LightCurve

Table of Contents

1   Start Here

What is LightCurve?

In simple terms, 'LightCurve' is an application that can be used to measure the light output of a selected target circle in an image recorded by a computer webcam.

Why use it:

- It can be used to simulate the light received from astronomical targets such as stars or asteroids. These targets 'paint' a certain light curve either because of their rotation or because other objects (such as exoplanets) move in front of them.
- The main aim is to use it as a classroom teaching aid to illustrate these concepts to pupils and engage them in a hands on task.

It has the following features:

- Camera controls can be adjusted
- The application can automatically find the best target circle in an image
- The target circle can be manually adjusted in location and size
- The application will show a close-up live image of the selected target circle
- The brightness of the selected target can be plotted over time.
- The recorded light curve data points can be exported as csv file
- The recorded light curve can be recorded in a video file (input images and line plot)
- The light curve plot can be adjusted as required

For full details on all features and the user interface please see: User Interface

Requirements

- Windows 7 or higher
- .NET framework 4.6 (already installed in Windows 10 and above)
- Internal or External Webcam

Please note that recording a light curve video file can be fairly processor intensive. If your computer is not up to the task you might experience some stutter in the recording. You can mitigate this by selecting a lower webcam image resolution and reducing the output movie file frame rate.

Basic Workflow

The basic steps are:

1. Select a webcam
2. Click Connect
3. Use drop down box to set desired image resolution then click Start to stream images,
4. Set the camera settings by clicking the 'Setup' button

5. Select a target circle inside the image (via auto find or manual controls)
6. If you want to save a movie file of your recording set file name and path as well as required settings
7. Tick 'Save Movie' if you want to create movie file. If required adjust time and brightness range of plot area.
8. Start the light curve recording

The application will now measure the brightness of the selected circle in each frame and plot it against time on the light curve plot
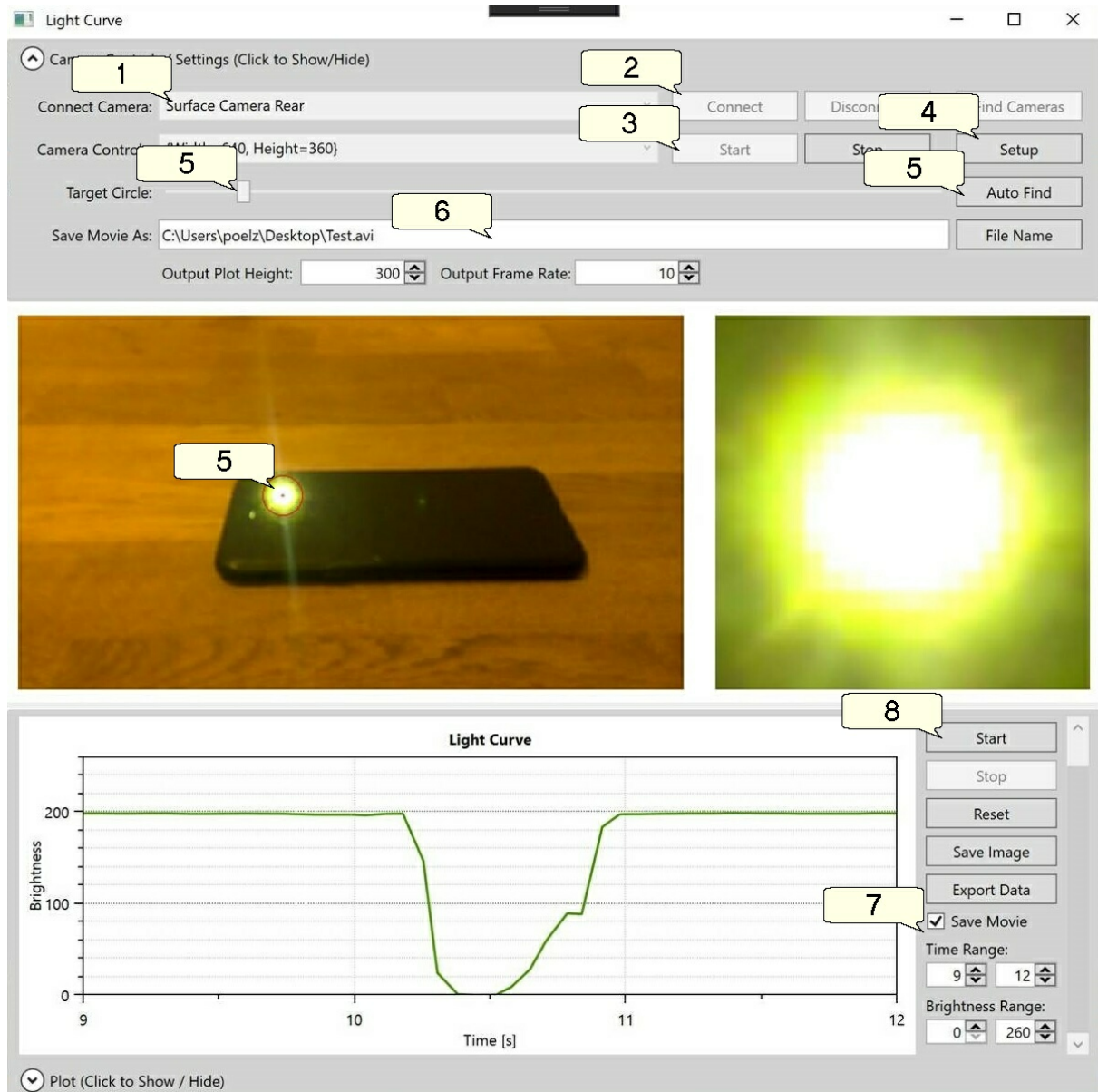
2   User Interface

The user interface has three sections (top to bottom):

- **Camera Controls and Settings**: Can be shown and hidden by clicking the bar at the top. Typically this part is only required for setup and can be hidden when running a recording.
- **The image section**: Here you will see two images, the original webcam image and a close up of the selected target circle
- **The plot areas and recording controls:** This will show the light curve plot and let you start/stop a recording. You can also adjust the plot area, reset it and export it as an image or the captured data as a csv file
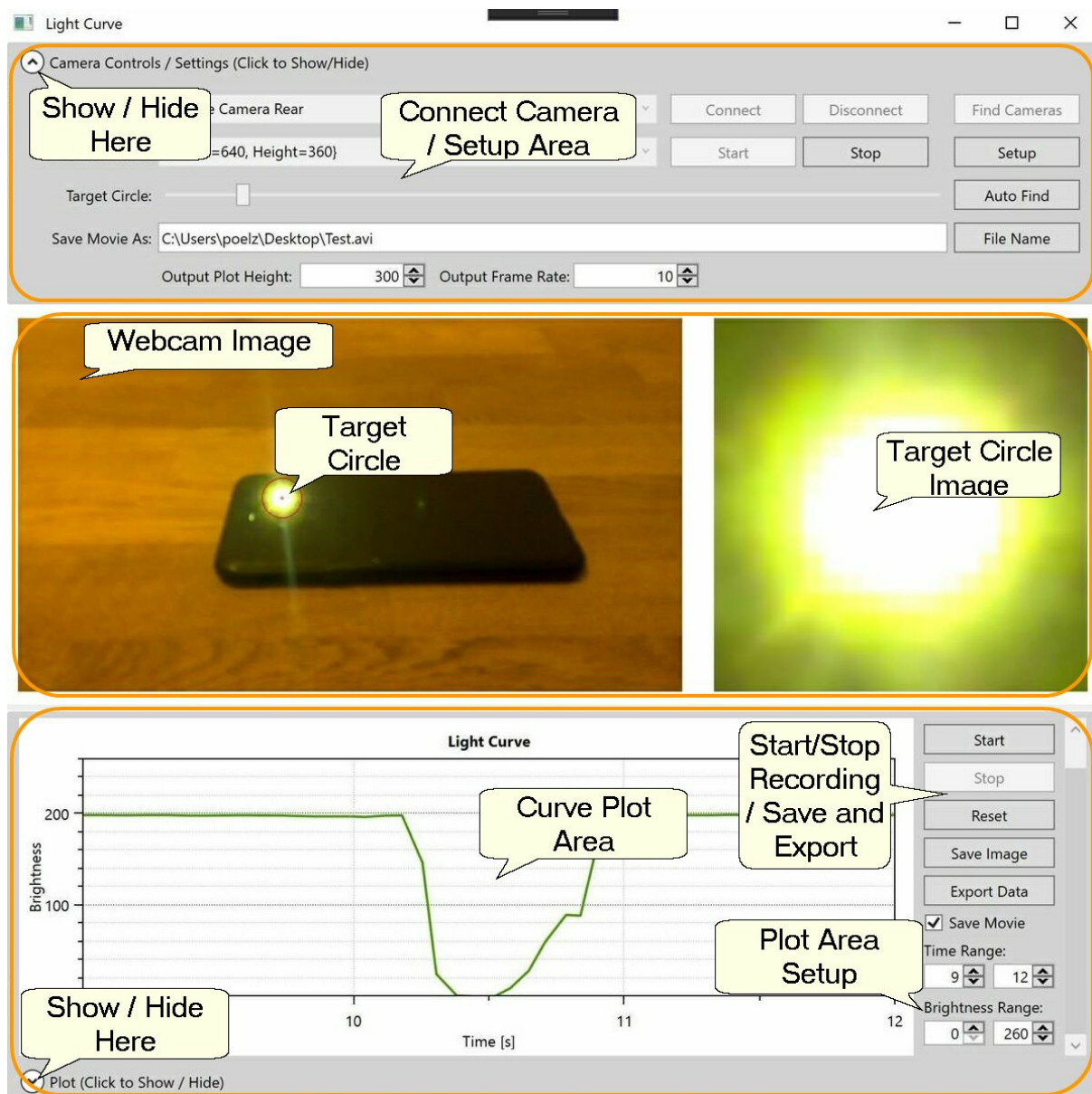
Connect Camera / Camera Setup
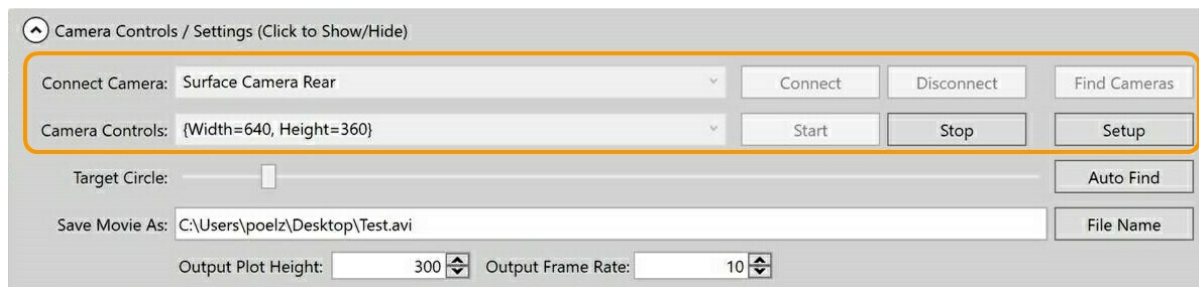
- The application will automatically search for available webcams and populate the drop down box. If you have connected a new camera and cannot find it in the list click 'Find Cameras' to refresh it.
- Select the camera you would like to use from the drop down box and click 'Connect'
- Once connected you can select the required image resolution in the camera controls drop down
- Click 'Start'. This will start capturing images and show them in the image area below.

Please note that the 'Save Movie' option to create a movie of your light curve capture can require a lot of computing power and will cause your webcam stream to slow down. Depending on your computers resources this can be fairly significant. One way to improve this problem is to reduce the image resolution in the drop down box.

Once image capture is started you can also access the camera setup panel by clicking the 'Setup' button. This will give you access to the available controls of your connected camera. Please note that this will differ from camera to camera but in most cases you should be able to control the exposure time of the camera to change brightness levels:
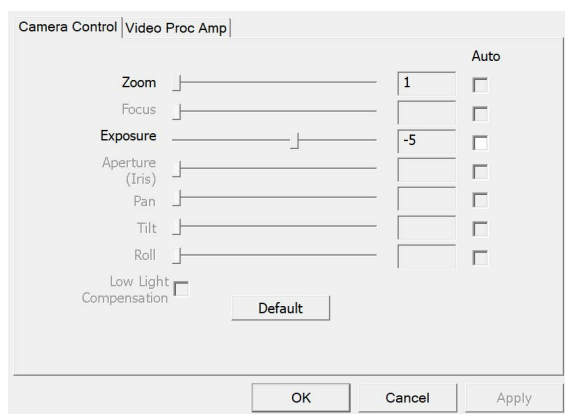
Please not that it is <u>NOT</u> recommended to enable any 'Auto' settings for exposure time, gain or brightness levels. This will change the webcam image during image capture and affect the captured light curve! The application has been programmed to automatically turn off any auto settings but if you find them enabled please disable them.

Select Target Circle
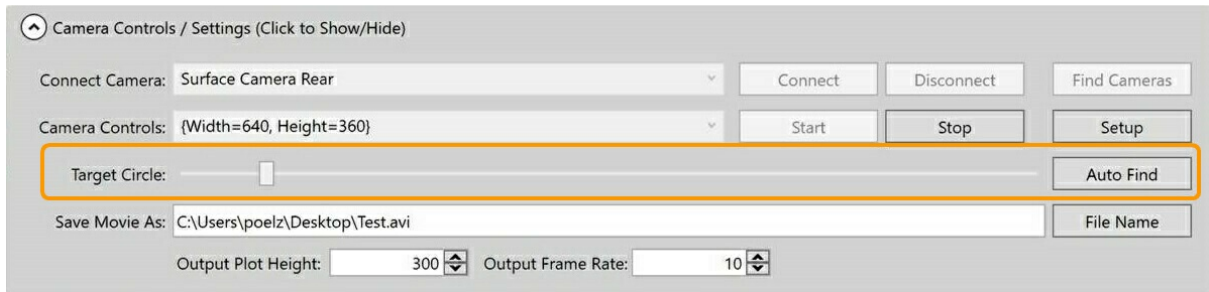
There are several ways to set the target circle location:

- Click the 'Auto Find' button: This will find the brightest light source in the image and fit a circle around it. You can further fine tune the circle using the manual controls
- Double click the desired location in the preview image (image on the left)
- Click and hold the left mouse button on the preview image. The target circle will follow the mouse cursor as long as the left mouse button remains clicked

Once the circle has the correct location you can use the Target Circle slider control to adjust the diameter of the circle to fit the light source.
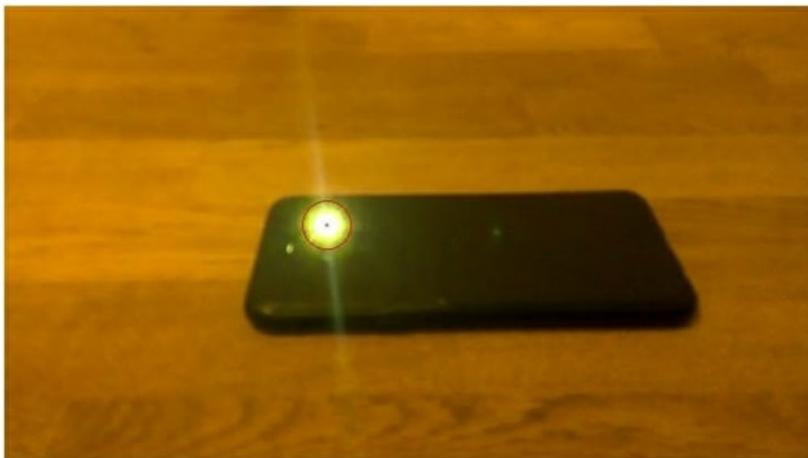
Save Movie Settings
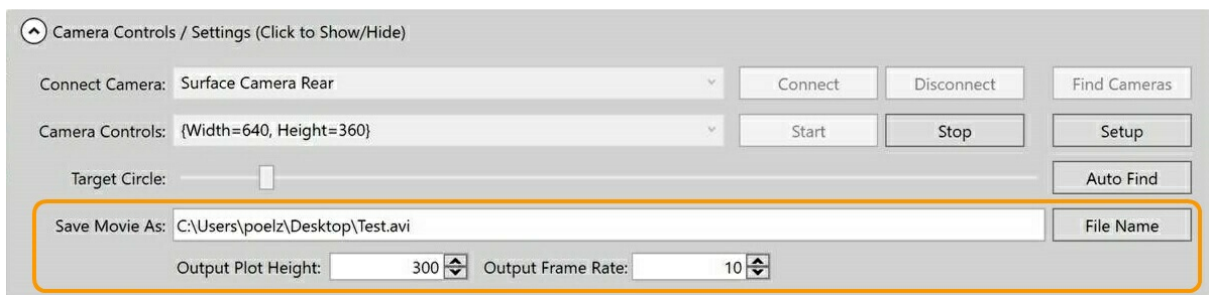
The LightCurve application can capture a movie file which will record the capture of the light curve on the

graph as well as the normal and zoomed in webcam images. The available settings are:

- File name / path: Choose the folder and file name for the movie file
- Output Plot Height: Set the height of the plot area in the movie
- Output frame rate: Determines the frame rate the output video will be created at

Please note that if there is not enough processing power then the frame rate will not be achieved and the created movie will run 'quicker' than normal. If you find that the movie is running fast or jerky, you can try to reduce this setting.
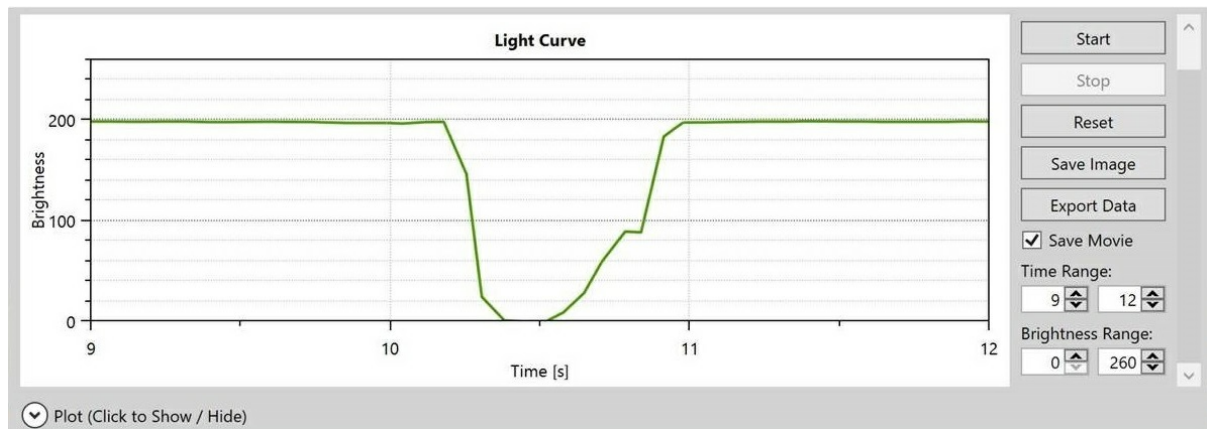
Image Preview

The image preview area will show two images once the camera is started:

- The webcam image
- A zoomed image of the selected target circle

Curve Plot Area

Once everything is setup this area can be used to capture the actual light curve:

- Start: Start (or restart) capturing the light output from the selected target.
- Stop: Stop capturing the light output from the selected target.
- Reset: Clear the light curve plot area and discard light curve data.
- Export Data: Save captured data points (time/brightness) as .csv file.
- Save Movie: If ticked the captured preview images and plot will be saved as a movie file (movie filename, folder and additional settings must be set at the top of the application).
- Time Range: The time range of the x axis of the plot area. The application will automatically extend the plot area if the current recording exceeds the time range setting.
- Brightness Range: The brightness range of the y axis of the plot area.

Please note that when a recording is taking place with 'Save Movie' enabled', two files will appear in the folder the movie is created in:

- YourMovieName.**h264**: This is a temporary file that will be deleted once the movie has been created when the recording has been stopped.
- YourMovieName.**avi**: This is the actual movie file. Please note that this file will also appear during the recording of the movie. It won't be playable however until the movie conversion has been completed after the recording is stopped.

3 Change Log

Version 0.6.0.0 (28/07/2021)

Changes:

- Create installer
- Add user manual

Version 0.5.0.1

Changes:

- Initial Release

4   License

Please Note:

DISCLAIMER:

THE SOFTWARE LICENSED HEREUNDER IS CONSTANTLY IN DEVELOPMENT AND IS PROVIDED ON AN "AS IS" AND "AS AVAILABLE" BASIS AND IS BELIEVED TO CONTAIN DEFECTS. LICENSEE IS ADVISED TO SAFEGUARD IMPORTANT DATA, TO USE CAUTION AND NOT TO RELY IN ANY WAY ON THE CORRECT FUNCTIONING OR PERFORMANCE OF THE LICENSED SOFTWARE AND/OR ACCOMPANYING MATERIALS.

LICENSE AGREEMENT:

PLEASE READ THE TERMS OF THIS SOFTWARE LICENSE AGREEMENT ("LICENSE") WHICH IS PRESENTED ELECTRONICALLY WHEN RUNNING/INSTALLING AND CAN BE VIEWED BY ACCESSING THE "ABOUT" PAGE OF THE SOFTWARE. BY CLICKING OR TICKING ANY FORM OF "AGREE/ACCEPT" TICK BOX OR BUTTON, YOU ARE AGREEING TO BE BOUND BY THE TERMS OF THIS LICENSE. IF YOU DO NOT AGREE TO THE TERMS OF THIS LICENSE, DO NOT USE THE SOFTWARE.

1. General: The software and documentation accompanying this License whether on disk, in read only memory, on any other media or in any other form (collectively the "LightCurve Software") are licensed, or given, to you by the software developer for use only under the terms of this License, and the software developer reserves all rights not expressly granted to you. All Intellectual Property Rights in the Software belong to the Licensor. The rights granted under the terms of this License include any software upgrades that replace and/or supplement the original LightCurve Software product, unless such upgrade contains a separate license.

2. Permitted License Uses and Restrictions: This License allows you to install and use copies of the

LightCurve Software on computers owned by you or on computers you are legally authorized to administer for the intended use as described in the manual. You are not allowed to use the software for any illegal activities. Except as and only to the extent expressly permitted in this License or by applicable law, you may not decompile, reverse engineer, disassemble, modify, or create derivative works of the Software or any part thereof. THE LIGHTCURVE SOFTWARE IS NOT INTENDED FOR USE IN THE OPERATION OF EQUIPMENT IN WHICH THE FAILURE OF THE SOFTWARE COULD LEAD TO DEATH, PERSONAL INJURY, OR PHYSICAL, EQUIPMENT OR ENVIRONMENTAL DAMAGE.

3. Cost: The LightCurve Software is provided free of charge.

4. Transfer: You may not sell, rent, lease, lend or sublicense the LightCurve Software.

5. Termination. This License is effective until terminated. Your rights under this License will terminate automatically without notice if you fail to comply with any term(s) of this License. Upon the termination of this License, you shall cease all use of the LightCurve Software and destroy all copies, full or partial.

6. Disclaimer of Warranties: THE LICENSED SOFTWARE AND, IF ANY, DOCUMENTATION ARE LICENSED "AS IS", AND THE DEVELOPER DISCLAIMS ANY AND ALL OTHER WARRANTIES OF ANY KIND, WHETHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, SUITABILITY, USABILITY OR FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABLE QUALITY, TITLE OR NONINFRINGEMENT OF THIRD PARTY RIGHTS, TO THE EXTENT AUTHORIZED BY LAW.

WITHOUT LIMITATION OF THE FOREGOING, THE DEVELOPER EXPRESSLY DOES NOT WARRANT THAT THE LICENSED SOFTWARE WILL MEET LICENSEE'S REQUIREMENTS OR THAT OPERATION OF THE LICENSED SOFTWARE WILL BE UNINTERRUPTED OR ERROR FREE. THE LICENSED SOFTWARE IS BEING PROVIDED TO LICENSEE "AS IS" WITHOUT WARRANTY OF ANY KIND. LICENSEE ASSUMES ALL RESPONSIBILITY FOR SELECTING THE LICENSED SOFTWARE TO ACHIEVE ITS INTENDED RESULTS, AND FOR THE RESULTS OBTAINED FROM ITS USE OF THE LICENSED SOFTWARE. LICENSEE SHALL BEAR THE

ENTIRE RISK AS TO THE QUALITY AND THE PERFORMANCE OF THE LICENSED SOFTWARE. ANY DOWNLOAD AND USE OF THIS LICENSED SOFTWARE IS DONE AT THE LICENSEE'S OWN RISK AND THE LICENSEE WILL BE SOLELY RESPONSIBLE FOR ANY DAMAGE TO – WITHOUT LIMITATION – ANY COMPUTER SYSTEM OR LOSS OF DATA THAT RESULTS FROM SUCH ACTIVITIES. SHOULD IT PROVE DEFECTIVE, LICENSEE ASSUMES THE COST OF ALL NECESSARY SERVICING, REPAIR AND/OR CORRECTION.

7. Limitation of Liability: IN NO EVENT SHALL THE SOFTWARE DEVELOPER BE LIABLE FOR PERSONAL INJURY, OR ANY INCIDENTAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES WHATSOEVER, INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF PROFITS, LOSS OF DATA, BUSINESS INTERRUPTION OR ANY OTHER COMMERCIAL DAMAGES OR LOSSES, ARISING OUT OF OR RELATED TO YOUR USE OR INABILITY TO USE THE SOFTWARE, HOWEVER CAUSED, REGARDLESS OF THE THEORY OF LIABILITY AND EVEN IF HE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

8. Severability: If any provision in this Agreement is held invalid or unenforceable by a body of competent jurisdiction, such provision will be construed, limited or, if necessary, severed to the extent necessary to eliminate such invalidity or unenforceability. The parties agree to negotiate in good faith a valid, enforceable substitute provision that most nearly effects the parties' original intent in entering into this Agreement or to provide an equitable adjustment in the event no such provision can be added. The other provisions of this Agreement will remain in full force and effect. The same will also apply in the event of any unintended omissions.