~isempty(stObs)
    stObs.switch = true;
else
    stObs.switch = false;
    stObs.A = eye(4);
    stObs.B = [0;1;0;1];
    stObs.C = [1 0 0 0; 0 0 1 0];
    stObs.L = stObs.C';
    stObs.x0 = [0 0 0 0];
end

Tend = 10;
stOptions = simset( 'SrcWorkspace', 'current');
sim('Modell_V4', Tend, stOptions);

vT = mZustand.Time;
mX = mZustand.Data;
mXobs = mBeobacht.Data;
% u.Data = vInput.Data;
% u.Time = vInput.Time;
end
```

Die Codes/Ergebnisse jeweils in eigene Abschnitte

Aufgabe 1.4 - auch Verläufe/Screenshots einfügen!?

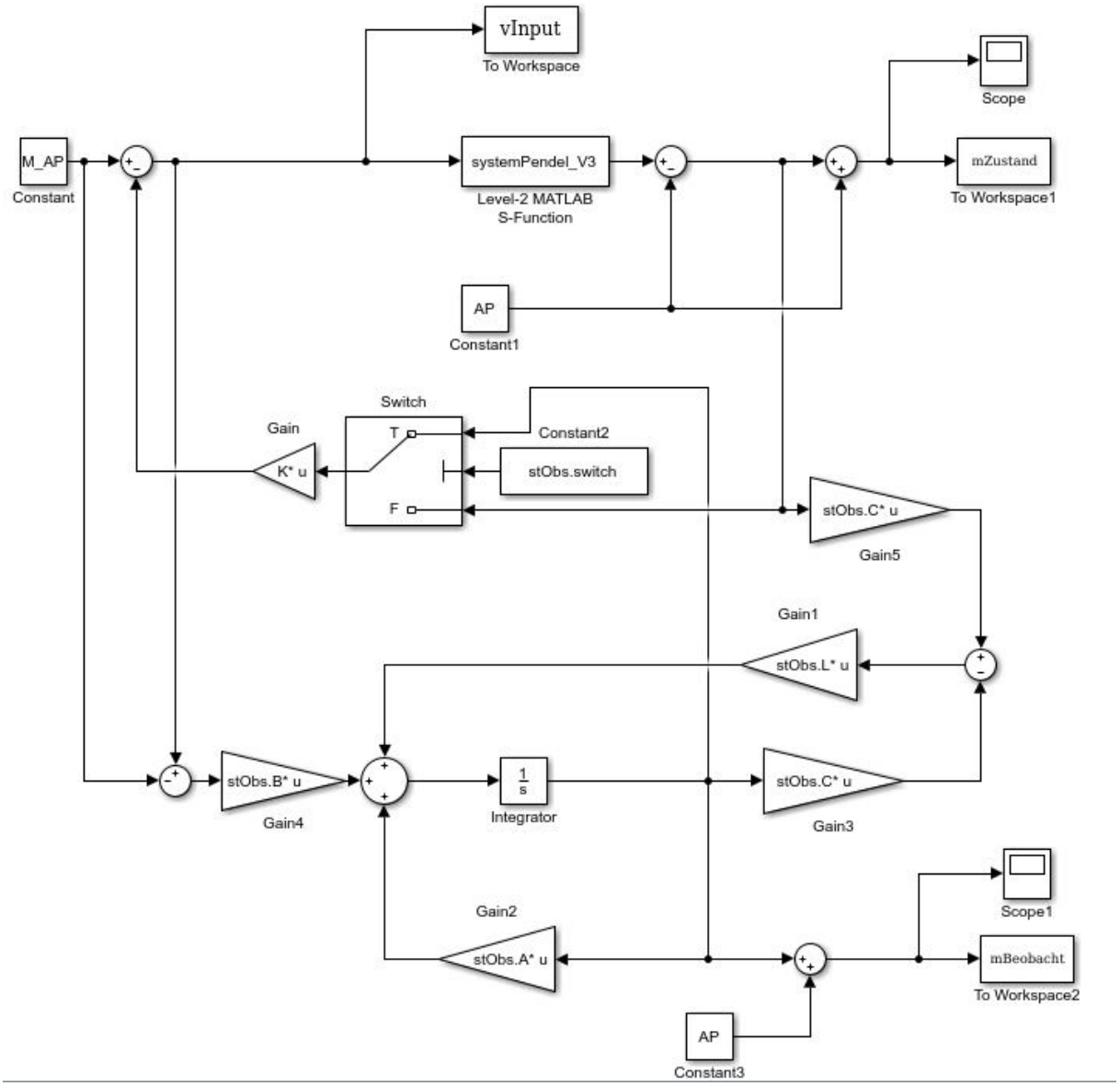

Figure 4.1: Simulink-Modell mit Lünberger-Beobachter

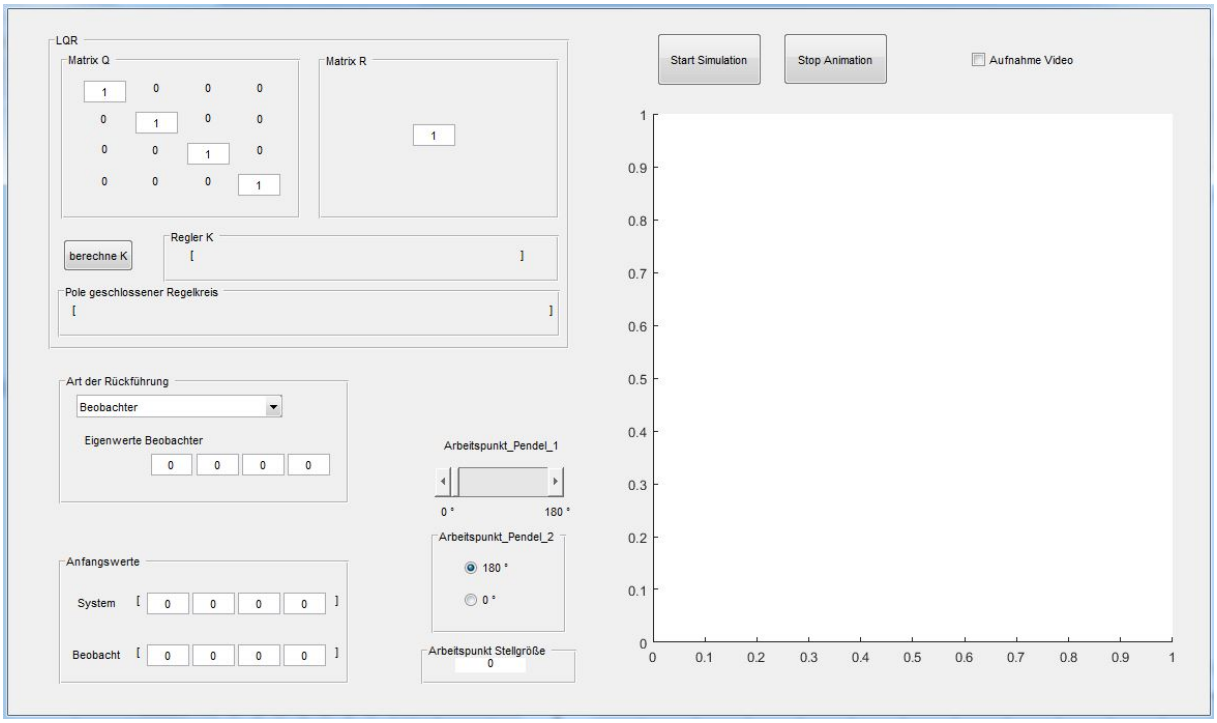

Figure 4.2: Finale grafische Benutzeroberfläche