

Wearable Web Technology: Google Glass and the Mirror API

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ABSTRACT

Glass is a commercial head-mounted display which is currently being developed by Google. This paper provides a concise overview of the history and context of Glass, a technical overview of the hardware and GUI, as well as an overview of the Mirror API in which applications for Glass can be developed. Furthermore, we discuss the advantages and disadvantages of Glass as well as intended and unintended applications. Finally, we provide the reader with a 'getting started' guide in which the basics of development for Glass are explained.

1. PURPOSE, CONTEXT AND HISTORY

Google Glass is a wearable computer in the form of a headset that looks like a pair of glasses and lets users accomplish various tasks and receive quick information in a smartphone form. The difference is that Google Glass is used hand-free and does not require the user to look away to receive information, which is officially called a heads-up display [1]. Google Glass was created to ease the user's daily and social life by taking the bulky and physical part of technology out of the way to help the user connect to the world in a faster way. It is connected to the Internet, and the user can take photographs, record videos, send and receive messages, and stream live recordings, amongst others [2]. It supports Apps that people can develop for Google Glass using its API, which is called Mirror API.

The idea of having a wearable computer with a heads-up display is not new. MIT researchers Thad Starner and Steve Mann have been working on these devices for almost half a century. Mann stated the idea behind a wearable computer as "Wearable computing, however, is based on the idea that computing is NOT the primary task". He believes that the wearable computer should augment the user's senses [3].

Other companies started working on heads-up displays, perhaps sharing Mann's view, whether knowingly or unknowingly, but with the similar idea to help the user's life. Car companies were one of the first to include commercially-available heads-up displays on their windshields to give the driver information about directions or speed limits.

There are also other entertainment systems that display movies right in front of the user's eyes on the heads-up display. Other devices similar to Google Glass are currently being developed and also in the form of contact lenses [1].

Despite of other alternatives, Google Glass became the most popular and anticipated heads-up display rather quickly after its announcement.

- **April 2012:** Google Glass was announced on Google+ [4]
- **June 2012:** Google posted videos online that were taken with Google Glass while skydiving, recording, amongst others, to give a hint of what people can do with the technology [4]

Also in this month, Google released an "Explorer" version of the Glass for developers to buy for \$1,500 [4].

- **February 2013:** Google started the "#ifihadaglass" contest in which the competitors were asked to post what they would do with Google Glass on Google+ and Twitter. The winners would be awarded with an Explorer edition of Glass with the condition to pay \$1,500 for the device and travel to the United States of America to pick it up [5].
- **April 2013:** Google released the Mirror API for developers to start coding for Google Glass. However, it can only be accessed by people who own a Glass for now [6].

2. OPERATING PRINCIPLES

This section provides an overview of the hardware, software and networking principles of Google Glass and the Mirror API.

2.1 Hardware and Connectivity

Since Glass is a wearable device, it should be non-intrusive, lightweight and robust. The device is therefore made out of an extremely flexible titanium frame with all electronics located inside a container underneath the right side arm. This container also includes a touchpad which can be swiped to scroll through menus, or tapped to select items.

Another way to control Glass is by using voice-commands starting with the initiation statement 'ok glass' followed by the desired function ('take a picture', 'send a message to..' etcetera). This proves to be very helpful in everyday life situations where hands-free controls are required.

In order to provide the Augmented Reality overlay, Glass uses a small projector which beams a 740x360 pixel image into a plastic prism where the rays of light are directly deflected onto the user's retina. The device contains a microphone and camera capable of taking 5 megapixel pictures and record movies in 720p. The recorded media can be stored on 12 gigabytes of available on-board memory. Glass also comes with a build-in bone conduction transducer, transmitting sounds to the inner-ear through the bones of the user and therefore eliminating the need for headphones or earplugs. The device's battery is located behind the right ear and, according to Google, has enough capacity to provide the device with power for 'a typical day of use'. Glass runs on Android 4.0.4 ('Ice Cream Sandwich') and uses the same CPU as the infamous Kindle Reader (OMAP 4430) [7]. The early 'Explorer' edition of Glass contains at least 682MB of RAM memory but Kernel messages suggest a total of 1GB [8]. Google hasn't officially confirmed this.

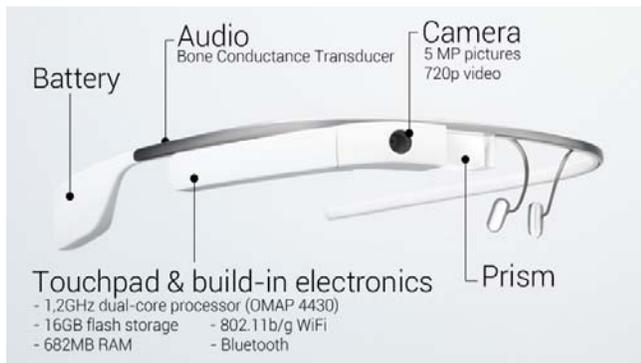


Image: A hardware overview of the Glass device

Although Glass is great for recording videos or taking pictures, the real power of the device lies within its possibility to provide the user with information such as navigational instructions, social-media messages and a wide range of location-based services such as public transport information and weather forecasts.

However, most of these features require some sort of mobile telecommunications technology or GPS. Glass contains a 802.11b/g WiFi and Bluetooth adapter with which it can connect to mobile devices by using a technique known as 'tethering' in order to access shared resources such as GPS information or a mobile data connection. The 'Explorer' edition of Glass supports tethering on both Android- and iOS devices via a special smartphone app [9].

2.4 Interaction and interface

The Glass interface consists of 640 by 360 pixel 'cards' which are displayed on the right side of the users field of vision. These cards can contain text such as notifications and messages but also HTML, pictures and videos. Cards are always displayed one at a time [10].

The main component of the Glass interface is the so-called 'Timeline', a sorted row of cards through which the user can swipe by using the touchpad. The center of this timeline always shows the clock and the 'ok glass' command. Cards to the left display information about the future, such as the weather or calendar-events. Cards on the right contain information from the past, such as messages, videos and photos. Cards can be combined into so-called 'bundles'. A bundle can be recognized by a white 'fold' in the top-right of the card.

By tapping on the bundle card, a new sub-timeline opens and a white bar on the bottom of the card shows the user's location within the timeline [11]. This navigation, consisting of a main timeline, cards and bundles is fixed and provides a intuitive and user-friendly interface. The individual cards however can be styled by using HTML and CSS, although Google strongly suggests using their pre-made templates in order to ensure a consistent user experience throughout Glass [10].

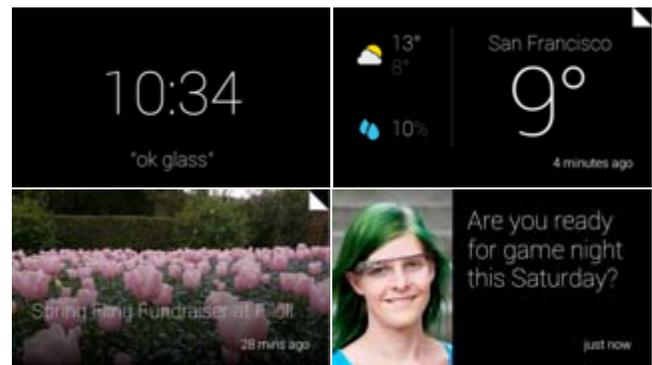


Image: Examples of Glass 'cards' [f1]

2.2 Glass and Web Technology

Although Glass runs on Android, it is not possible to execute services directly onto the device [12]. Applications for Glass are known as 'Glassware' and can be developed by using Google's 'Mirror API'. This API is a set of RESTful services; the style of software architecture several distributed services such as the World Wide Web are based upon [13]. A RESTful service consists of clients that send requests to servers and servers that process these requests and return appropriate responses. Both client and server continuously transfer representations of resources, keeping each other abreast about data available. RESTful services are stateless, which means that they treat each request as an individual transmission. RESTful services use HTTP methods such as 'GET', 'POST', 'PUT' and 'DELETE', to request, supply, replace and delete data [14]. Since the

Mirror API is fully web-based, Glassware is always server-side and can be developed in Java, PHP, Python, Go and .NET. Because of this approach, the only way of interacting with Glass is through the cloud [13].

Cloud computing, as used in Glass, is a technology that allows a large number of devices to access and interact with one or multiple services simultaneously [15]. Glassware is deployed to the Google App Engine which is a type of cloud service known as 'PaaS' (Platform as a Service). This distributed development platform allows developers to build and manage their Glassware without having to worry about hosting, scalability and hardware maintenance [16]. The Glassware built within the Google App Engine can be considered 'SaaS' applications (Software as a Service). These applications run within the cloud and can connect to a large number of clients (users) simultaneously.

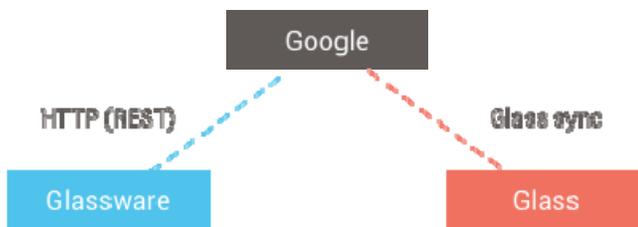


Figure: Stack showing the communication between Glassware and a Glass device using Google's Cloud [f2]

Because the applications are approached via the Internet, users don't have to worry about installing and updating Glassware and can easily manage with which applications they want to share information.

Users simply select the Glassware they want to use and give the application permission to access their data by sending credentials. The application then stores these credentials and returns a new contact-request to the user through which he or she can access the service. The user is now able to share data such as commands, media and location-based information with the application that runs within the cloud. After receiving data from the user, the application selects an appropriate response which is delivered to the user immediately after Glass syncs with the cloud [17].

3. STRENGTHS AND WEAKNESSES

This section focuses on the strengths and weaknesses of the hardware, software and connectivity. It's important to mention that Glass is still in development. The pro's and con's in this section are partly derived from the experience of users who obtained the early 'Explorer' version of Glass.

3.1 Strengths

3.1.1 Web Technology

The use of a web-based API which supports a wide range of popular programming languages offers a large number of advantages for developers. It's extremely easy to implement

Glass features in existing web applications and it's also possible to communicate with already-existing databases. The large advantage of the cloud-based approach is the scalability of each application and the possibility to manage applications using a simple dashboard. This reduces the costs of a software-development trajectory significantly.

Although the used web technology is obviously invisible to the average user of Glass, it nevertheless offers several interesting advantages. Because Glassware only runs in a Google-moderated cloud, users can be sure that the Glassware they use is secure, which is of extreme importance concerning the privacy-sensitive nature of the device. Furthermore, users don't have to install or update any firmware or applications on their device since Google does this automatically each month [12]. On a final note, users won't be bothered by advertisements since Google doesn't allow developers to display ads on Glass [18].

3.1.2 Hardware

The decision to run applications externally and distribute several hardware functions to a separate device results in a robust, lightweight and stylish device which is truly unobtrusive and therefore suitable for everyday use. By including WiFi functionality, users don't have to use 3G tethering all the time which is very convenient to those who like to share media but don't have an extensive data-subscription.

Both the nose-pads and prism of Glass can be adjusted in position to ensure a comfortable usage of the device throughout the day. The frame itself is made out of flexible titanium which makes Glass a true 'one size fits all' device and accessories such as UV-protecting clip-on sunglasses can be purchased to personalize Glass even further.

3.1.3 Usability & GUI

Designing a user-interface for a new technology is extremely difficult and poses interesting challenges concerning usability and aesthetics. As usual, Google did a great job in designing and documenting a powerful clear interface while still maintaining the recognizable Android look. Various design-guides, templates and best-practices are available on the Google Developers website which makes designing consistent and well-formatted applications for Glass easy [10].

The use of a touchpad to slide through timelines and select items resembles the common use of a touchscreen in mobile devices and is therefore a very intuitive way of controlling Glass. The navigational structure in Glass consisting of a chronologically ordered timeline feels familiar and is extremely powerful in its simplicity and efficiency, although it might become more difficult to navigate as the number of cards on one's timeline increases. This is partly resolved by automatically deleting items from the timeline after 7 days. These items can still be accessed via Google's

servers for a maximum of 30 days [11]. The concept of a timeline which chronologically orders items is extremely powerful in both its efficiency and simplicity.

By making the most popular features available via voice-commands, Glass creates an environment in which users can interact with information and technology in a quick and unobtrusive way which is perfect for mobile use.

3.2 Weaknesses

3.2.1 Web Technology

Since each piece of Glassware has to run within Google's cloud, Google will always be in control of the content displayed on Glass. Developers have to comply to Google's terms and conditions which doesn't only result in limitations concerning application functionality and design, but might also pose a threat for users of Glass. Google's largest income is derived from targeted, online advertisements [19]. A pair of high-tech glasses, packed with a camera, microphone and WiFi adapter capable of determining the user's location sounds like the perfect device to collect valuable information about the daily life of its user, ultimately resulting in better-targeted advertisements. Because of the developer policies mentioned earlier, any sexually explicit, violent or dangerous material is banned from Glass, as well as gambling applications [18].

Another weakness of Glass lies within its shared data-connection with a smartphone over Bluetooth or WiFi (tethering) which is necessary to use the majority of Glassware and build-in functions on the go. This doesn't only require a decent smartphone and sufficient 3G-subscription, but also causes the smartphone's battery to drain rapidly, especially when GPS is enabled as well [20].

The biggest drawback however was already mentioned briefly, but deserves a more extensive explanation. Several developers who had a first glance at the Mirror API were extremely disappointed by the fact that applications are solely web-based and running code on the device itself is impossible. This, in combination with the fact that the prism of Glass only allows a relatively small display, applications which contain full Augmented Reality features such as image registration and object tracking are off the table, resulting in a head-mounted display (HMD) rather than an Augmented Reality device [21] often suggested by the media.

3.2.2 Hardware

Some concessions had to be made in order to keep the Glass device lightweight and comfortable. Unfortunately, this results in an extremely limited battery capacity, and early users of Glass were not pleased to find out that the battery was completely drained after recording 30 minutes of video [22].

Another often heard issue concerning the hardware is the low audio level caused by the use of a Bone Conduction Transducer instead of regular speakers or earphones. Because of this, it is nearly impossible to make phone calls, listen to music or watch a video in noisy environments [23].

The dimensions of the prism and the fact that it only covers one eye can be considered both a strength and weakness. It definitely adds in the unobtrusive nature of Glass, but also makes it technically impossible to display extensive content or implement full Augmented Reality. On a final note, it turns out to be quite difficult to see the display in bright daylight [23].

3.2.3 Usability & GUI

The user interface of Glass proves to be very successful and the only weakness can be found in the responsiveness of the voice-commands used to control Glass. Bystanders can easily take control of the device by saying 'Ok Glass' followed by a command. Although these commands can be canceled by quickly swiping down on the touchpad, it turns out to be quite bothersome when this happens frequently [24].

Two final weaknesses concern usability and communication. First of all, a Google+ account is required in order to use Glass. This can be considered a minor weakness to those not interested in using Google's social platform. Luckily, messages can be sent to members of other social media (such as Facebook, Twitter and Tumblr) as well by using third-party Glassware.

Secondly, it's only possible to send messages, make calls and share media with a total of ten contacts [25]. This can be considered a huge drawback for people with a large number of contacts and limits the functionality of Glass significantly.

4. INTENDED APPLICATIONS

Head mounted displays such as Google Glass offer an almost infinite number of possible applications in a wide variety of fields. This section discusses some of the basic functionalities of Glass and possible future applications.

4.1 Informational purposes

The sentence "*Glass should be there when you need it, and out of the way when you don't*", which is often used by Google in explaining the philosophy behind Glass, summarizes one of the most important features of the device; displaying useful information in specific situations or contexts. Using current Glassware it is already possible to view stock information, check the weather forecast, read the latest news headlines and receive fashion tips [24], but these applications are just the beginning..

The RESTful Mirror API is perfect for quick exchange of information derived from sources all over the Internet and seamlessly integrates with popular Google services such as

Google Calender and Maps. Because Glass contains a WiFi chip and can be paired with mobile devices, it is possible to use location-based services providing the user with realtime information such as interesting places nearby and public transport schedules. This also allows third-parties to develop Glassware that makes it easy to locate specific stores or order location-dependent services such as food or a taxi. And while sitting in that taxi, the user can easily keep track of the costs and predicted time of arrival [26].

In the future, it might even be possible to scan bar codes of products, resulting in Glassware capable of finding reviews, comparing prices and displaying general product information. This can, of course, be combined with the user's current location in order to find better deals nearby or display special offers and coupons [26].

Another application of Glass is the possibility to turn the device into the ultimate 'how-to' guide capable of displaying step-by-step instructions on a wide range of topics. Learning how to cook a certain dish, repair a broken item or play the piano will be easier than ever before. This application is also very promising in providing people who are suffering from mental conditions such as autism or dementia with an easy-to-understand manual for common tasks or situations [27].

Although Glass itself doesn't contain sensors, it doesn't mean that external sensors can't be connected to Glass using Bluetooth. This makes biofeedback [28] applications possible, measuring several body functions such as heart rate, blood pressure and skin resistance. Results of these measurements can be outputted to the user's Glass directly or can be used to monitor the health of a patient in medical appliances. The use of biofeedback is also very suitable in Glassware focusing on sport and exercise. Users will be able to keep track of their progress, speed, distance and burned calories.

But aside from its use in personal and medical applications, Glass is very promising for professionals as well. Think of firefighters who can keep track of their oxygen supply, receive detailed building-plans and monitor the level of toxic gases while entering a burning property, or pilots who receive real time information on weather conditions and altitude. Glass might even prove to be helpful for order-pickers and postmen, making it easier to locate and deliver parcels.

4.2 Communication

Since Glass is equipped with a camera, microphone and bone conductance transducer, it is a very suitable device for communication. Using Glass, it is possible to select a maximum of ten contacts or groups with which messages and media can be shared and phone calls can be made.

Video calls with friends are possible using Google+ hangout. This was one of the earliest features of Glass and

was first presented at the Google I/O developers conference in San Fransisco where skydivers, abseilers and mountainbikers shared their points of view live with the audience [29]. Although video conferencing currently only works through Google+, it is not unlikely that third-party application such as official Skype Glassware will be released in the near future.

Sending and receiving status updates, pictures and videos to friends is possible using third-party applications. Although most applications are still very basic in functionality, there is already Glassware available for major networks such as Facebook and Twitter [30].

By connecting Glass to an Android or iOS smartphone using Bluetooth, it is possible to make and receive text-messages and phone calls, transforming Glass into a wireless headset. Since the Mirror API is based upon RESTful services, a possible application is exchanging resources such as text and graphics during phonecalls. This allows "remote assistance" which is extremely helpful in, for example, emergency situations where the 911 operator can send easy-to-understand instructions on how to perform first aid [26].

Glass also supports language processing, including real time translation of spoken text into a wide variety of languages. Future appliances might include Glassware capable of translating spoken text into subtitles which would be extremely helpful for people suffering from hearing impairments. But aside from natural languages, Glass might even be able to communicate with machines in the future, extending the user interface or displaying instructions on how to use a specific function of the device [26]. Glassware could be paired with televisions and consoles in order to display additional information while watching your favorite show or playing a game. In theory, the communication with existing payment services such as Google Wallet, Paypal and iDEAL is possible as well, although this might be a bad idea concerning the current hackability of Glass. (see section 5 'Unintended Applications').

4.3 Media and Entertainment

A final application of Glass can be found in media and entertainment. Glass can be used to take 5 megapixel pictures and capture video at 720p quality, which makes the device perfect to capture your everyday life on camera. Media recorded with Glass can be stored on the 14 gigabytes of available memory, or can be shared on Instagram (pictures), Google+, Facebook and Youtube.

Glass can also be used for playing games, as Google proves by releasing the first Glass-game called 'Ice breakers'. In this game, the user of Glass gets a notification when other players are around. The goal of the game is to meet other players, take a picture and review the conversation in order to earn points [30].

5. UNINTENDED APPLICATIONS

Google allows third-party applications to be developed using the Mirror API. Naturally, this can cause Google Glass to be misused. Although Google Glass might be a closed-platform device when it is released, currently it appears to be open-platform. Below are examples of how this technology is and can be misused.

5.1. Hacking

It was recently discovered that Google Glass can be hacked and the user's data, including their location, photographs, videos and messages amongst others, can be accessed by hackers. It is already possible to find many people exploiting bugs on Google Glass to warn both the users and Google of the security issues that the current Explorer edition of the device has.

For instance, a security issue was found which lets people gain access to someone's Glass in only a minute. This attack can be done scarily fast and easy by only physically being in the same place as the owner of the Glass. The attacker just needs another Android device in order to gain access to the data of the Glass owner.

The biggest concern with this security issue is that once they have access to a Glass, they can see its contents and gain control over its components any time they want. Normally, most people want to wear the Glass all the time; when they are working, studying, walking. This means that if their devices get hacked, the attacker can see through the hacked Glass' video camera, for example, as the user types in passwords on the computer. Using this hack, the attacker can gain access to the user's accounts quite easily [31].

5.2. Abusing Facial Recognition

In October 2012, Google was said to be buying Viewdle, a Ukrainian company that specializes in facial recognition technology. It was going to be used to automatically tag the user's friends on photographs that are taken with Google Glass. While this functionality can be very useful for also other purposes, for instance, finding friends in crowded places, it can also be easily abused. Most people would not like to know that Glass owners can get all the information available about themselves simply by looking at them with the device using apps. However, it was unclear whether or not Google bought Viewdle in the end [32].

As the Explorer edition of Google Glass got more and more tested by many people, more concerns about the possibility of Google integrating and/or approving third-party apps with facial recognition have been raised. So much so that Google Glass product director Steve Lee responded to these concerns in May 2013, stating that facial recognition does not exist on the current version of the device, although they have experimented with it before. He also added that having facial recognition can be a possibility in the future [33].

At the end of May 2013, a company called Lambda Labs

developed a software that allows facial recognition on Glass via a hack. It asks people to take photographs first and then tag people in them with information. It was stated that the future releases could include real-time facial recognition [34].

However, after the continuation of opposition and concerns about facial recognition, and perhaps after the new app mentioned above, Google strongly made it clear that they will not include the technology without setting privacy rules for it first and will not approve any third-party apps that support facial recognition. They also released new terms and conditions to make sure that people do not develop apps for facial recognition. Nevertheless, it is worth mentioning that they did not discard the possibility of having it in the future [35].

5.3 Privacy Concerns

By using Google Glass, anyone can be recorded anywhere at any time. Most people would find it uncomfortable to know that they can be recorded by a stranger. In the current Explorer version of the device, there is a light in the prism of the Glass when the video camera is on. However, what the people that tested the device have noticed was that people in front of them usually have no idea what is going on and how the device works, and consequently, they do not notice that they are being recorded [36].

For instance, Joshua Topolsky from The Verge who tested Google Glass mentioned in his review of the device that as part of the testing, he and Google representatives went to Starbucks in the city along with Topolsky's camera crew. He states that the people working in Starbucks immediately asked the camera crew to stop filming. However, according to Topolsky, who were wearing the Glass and recording with it, no one noticed that in fact he did not stop filming [36]. Some people might exploit this as it is not similar to taking a phone or camera out and holding it to take a photograph. People would be "wearing" the device and no one could tell if they are recording random people or using their devices innocently.

Another example is of a bar in the United States of America that already banned Google Glass in its premises before it is even released. The reason is that they share the same concern as some people about privacy issues that come with the device. They stated that they simply do not want to have the risk of their customers being abused by people that misuse Google Glass [37].

6. GETTING STARTED

In this section, it will be described how to start developing for Google Glass using the Mirror API. It should be noted that since the device is not released to the public yet, currently only the people who are part of the Explorer program and possess the Explorer edition of Glass can use the Mirror API [6].

To develop for Google Glass, it is possible to choose between five programming languages; Java, PHP, Python, Go, and Microsoft .NET [38]. In this paper, we chose Java because we are more familiar with it than the other two languages.

6.1. Requirements

To start coding in Java to implement a Glassware using the Mirror API, you first need to download and set up all the software needed [39]:

- Java 1.6
- Java SE Development Kit (JDK)
- Apache Maven
- Eclipse
- Google Plugin for Eclipse
- Google App Engine SDK for Java

6.2. Setting Up

In this section, instructions on how to set up each of the software mentioned in the previous section can be found.

6.2.1. Java 1.6

You need to have minimum Java 1.6 downloaded on your computer, which can be accomplished by downloading the software from Oracle’s website

<http://www.oracle.com/technetwork/java/index.html>

6.2.2. Java SE Development Kit (JDK)

Java Development Kit is needed for developing Java applications and executing a software project management tool, such as Apache Maven. This can be downloaded from

<http://www.oracle.com/technetwork/java/javase/downloads/index.html>

6.2.3. Apache Maven

A software project management tool is needed for the build process of Glassware. Google suggests using Apache Maven for this task. Unless you want to build Maven yourself, you have to download the binary distribution of Maven 3.0.5., which can be found on the following website

<http://maven.apache.org/download.cgi>

Now you need to set up Apache Maven [40]:

1. First you need to unzip the download to the *C:\Program Files\Apache Software Foundation* directory, which will create the subdirectory *apache-maven-3.0.5*.
2. Now you need to access the environment variables of your computer from *Control Panel – System and Security – Advanced System Settings*. This will prompt

a system window (see Figure 1), where you can find the *Environment Variables* at the end.

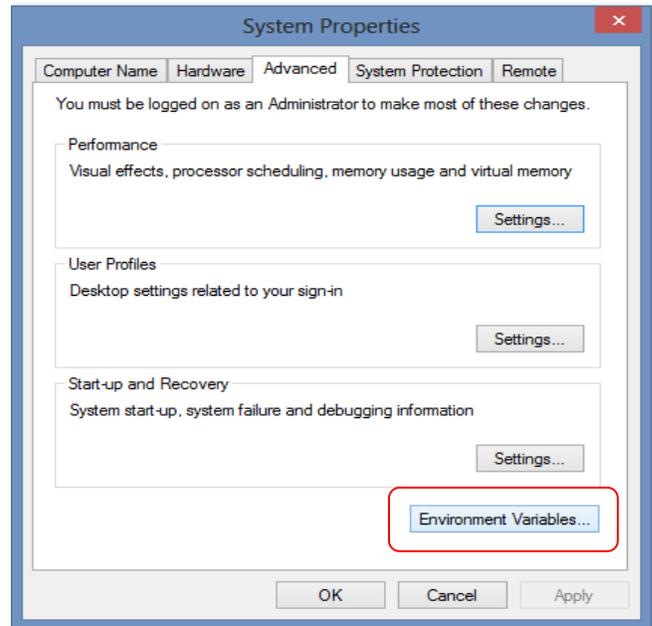


Figure 1. Accessing environment variables

3. Clicking on the *Environment Variables* button will prompt another window in which you need to add the *M2_HOME* environment variable in the user variables by clicking on the *New* button. You need to set the variable name as “*M2_HOME*” and the value “*C:\Program Files\Apache Software Foundation\apache-maven-3.0.5*” (see Figure 2).

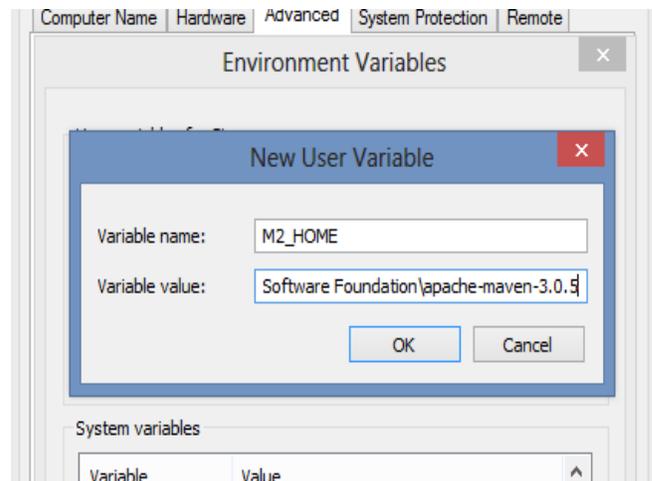


Figure 2. Adding a new user variable

4. In the same way, also add the *M2* environment variable in the user variables. Set the name as “*M2*” and the value “*%M2_HOME%\bin*”.
5. Also add or update the *Path* environment variable in

the user variables and set the value as "%M2%".

6. In the same window (see Figure 3), make sure that JAVA_HOME appears in the user variables or system variables and its value is set to the location where your JDK is.

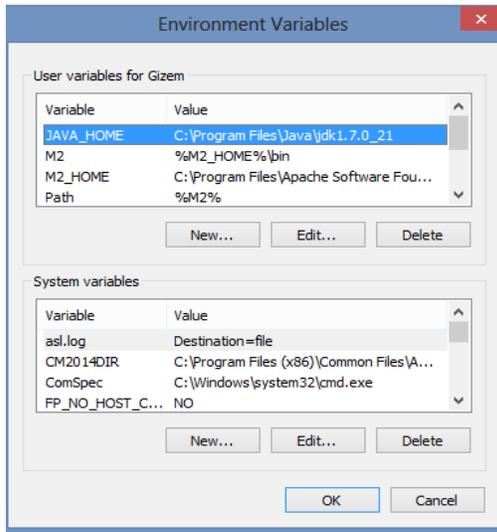


Figure 3. Adding/updating JAVA_HOME variable

7. Finally, you can check if you correctly installed everything by opening *Command Prompt* and writing "mvn -version".

6.2.4. Eclipse

You need a development environment to create apps for your Glass. Google has a plugin that works with Eclipse, therefore it is recommended to download Eclipse as the development environment. You can download Eclipse IDE for Java EE Developers from

<http://www.eclipse.org/downloads/>

6.2.5. Google Plugin for Eclipse and Google App Engine SDK for Java

You can download the Google Plugin that includes everything you need to create Glassware. There are plugins for each version of Eclipse, starting from Eclipse 3.3 (Europa). In this paper, we will use Eclipse 4.2 (Juno). Please refer to the following website to see the locations of the plugins for the previous versions of Eclipse.

<http://developers.google.com/appengine/docs/java/gettingstarted/installing>

You also need Google's App Engine Software Development Kit for Java to develop and deploy projects. You can download it from

<https://developers.google.com/appengine/downloads#GoogleAppEngineSDKforJava>

You can install both the plugin and SDK with Eclipse's

Software Update feature [41]:

1. Start Eclipse and click on *Help – Install New Software*. In the dialog that is prompted, enter the following location in the "Work with" text box:

<https://dl.google.com/eclipse/plugin/4.2>

2. Click on *Add* and enter the same location in the "Location" text box, leave the "Name" text box empty, and click OK.
3. Click on the drop down menu icon in front of "Google Plugin for Eclipse" and "SDKs", and check the boxes (see Figure 4) next to "Google Plugin for Eclipse 4.2" and "Google App Engine Java SDK".

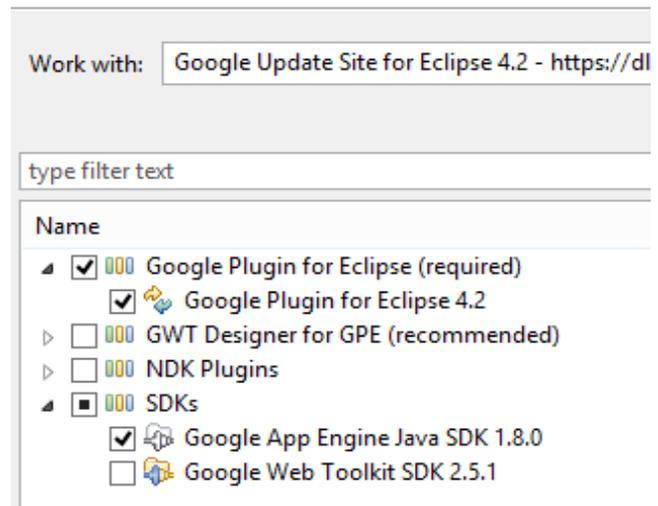


Figure 4. Installing the Google Plugin and SDK

4. Click on *Next* and restart Eclipse after the installation is complete.

6.3. Creating Your First Glassware

As it was mentioned before, the current version of the Mirror API can only be used by the people that own a Glass. Therefore, in this section, we cannot show how to upload Glassware onto the Google Cloud, but we will show how to write a simple program for Google Glass.

You can create a new project on Eclipse to start developing for Google Glass. To do this, you have to click on *File – New – Web Application Project*. This will prompt a dialog, in which you can give a name to your project. Also, make sure to uncheck *Use Google Web Toolkit* and check *Use Google App Engine* [42].

6.3.1. Inserting a Timeline Item

You can insert a timeline item with the following lines of code [11]:

```
TimelineItem timelineItem = new TimelineItem();
timelineItem.setText("Hello World");
```

```
service.timeline().insert(timelineItem).execute();
```

The first line defines a new `TimelineItem` called `timelineItem`. You can write the text that you want to be displayed on your timeline item with the second line. Lastly, you need to insert your new timeline item. To do this, you need to access your general timeline that has all your other timeline items, insert your new timeline item, and execute it. Upon compiling this program and uploading it to the Cloud, you will get a response code stating that your item has been created. Your new timeline item is ready (see Figure 5) [11].



Figure 5. Inserting a new timeline item

6.3.2. Inserting a Timeline Item with an Attachment

You can also insert a new timeline item with attachments, such as images and videos. You first need to upload your attachment using the Media Upload on Google's Mirror API. The following lines of code will allow you to attach an onto a timeline item [11]:

```
TimelineItem timelineItem = new TimelineItem();  
timelineItem.setText("A solar eclipse of Saturn. Earth is  
also in this photo. Can you find it?");  
InputStreamContent mediaContent = new  
InputStreamContent(contentType, attachment);  
service.timeline().insert(timelineItem,  
mediaContent).execute();
```

The only thing that is different than just inserting a simple timeline item can be seen in the third line. You need to define it as an `InputStreamContent` and name it `mediaContent`. You also need to specify the content type, which can be "image/jpeg" in this case. In the next line, you need to add your new `mediaContent` by inserting it onto your general timeline. After executing and uploading the program, you will have an image on your new timeline item (see Figure 6) [11].



Figure 6. Adding an attachment on a timeline item

7. FINAL THOUGHTS

Ever since the first portable computers arose, technology has conquered its place in our everyday lives. To many, living without the presence of smartphones is almost unimaginable as technology keeps us in contact with each other and makes our daily lives easier. Because of the increased use of smartphones, tablets and other mobile devices, hardware is getting more and more in the way. By introducing Glass, Google offers an exciting new way of integrating technology in our everyday lives and marks the beginning of a new era in computing.

We are very glad that Google decided to release the Explorer edition of Glass so early in the development trajectory, enabling developers and enthusiasts to join their exploration into the world of wearable computers and head mounted displays. Although there are still some serious bugs and disadvantages to Glass, including the lack of direct mobile communication technology and not supporting Augmented Reality, the device is still under development and is improving every single day. Google made a clever decision by choosing a web-based approach using RESTful- and Cloud-based services. This results in an easy-to-use API and ensures Google in keeping control over their project, while making the development of Glassware very accessible.

Glass shows us some of the many promising applications of head-mounted displays and will hopefully trigger other companies to develop more advanced glasses, ultimately resulting in the perfect interface between the real- and virtual world.

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